ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES SCHOOL OF MEDICINE

DEPARTMENT OF ANESTHESIOLOGY CRITICAL CARE AND PAIN MEDICINE

EFFICIENCY OF BLOOD UTILIZATION IN ELECTIVE SURGICAL PATIENTS AND ASSOCIATED FACTORS IN ADDIS ABABA, ETHIOPIA FROM NOVEMBER 2023 TO APRIL 2024. A MULTI-CENTER PROSPECTIVE STUDY

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THESIS REPORT

This is to certify that the thesis prepared by Yidersal Demsie entitled:

"Efficiency of Blood Utilization in Elective Surgical Patients and Associated Factors in Addis Ababa, Ethiopia from November 2023 to April 2024." Submitted in partial fulfillment of the requirements for specialization in Anesthesiology Critical Care and Pain Medicine complies with the regulations of the University and meets the accepted standards for originality and quality.

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By my signature below, I declare and affirm that this thesis is my original work. I have adhered to all ethical principles of scholarship in its preparation, including data collection, data analysis, and completion. All scholarly content included in this thesis has been properly cited. I affirm that I have referenced all sources used and have made every effort to avoid plagiarism. This thesis is submitted in partial fulfillment of the requirements for a specialty in Anesthesiology, Critical Care, and Pain Medicine at AAU. I also declare that this thesis has not been submitted to any other institution for the award of any academic degree, diploma, or certificate.

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CONTENTS

Abbreviations

FFP - Fresh Frozen Plasma

%T - Transfusion probability

PRBC - Pack Red Blood Cell

C|T ratio - Cross-match Transfusion ratio

CRC - Concentrated Red Cells

FNHTR - febrile nonhemolytic transfusion reaction

WHO - World Health Organization

OR - Operation Theater

EBV- Estimated Blood Volume

EBL-Estimated Blood Loss

TASH - Tikur Anbessa Specialized Hospital

MH – Menelik II Hospital

SPSS - Statistical package for the social science

TACO – Transfusion-associated circulatory overload

TAS – Transfusion-associated sepsis

TI - Transfusion index

TRALI – Transfusion-related acute lung injury

TTI - Transfusion transmitted infection

GMH- Gandhi Memorial Hospital

EBRS: Emergency Blood Releasing System

TTI-Transfusion transmitted infection

LGH - Lancet General Hospital

FMOH: Federal Ministry Of Health

GSH: Group Save and Hold

Obs/Gyn: Obstetrics and Gynecologic department

ENT-Ear Noth and Throat Surgery

ASA: American Society of Anesthesiology

COR: Crude Odd Ratio

AOR: Adjusted Odd Ratio

MSBO: Maximum Surgical Blood Ordering

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Abstract

Background: Blood transfusion is vital for managing patients with significant blood loss preoperatively. However, over-ordering of blood is prevalent, resulting in increased costs and resource wastage. Implementing various transfusion indices can help reduce unnecessary blood requests for elective surgical patients without compromising patient care.

Objective: To assess the efficiency of blood utilization in elective surgeries and associated factors at different hospitals in Addis Ababa from November 1, 2023, to April 30, 2024.

Methods: A multi-center cross-sectional analytical study was conducted over a period of six months from November 1, 2023, to April 30, 2024, at TASH, MH, GMH, and LGH. Using sequential sampling and a structured checklist, data were collected from all elective surgical patients during this period. Collected data were coded, entered into a Google form and Excel, and analyzed using SPSS version 26. Blood utilization was assessed using various parameters including cross-match to transfusion ratio (C/T), transfusion probability (%T), transfusion index (TI), and Maximum Surgical Blood Ordering Schedule (MSBOS) based on Mead's criterion for common surgical procedures. Bivariate binary logistic regression analyses were employed to identify independent predictors of intraoperative blood transfusion, with odds ratios and 95% confidence intervals estimated for each predictor. Statistical significance was considered at a p-value ≤ 0.05.

Results: A total of 574 elective surgical patients (30% from TASH, 26% from MH, 22% from GMH, and 22% from LGH) participated in the study; with 22% (126 patients) receiving intraoperative blood transfusions. From all, 469(81.7%) had blood requested and prepared. The cross-match to transfusion ratio (C/T) was 4.5(C/T<2.5 is indicative of efficient blood usage), with a transfusion probability (%T) of 26.8% (%T>30% is considered efficient blood usage), and a transfusion index (TI) of 0.39(TI>0.5 is considered efficient blood usage), leading to a Maximal Surgical Blood Order Schedule (MSBOS) of 0.59.

Independent predictors of intraoperative blood transfusion that we get from this study include ASA class III and above (p=0.000), ASA class II(p=0.018), Patient Transfused Preoperatively (p=0.000), Intraoperative blood

loss > 15% ($p=0.000$), Duration of surgery greater than three hours ($p=0.017$), Type of Anesthesia (General Anesthesia) ($p=0.002$), of the study groups.

Conclusion and Recommendations:

In this study, we observed that there is a concerning disparity between the quantity of blood requested and cross-matched for elective surgery patients and the actual amount utilized. This excessive cross-matching results in resource wastage, heightened workload, and increased financial burden. Moreover, it poses potential challenges to the blood supply, prompting a need to revise our blood requisition protocols. To optimize blood utilization, we recommend revising the current blood ordering pattern and minimizing over-ordering. This can be achieved by implementing an updated Maximum Surgical Blood Order Schedule (MSBOS) tailored to our institution, alongside an emergency blood-releasing system. Utilizing parameters such as Crossmatch-to-Transfusion (C/T) ratio and Transfusion Index (TI) can guide the development of the MSBOS, with consideration for a Group Save and Hold (GSH) for procedures with low TI values. Regular surveillance of utilization patterns and feedback mechanisms are essential for continuous improvement in transfusion practices

CHAPTER ONE

INTRODUCTION

1.1 Background

Blood transfusion was first documented in 1666 when Richard Lower experimented by transferring blood between animals. James Blundell, an obstetrician in London, is recognized as the first person to successfully transfuse blood from one human to another. The ABO blood grouping and antigen-antibody typing were developed by Karl Landsteiner in 1901. (1).

Blood transfusion is crucial for managing patients who experience major blood loss during the perioperative period. Once blood is cross-matched for a patient undergoing elective surgery, it remains reserved for that patient for up to 48 hours. This can lead to shortages for other patients in urgent need of blood for life-saving procedures. (2,3)

In the late 1970s, studies began examining blood ordering and transfusion practices due to the increasing demand for blood products, rising costs, and associated morbidity. There has been a growing body of evidence supporting lower transfusion thresholds and highlighting the risks of transfusions. (4)

Unnecessary blood requests for elective surgical patients can be reduced using various methods without compromising patient care. Different authors have suggested using the cross-match-to transfusion ratio (C/T) to evaluate blood utilization practices. The C/T ratio was first used in 1975 by Boral and Henry. Mead et al. introduced the probability of a transfusion (%T) in 1980, suggesting that over 30% of cross-matched blood should be transfused. (2,3)

The transfusion index (TI), which measures the average number of units transfused per patient, indicates efficient blood usage if it is 0.5 or more. Blood conservation policies, such as the Maximal Surgical Blood Order Schedule (MSBOS), limit unnecessary transfusion practices. The MSBOS, equal to 1.5 times the TI, estimates the amount of blood needed for individual procedures based on institutional usage statistics. (2,3)

In Ethiopia, the Federal Ministry of Health is working to expand blood transfusion services. However, many medical facilities lack proper knowledge about the efficient use of blood and blood components. Blood is often ordered based on subjective anticipation rather than a thorough assessment of the patient's condition, leading to excessive ordering and unnecessary transfusions. This not only wastes resources but also exposes patients to unnecessary risks. (3,5)

Thorough monitoring of transfusion safety procedures and proper use of blood components will improve patient quality of life, reduce hospital expenses, and mitigate complications associated with blood transfusions. To address blood scarcity, evidence-based guidelines are necessary to ensure efficient, cost-effective, and judicious use of blood resources. (4,6)

1.2 Statement of the problem

About 80% of the world’s population gets only 20% of safe blood which passed the proper collection and screening(7).

Blood ordering for elective surgery is mainly based on the subjective anticipation of blood loss that is decided during the preoperative period rather than evidence-based estimations(3).

Blood requests based on physicians’ assumptions may lead to excessive ordering of blood which leads to unintentional misuse of blood bank services, wastage of blood and reagents, and human resources and increases the extra cost for the patients as well as the hospital(8–10).

Historically, only 30% of cross-matched blood has been used for elective surgical patients. Awareness of the negative effects of blood transfusions is growing as transfusion sciences advance. Transfusions incur direct and indirect costs, including those for products, labor, transport, testing, and hospital services. A large multicenter study done by Shandar A. et.al (2007) showed that transfusions increase hospitalization costs by 40%, estimating the cost at $1200-1400 per unit. In Ontario, Canada, processing one unit of red cells costs nearly $450.(3,11)

Access to safe surgery depends on a sufficient and timely blood supply, a common problem worldwide, including in Ethiopia, where demand far exceeds donation rate. At Tikur Anbessa Specialized Hospital in 2016, a study among 242 elective surgical patients found a cross-match-to-transfusion ratio of 4.9, a transfusion probability of 22.7%, and a transfusion index of 0.44. (9,12,13)

Ethiopia's blood donation rate is among the lowest globally, with only 0.6 units per 1000 people annually, compared to 36.4 units per 1000 in high-income countries. Despite over 3 million births annually, which could require 66,000 to 230,000 transfusions for postpartum hemorrhage alone, blood is often unnecessarily transfused, raising the risk of HIV, hepatitis, and other complications.(5,12,14)

Perioperative blood preparation for elective surgeries is usually based on worst-case assumptions by physicians, leading to over-ordering and resource wastage. This practice reduces the availability of blood for emergencies and increases the risk of transfusion-related complications. The Federal Ministry of Health in Ethiopia prioritizes expanding blood transfusion services, but many facilities lack proper knowledge about efficient blood use. (3,5,15)

A revision of blood ordering procedures is necessary to ensure efficient use of blood and blood products, addressing the scarcity and improving patient outcomes. Assessing the efficiency of blood utilization and associated factors is crucial for developing evidence-based, case-specific transfusion practices to reduce costs and complications and distribute blood efficiently.

This change in blood ordering habits requires a cultural shift at all levels of the healthcare system, including clinicians, managers, and policymakers. This research aims to assess the efficiency of blood utilization practices and associated factors for patients undergoing elective surgeries at various hospitals in Addis Ababa. (3,5,16,17)

1.3 Significance of the study

Although blood sampling is common in surgery, the average requirement for blood is usually based on subjective predictions rather than evidence-based estimates. Over-ordering wastes technical time and reagents, creating additional costs and leading to blood scarcity for those in real need. A revision of the surgical blood ordering procedure is required for efficient utilization of blood and blood products. (5,16)

The findings of this study assessed the efficient utilization of blood and associated factors, providing an evidence-based framework for case-specific blood transfusion practices. This will help reduce costs and complications, ensuring blood is distributed to those most in need. The study aims to prevent the waste of blood already collected by evaluating current utilization practices and providing guidelines for more efficient blood use. (3,17–19).

The results will inform blood banks, Red Cross societies, and other organizations, prompting further research to curtail unnecessary cross-match ordering without compromising quality and safety. Guidelines supporting balanced transfusion and blood requisition practices will be provided. This study will also offer baseline information for scholars and decision-makers, as no similar study has been conducted in this field. (3,17–19).

CHAPTER TWO

LITERATURE REVIEW

Efficient utilization of blood transfusions is essential to preserve this life-saving resource for those who genuinely require it. While blood transfusions are critical in cases of significant blood loss, unnecessary administrations can pose risks and deplete scarce resources. Decisions to transfuse should be based on a thorough clinical evaluation of the patient's condition, considering factors such as hemodynamic stability, general health, and bleeding rate, rather than solely on laboratory metrics. (1)

In elective surgeries, optimal blood management is particularly crucial. Strategies such as correcting preoperative anemia, utilizing intraoperative blood salvage techniques, and minimizing blood loss through precise surgical procedures should be prioritized. Moreover, adhering strictly to evidence-based transfusion guidelines and protocols can standardize practices and reduce the risk of unnecessary transfusions. Educating healthcare professionals on proper transfusion practices can significantly enhance patient outcomes and conserve blood resources. (1–3)

Approximately 80% of the global population relies on just 20% of the safe blood that has undergone proper collection and screening. In elective surgeries, relying on subjective estimations of blood loss rather than evidence-based assessments can lead to inefficiencies and resource wastage within the healthcare system. When blood requests are based on individual physician assumptions rather than objective criteria, there is a heightened risk of overordering blood products, depleting both blood and resources unnecessarily. This overordering not only wastes valuable human and financial resources but also further burdens the healthcare system, increasing costs for patients and hospitals and straining blood bank services. (1,2,4)

To address this concern, establishing evidence-based protocols for blood ordering during elective surgeries is crucial. These protocols should consider factors such as the patient's preoperative hemoglobin levels, expected blood loss during surgery, and specific patient characteristics influencing transfusion needs. Continuous education and quality enhancement efforts targeted at healthcare professionals are essential to improve understanding of proper blood ordering practices and promote prudent blood usage. By advocating evidence-based strategies in blood management, healthcare institutions can enhance patient outcomes, streamline resource utilization, and minimize avoidable expenses. (5)

The data highlight the considerable economic impact of blood transfusions, including direct expenses related to blood products and indirect costs associated with hospital resources and patient care. Alarmingly, only 30% of cross-matched blood is utilized for elective surgical cases, indicating significant underutilization of blood resources. This underscores the need to improve blood utilization practices to reduce waste and enhance resource distribution. (6,7)

Direct expenses linked to blood transfusions include procurement of blood products, ancillary supplies, labor, transportation, and laboratory testing. Hospitals also incur additional specific costs related to blood bank operations, such as cross-matching and administrative tasks. Indirect costs include increased hospitalization expenses and the use of additional resources like intensive care unit (ICU) services and prolonged hospital stays, adding to the economic burden of transfusions. These costs can significantly pressure healthcare budgets and exacerbate the financial challenges faced by healthcare systems. (1)

Improving blood utilization practices by adopting evidence-based transfusion guidelines and protocols is essential to reduce unnecessary expenses while promoting the efficient use of blood resources. By optimizing blood management strategies and minimizing unwarranted transfusions, healthcare institutions can decrease both direct and indirect costs associated with transfusions. This, in turn, enhances patient care standards and facilitates more effective resource allocation. (8)

Unnecessary blood transfusions not only limit access to blood products for patients in need but also drive up costs. Administering more blood than required offers no advantage and may even harm patients, as various clinical trials have shown. Moreover, unnecessary transfusions increase the likelihood of adverse events, including transfusion-associated lung injury, transfusion reactions, and transfusion-transmissible infections. (9,10)

Several methods have been developed to gauge the efficiency of blood requisition relative to its utilization. In the 1970s, Boral and Henry introduced the cross-match to transfusion (C/T) ratio, defining blood usage as appropriate if the ratio was 2.5:1 or lower. Ideally, a ratio of 1.0 would signify optimal utilization, indicating that all cross-matched blood was transfused . The concepts introduced by Mead and colleagues in 1980 regarding transfusion probability (TP) and by Friedman and colleagues in the 1970s regarding the Maximum Surgical Blood Ordering Schedule (MSBOS) have significantly influenced strategies to enhance blood utilization in healthcare settings. (11)

Transfusion probability (TP) offers a quantitative measure to evaluate the appropriateness of blood requests for specific medical procedures. A TP of 30% or higher indicates appropriate blood utilization, reflecting alignment between blood requests and clinical needs. The MSBOS provides guidelines for the maximum number of blood units to be cross-matched for specific surgical procedures based on historical usage data, helping reduce unnecessary blood wastage and optimize resource allocation.(3,12,13)

An 18-month prospective study at a tertiary care teaching hospital revealed several critical blood utilization metrics: Cross-match/Transfusion Ratio (C/T Ratio), Transfusion Probability (%T), and Transfusion Index (TI). The C/T ratio of 5.95 indicates that, on average, approximately 6 units of blood were cross-matched for every unit transfused, suggesting inefficient blood utilization. The %T of 67.7% shows that about 68% of cross-matched patients received a transfusion, while the TI of 0.87 implies less than 1 unit of blood was transfused for every unit cross-matched.(14)

In a 3-month prospective observational study in India in 2003, 1,239 units of whole blood were required for 831 adult patients undergoing elective non-cardiac surgery, with a C/T ratio of 6.6:1. The main trigger for transfusion was low hemoglobin (72.1%), followed by hypovolemia (11.4%). Blood was transfused without these indications in 16.5% of cases. Similarly, a study in Malaysia (2001) found that 1474 units were cross-matched for 538 surgical cases, with a C/T ratio of 5. Many procedures had high C/T ratios and low transfusion indices. In Mumbai, India (2000), only 53% of cross-matched patients received blood transfusions, with 76.86% of ordered blood remaining unused. Implementing an index and MSBOS substantially reduced waste and improved blood utilization. (10,15,16)

Another hospital-based audit conducted in India from July 2017 to June 2018 assessed preoperative blood ordering for elective surgeries. Data from 1151 patients revealed that of the 160 units of blood issued, only 138 were transfused to 116 patients, indicating inefficiencies. Among 71 procedures studied, only 16 had an ideal cross-match-to-transfusion (C/T) ratio, highlighting the overuse of cross-matching. The audit suggests that adopting a group and screen policy for many procedures could avoid unnecessary cross-matching, reduce resource wastage, and maintain patient safety. (17)

A retrospective cross-sectional study conducted at a government medical college in Rajouri from November 2019 to November 2020 evaluated blood utilization efficiency. The study reviewed 974 patients requesting 1,270 crossmatched units, with 1,141 units transfused to 664 patients. During this period, there were 1,197 total donations, including 998 from replacement donors and 199 from voluntary non-remunerated donors. The study found a crossmatch-to-transfusion ratio (C/T) of 1.1, a transfusion probability (T%) of 68.1%, and a transfusion index (TI) of 1.1, indicating efficient blood usage. The study concluded that implementing a maximum surgical blood ordering schedule (MSBOS) could help reduce overordering and minimize unnecessary reagent use, manpower, and blood wastage.(18)

A retrospective analysis at Aga Khan University Hospital (Pakistan, 2001) showed notable improvements after implementing MSBOS, reducing over-ordering and unnecessary transfusions. A study at the University Hospitals of Leicester (UK, 2013) found that introducing MSBOS and G and S recommendations for elective surgery reduced excessive preoperative blood orders and saved significant costs. A comprehensive study at Johns Hopkins Hospital (Baltimore, Maryland, 2014) revealed a significant reduction in preoperative blood tests and blood orders, translating into substantial annual savings.(13,14,19,20)

In the US, nearly one out of five cross-matched procedures was unnecessary, increasing costs and transfusion-related adverse events. Improving transfusion practices and implementing well-accepted transfusion policies are crucial, with recent high-quality clinical trials supporting a restrictive transfusion strategy . Efficiently managing the amount of cross-matched blood is essential for elective surgical procedures to ensure optimal utilization and availability for those in need, with MSBOS emerging as a key approach.(21,22)

There was considerable ambiguity regarding which patients truly necessitated a blood transfusion and the appropriate preoperative quantity of blood units due to variations in patient characteristics and procedural setups. Nevertheless, numerous publications have focused on optimizing blood utilization.

In a retrospective audit conducted at a specialized orthopedic hospital in Scotland (2000/01), independent predictors of transfusion included patient age, preoperative hemoglobin level, and the type of procedure performed. Factors strongly and independently associated with transfusion included preoperative hemoglobin level of 11g/dl (odds ratio: 13.92, 95% CI 7.77-24.9) and undergoing revision hip surgery (OR: 17.80, 95% CI 9.59-33.02).(31)

In a retrospective analysis undertaken at Nottingham City Hospital (2003/04), focusing on the examination of blood transfusion predictors among patients undergoing elective esophagectomy for cancer, the crossmatch to transfusion ratio was found to be 4:1. Independent factors predictive of transfusion requirement included age exceeding 70 years, hemoglobin levels below 11.0 g/dl, T stage, the occurrence of postoperative complications, and anastomotic leakage. (32)

In a prospective investigation involving liver transplant patients at Indraprastha Apollo Hospital, New Delhi (2010/11), several hematological parameters emerged as significant indicators of transfusion needs. Notably, preoperative hematocrit (Hct), hemoglobin (Hgb), platelet count (PLT), and International Normalized Ratio (INR) were identified as key predictors. Specifically, lower preoperative Hct levels were associated with a higher intraoperative requirement for packed red blood cells (PRBCs). (33)

In a prospective cohort investigation carried out at the urologic units of Kenyatta National Hospital, several factors emerged as significantly associated with the requirement for blood transfusion. Notably, patient age and pre-operative systolic blood pressure were among these factors. Additionally, a statistically significant relationship was observed between the degree of blood loss and the weight of resected prostatic tissue, particularly in patients with a positive history of preoperative use of acetyl-salicylate or warfarin sodium ($P < 0.05$).(34)

Research conducted at Kenyatta National Hospital in 1995 revealed that among surgical patients, 18% with blood loss under 500ml and 78.6% with blood loss between 500-1000ml received a blood transfusion. The study emphasized that blood loss stood out as the primary determinant of the blood transfusion rate in surgical procedures.(14,35)

Global research findings have consistently highlighted inadequate blood utilization in specific regions, as evidenced by the C/T ratio parameter. For instance, Malaysia, Egypt, Tanzania, and Zambia have reported C/T ratios of 5.0, 3.9, 3.7, and 2.8, respectively, signaling inappropriate blood usage (C/T ratio > 2.5). Conversely, Ethiopia and Nepal have demonstrated relatively better blood utilization, with C/T ratios of 2.3 and 2.5, respectively. (36)

Although useful for assessing the tendency to over-order, this ratio may not accurately predict the necessity for a transfusion in a particular surgical procedure, nor does it determine the appropriateness of the quantity of units requested for that procedure..(21)

Across various teaching hospitals in Zambia, Nepal, Egypt, and Ethiopia, the overall transfusion prevalence (TP) was reported as 20%, 11.1-25%, 36.9%, and 47%, respectively. Similarly, the overall transfusion index (TI) varied among studies, registering at 0.4, 0.69, and 0.77 in Zambia, Egypt, and Ethiopia, respectively. The proportion of surgical patients requiring transfusions, as determined by cross-matching blood, exhibited notable disparities across different medical facilities. Reports indicate utilization rates of 18% in a teaching hospital in Nepal, 35.2% in Zambia, and 43.6% in Ethiopia.(36,37)

According to a cross-sectional study conducted at Yekatit-12 Hospital in Ethiopia, a total of 1,540 matching blood units were required for 616 patients (53.2% males), with an average age of 43 years. Out of these, 1,498 blood units were administered to 615 individuals, averaging 2.43 units per person. Whole blood was the most commonly utilized blood component, accounting for 46.3% of transfusions, with 83.6% of all transfused units being 'RH' positive. Among the total transfused patients, 68 (11.1%) did not show improvement, with 48 (10.5%) having received whole blood transfusions. However, those who did improve after transfusion experienced enhancement ranging from 83.3% to 100%, with no documented post-transfusion reactions. Notably, a significant improvement in hematological profiles (hemoglobin, red blood cells, hematocrit, platelets, and white blood cells) was observed in transfused individuals ($P < 0.05$). Nevertheless, as this study was hospital-based, further research involving multiple centers is warranted to evaluate the efficacy of blood utilization. (15)

Tamene et al. conducted a study at Tikur Anbessa Hospital, a tertiary care teaching facility in Ethiopia, examining the utilization of blood components and patient outcomes among 361 transfused individuals. The findings revealed that 27 patients (7.5%) received a combination of two components, while 85% underwent complete blood transfusions. Notably, 66.2% of patients who did not experience clinical improvement received whole blood transfusions.(37)

A prospective cross-sectional study was conducted at Tikur Anbessa Specialized Hospital from December 1, 2017, to February 28, 2018. Among the 406 patients, a total of 898 units of blood were crossmatched. The overall transfusion likelihood, crossmatch to transfusion ratio, and transfusion index were recorded as 7.6, 15.3%, and 0.29, respectively, indicating minimal blood utilization. Notably, the neurosurgical unit exhibited a notably higher blood utilization rate compared to other departments and units, with a C/T ratio, TP, and TI of 4.9, 24.4%, and 0.6%, respectively. Conversely, the obstetrics unit showed the poorest indices, with a C/T ratio, TP, and TI of 31.0, 6.5%, and 0.06, respectively.(30)

Ethiopia faces a significant shortage of blood and blood products, with approximately 0.6 units per 1000 population, totaling around 56,000 units annually. This pales in comparison to the availability in high-income countries, which typically have 36.4 units per 1000 population. Particularly concerning is the obstetrics department, where an estimated 66,000 to 230,000 laboring mothers require blood and blood products annually. Addressing this need effectively requires a more efficient utilization of blood resources to meet the demands of around 3 million laboring mothers.(13,38)

CHAPTER THREE

OBJECTIVES

3.1. General Objective

To assess blood requisition, transfusion practices and factors associated with intraoperative transfusion in elective surgical procedures at different hospitals of Addis Ababa, from November 1, 2023, to April 30, 2024.

3.2. Specific objectives

Ø To assess the practice of blood ordering for elective surgical procedures at different hospitals in Addis Ababa, from November 1, 2023, to April 30, 2024.

Ø To assess the practice of blood transfusion for elective surgical procedures at different hospitals in Addis Ababa, from November 1, 2023, to April 30, 2024.

Ø To identify factors associated with blood transfusion in elective surgical patients at different hospitals in Addis Ababa, from November 1, 2023, to April 30, 2024.

CHAPTER FOUR

4. METHOD AND MATERIALS

4.1. Study Area and Period

According to World Population Review 2024, Addis Ababa has a population size of over 4 million, holds 527 square kilometers of area in Ethiopia. Currently, there are 12 state-run hospitals in Addis Ababa. For this study, we selected randomly Menelik II Hospital Gandhi Memorial Hospital (GMH), Tikur Anbessa Specialized Hospital (TASH), and Lancet General Hospital (LGH).

Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia, is a leading healthcare institution known for its specialized medical services and extensive capacity. With nearly 3,000 employees, including academic, clinical, and administrative staff, the hospital ensures high-quality care, research, and support. It houses 700 beds, extendable to 1,000 beds, accommodating diverse medical needs effectively. The hospital occupies a substantial land area of 81,146 square meters, with expansion plans on an additional 10,000 square meters. This infrastructure allows Tikur Anbessa to remain a cornerstone of healthcare, providing specialized services and comprehensive care to the community.(32)

Lancet General Hospital in Yeka Sub city, Addis Ababa, Ethiopia, established in November 2020, has had a significant impact on patient care. With 85,000 patients treated at its Outpatient Department (OPD), and 11,400 admissions, it shows a high demand for its services. The hospital has performed 5,500 major surgeries and 5,000 minor procedures, showcasing its advanced medical and surgical capabilities. With a focus on multidisciplinary treatment and high standards of care, Lancet General Hospital is positioned to become a leading institution in Ethiopian healthcare. (32)

Menelik II Hospital in Addis Ababa, Ethiopia, is a renowned healthcare institution known for its comprehensive services and substantial capacity. With over 1,200 employees, including clinical and administrative staff, the hospital ensures efficient operations and high-quality care. It features modern infrastructure and 267 beds distributed across various specialties, catering to diverse medical needs. Occupying a vast land area of over 62,000 square meters, the hospital has ample space for current and future expansions, enhancing its ability to serve the community effectively. As a cornerstone of Ethiopian healthcare, Menelik II Hospital remains committed to delivering excellence in medical services and meeting evolving patient needs. (32)

Gandhi Memorial Hospital in Ethiopia is a significant healthcare facility renowned for its focus on maternity services and neonatal care. With a workforce of 848 individuals, including clinical and administrative staff, the hospital ensures smooth operations. It features nine blocks housing various departments and facilities, with a total of 121 beds available for patient care, emphasizing maternity services and neonatal care. Spanning over 6,000 square meters, the hospital's ample space allows for potential expansions to meet growing healthcare needs. With its manpower, infrastructure, and land size, Gandhi Memorial Hospital remains a cornerstone of healthcare, providing essential services to mothers, infants, and the community(32)

This study was carried out at 4 major Hospitals in Addis Ababa over six months from November 1, 2023, to April 30, 2024. These hospitals are Tikur Anbessa Specialized Hospital, Menelik II Hospital, Gandhi Memorial Hospital, and Lancet General Hospitals.

4.2. Study design

Multi-centered cross-sectional study design was employed.

4.3. Population

4.3.1. Source Population

The source population was all elective surgical patients at Tikur Anbessa Specialized Hospital, Menelik II Hospital, Gandhi Memorial Hospital, and Lancet General Hospital.

4.3.2. Study Population

The study population was all elective surgical patients who underwent their surgical procedure in the specified study periods.

4.4. Eligibility criteria

4.4.1. Inclusion criteria

Elective Surgical Patients who were scheduled during the study period

4.4.2. Exclusion criteria

Patients with inadequate blood transfusion details and surgeries canceled from elective schedules were excluded.

4.5. Sampling Technique and Sample Size Determination

4.5. 1. Sample population

All patients who fulfilled the inclusion criteria in the specified study period were the sample population

4.5.2 Sample Size

The required sample size is determined by using the estimation of the single population proportion

According to a previous study conducted at Tikur Anbessa Specialized Hospital by Gebere Hiwot et. al (2017), the probability of intraoperative transfusion is 22.7%.(30) Hence we use the Cochrane formula $n = Z^2 P(1 - P)/ d^2$

n = sample size, Z = 95% confident interval corresponds to Z= 1.96

P = rate of blood transfusion obtained from same study =22.7%, d = margin of error= 5%=0.05

$n = Z^2 P(1 - P)/ d^2 = (1.96)^2 \times 0.227(1-0.227)/(0.05)^2=199.3=270$

Since we use a multi-center study, the design effect is used with an intra-class correlation between 0.2- 0.5, the design effect will be 1/0.5=2. Hence final sample size will be 270×2=540. When we add, a 10% non-respondent percentage, the final sample size will be 594

Based on the Ethiopian Ministry of Health 2018 report on Hospital's patient service capacity and hospital beds I used 30% of my sample size (178 of the total sample) for Tikur Anbessa Specialized Hospital and 26% (154) for Menelik II Hospital, 22% (131) for Gandhi and 22% (131) for Lancet General Hospital.

4.5.3. Sampling technique

By using simple random sampling, the study hospitals Tikur Anbessa Specialized Hospital, Menelik II Hospital, Gandhi Memorial Hospital, and Lancet General Hospital were selected; and the sequential sampling technique all consecutive elective surgical patients who were posted for elective surgery and those who had perioperative blood cross-match were included until the end of the study period.

4.6. Study variables

4.6.1. Independent Variables

Age

Sex

BMI

Preoperative Hct/Hgb

Platelet count

Antiplatelet and/or anticoagulant drugs

Co-existing diseases

ASA status

Preoperative transfusion

Type of anesthesia

Type of surgery

Intraoperative blood loss (ml)/% of EBV

Number of units cross-matched

Number of units transfused

Duration of Surgery

4.6.2 Dependent Variable

Intraoperative blood transfusion of patients

4.7. Data Collection and Procedures

4.7.1 Procedure

A structured questionnaire was prepared in English that will include socio-demographic data, physical characteristics of the patient, preoperative hemoglobin, platelet level, ASA status and anticoagulant status of the patient, medical co-morbidities, units of blood cross-matched, and total estimated blood loss, units of blood transfused, type of surgery, type of anesthesia, post-operative condition and post-operative disposal of patients. Data were collected by residents, anesthetists, and nurses who attend the surgical theatre and/or follow patients postoperatively.

4.7.2 Data processing and analysis

Data were coded and entered into Google form and exported for cleaning and analyses to SPSS version 26. Descriptive statistics was conducted and the result was introduced utilizing tables and figures. The scatter plot matrix and Pearson correlation coefficient(R) were used for the linear relationship of variables. Descriptive analysis was used to describe the percentages and number of distributions of the respondents by socio-demographic characteristics and other relevant variables in the study. Both bi variate and multivariate logistic regressions were fitted. Independent variables with a p-value of less than 0.25 in the bi-variate analysis were entered into final multivariate logistic regression

model to control for potential co-founders and to identify significant factors associated with the outcome variable. Finally adjusted odds ratio (AOR) along with a 95% confidence interval were estimated to assess the strength of the association and a P value <0.05 was considered to declare

the statistical significance of the multi-nominal analysis in this study.

Blood utilization indices were computed with the following equation:

Cross-match to transfusion ratio (C/T ratio) = 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 cross-matched × 100. A value of 30% and above was considered indicative of significant blood usage.

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

Maximal Surgical Blood Order Schedule (MSBOS) =1.5 × TI. Designed for the common surgical procedures that have >5 cases.

4.7.3 Data Quality Assurance

The principal investigator conducted one-day training sessions for data collectors at each operation theatre and ward unit, ensuring their proficiency in data collection procedures. Additionally, the principal investigator supervised the completeness of daily collected data. Before commencing data collection, an evaluation of data documentation errors was conducted by randomly selecting 30 elective surgical patients. The principal investigator cross-checked the documentation for accuracy by comparing it with data collected by the data collectors both intraoperatively and postoperatively. Furthermore, the principal investigator ensured the completeness and consistency of data through daily checks.

4.7.4 Dissemination of the result

Upon completion, this study could serve as valuable reference material for researchers, experts, and policymakers in the field. To ensure its accessibility to these stakeholders, the completed paper will be submitted to the College of Health Sciences Department of Anesthesiology Critical Care and Pain Medicine. Additionally, copies of the material will be provided to various institutions, including TASH, Addis Ababa University Student Research Office, MH, GMH, LGH, Ethiopian Association of Anesthesiologists, Ethiopian Red Cross Society, Addis Ababa Health Bureau, and the Ethiopian Ministry of Health. Furthermore, the results will be disseminated through publication in peer-reviewed local and international journals, as well as through presentations at related workshops and seminars.

4.7.5 Operational definitions

Elective Surgery: scheduled non-emergent inpatient surgical patients where blood is ordered perioperatively.

Canceled Surgery: surgery canceled from the scheduled date or canceled at OR by any means

Units of blood: A unit of whole blood or a packed RBC.

Cross-matched units of blood: units of blood ordered by the physician and cross-matched in the laboratory for elective surgery to be prepared perioperatively

Perioperative Transfused patients: patients transfused pre-, intra and post-operatively

ASA Class: American Society of Anesthesiology Physical Status Classification

ASAI- A normal healthy patient, ASA II-A patient with mild systemic disease

ASA III-A patient with severe systemic disease

ASA IV-A patient with severe systemic disease that is a constant threat to life

Preoperative Transfused patients: patients transfused preoperatively

Patients with inadequate blood transfusion details: Patients whose blood request and transfusion are not known

Intraoperative Transfused patients: patients transfused intraoperatively

Transfused units of blood: units of blood transfused for patients during the perioperative period.

Perioperative period: a day before the day of surgery to 24 hours of postoperative period.

Patient Stable = The patient is hemodynamically stable

Patient Unstable = Patient is in shock with MAP≤65mmHg and/or Tachycardic with Pulse rate increased by 20% from baseline

4.7.6 Ethical Consideration

Before commencing the study, ethical clearance was obtained from the Departmental Research and Ethics Review Committee (DRERC) of the Department of Anesthesia, School of Medicine, College of Health Sciences of Addis Ababa University (DOS/RES/REC/49/2023), as well as from the Addis Ababa Health Bureau (Ethical Clearance Number A/A/H/10442/227). Additionally, permission was secured from all of the study hospitals. The purpose of the study was thoroughly explained to the authorized personnel at the health facilities, and formal letters of cooperation were obtained from relevant authorities. Patients included in the study were also informed about the study's objectives, and verbal consent was obtained from them. Confidentiality of information was ensured through the use of code numbers and the secure storage of questionnaires.

CHAPTER FIVE

RESULT

5.1. Characteristics of surgical patients at TASH, MH, GMH, and LGH

A total of 574 elective surgeries were carried out over a six-month study period. Out of these, 172(30%) were from Tikur Anbessa Specialized Hospital, 150(26%) from Menelik II Hospital, 126(22%) from Gandhi Memorial Hospital and 126(22%) from Lancet General Hospital. All of the 126 elective surgeries at Gandhi Hospital were only females with obstetric and gynecologic surgeries. Of all, the majority of the patients were female 61.8% (355) making the Female: Male ratio 1.6:1. Majority of the patients 390(67.9%) aged between 25 to 55 years were 131(22.8%), 31(5.4%), and 22(3.8%) were age in between 2 and 24, greater than 65 years and less than 2 years old respectively. Those patients with normal BMI were 497(86.6%), and the rest 67(11.7%) and 10(1.7%) were overweight and obese respectively. The majority 291(50.7%) of patients were ASA II and the rest 167(29.1%), 113(19.7%), and 3(0.5%) patients were ASA I, ASA III, and ASA IV respectively. Of all cases, 184(32.1%) of patients come with additional co-morbidity, and 97(52.7%) and 35(19%) of the co-morbidities were Hypertension and Diabetes respectively. (Table two and three)

In all hospitals a total of 51(8.9%), 66(11.5%), 240(41.8%), 24(4.2%), 59(10.3%), 73(12.7%), 23(4.0%) and 38(6.6%) elective Pediatric, Orthopedics, Obstetrics and Gynecology, ENT, Cardiovascular, General and Trauma Surgeries, Neurosurgery, and Urological Surgeries were done respectively. The majority 337(58.7%) and 233(40.6%) of cases were done under general anesthesia and Spinal with or without epidural anesthesia respectively. Most 341(59.5%) of surgeries were done by consultants and the rest 112(19.5%), and 118(20.6%) of elective surgeries were done by fellows and senior residents. (Tables three and four)

The majority 249(53.1%) of blood requests were made by residents. For all patients, blood groups were determined during the preoperative time, and 269(46.9%), 143(24.9%), 104(18.1%), and 58(10.1%) of patients have blood groups O, A, B, and AB respectively. (Table three)

The majority 410(71.4%) of patients had preoperative hemoglobin (Hgb) of above 12 g/dl and after adjustment for age and sex, 26.0% of all cases were found anemic. Of 574 elective surgical patients, those with platelet count less than 150,000 were only 69(12%), and those patients taking anticoagulant prophylaxis were only 54(9.5%). (Table Two)

Three hundred sixty-five (63.6%) cases had intraoperative blood loss of less than 15%, and from those cases, 19 cases were transfused with a transfusion probability of 3.3%. Two hundred nine (36.4%) of cases have intraoperative blood loss of above 15% with a transfusion probability of 18.8%. Surgery duration was more than three hours in only 149(26%) of patients. The median number of blood units cross-matched from the preoperative period to 24 hours of the postoperative period was 2 units (1-5) with a median number of blood transfused one (1-4) unit. Out of 574 patients, 57 patients were admitted to ICU, and only 8(1.4%) patients were unstable. (Table five)

Table 1: Socio-demographic characteristics of surgical patients at TASH, MH, GMH, LSH 2024(N = 574).

Socio-demographic		TASH	MH	GMH	LGH	Frequency	Percentage
Sex	Male	89	79	0	51	219	38.2%
	Female	83	71	126	75	355	61.8%
Age	< 2 year	8	12	0	2	22	3.8%
	2 to 24 yr	50	37	21	23	131	22.8%
	25 to 65 yr	104	91	104	91	390	67.9%
	> 65 yrs	10	10	1	10	31	5.4%
BMI	18.5-24.9	159	136	92	110	497	86.6%
	25-29.9(overweight)	11	13	30	13	67	11.7%
	≥30(obesity)	2	1	4	3	10	1.7%
ASA Class	Class One	71	53	7	36	167	29.1%
	Class Two	69	69	91	62	291	50.7%
	Class Three	29	28	28	28	113	197%
	Class Four	3	0	0	0	3	0.5%

Table 2: Clinical characteristics of surgical patients at TASH, MH, GMH, LGH Ethiopia, 2024(N = 574).

Clinical characteristics		TASH	MH	GMH	LGH	Frequency	Percentage
Comorbidity	Yes	57	49	39	38	183	31.9%
	No	116	100	87	88	391	68.1%
Typeof comorbidity Others=like HIV,CLD, CKD	Diabetes	10	10	7	8	35	19.0%
	Hypertension	23	27	24	23	97	52.7%
	Cardiac disease	9	2	1	4	16	8.7%
	Asthma/COPD	1	2	3	2	8	4.3%
	Sepsis	0	4	1	0	5	2.7%
	Thyroid Disease	3	1	3	1	8	4.3%
	Others	10	3	1	0	15	8.2%

Table 2: Clinical characteristics of surgical patients at TASH, MH, GMH, LGH Ethiopia, 2024(N = 574).

Clinical characteristics	TASH	MH	GMH	LGH	Frequency		Clinical characteristics
Preoperative Hemoglobin	Above 12	95	113	99	103	410	71.4%
	10 to 12	62	35	23	21	141	24.6%
	Less than 10	15	2	4	2	23	4.0%
Preoperative plateletof patient	Above 150,000	153	133	108	111	505	88.0%
	Less than 150,000	19	17	18	15	69	12.0%
Treatment anticoagulant	Yes	28	10	2	14	54	9.5%
	No	142	138	124	112	516	90.5%

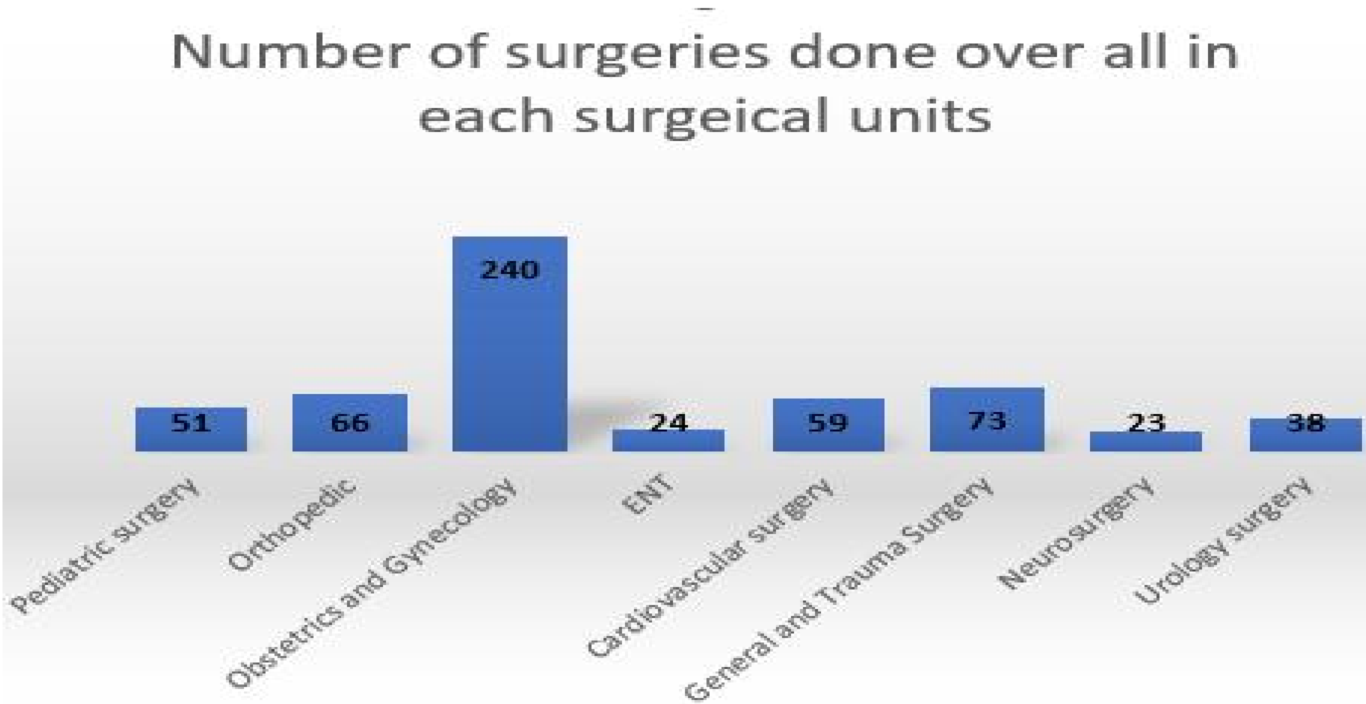
Table 3: Clinical characteristics of surgical patients at TASH, MH, GMH, LGH Ethiopia, 2024(N = 574).

Clinical characteristics		TASH	MH	GMH	LGH	Frequency	Percentage
Who ordered blood	Consultant	0	0	0	75	75	16.0%
	Resident	124	99	20	6	249	53.1%
	Intern	16	10	33	3	62	13.2%
	Nurse	27	18	36	2	83	17.7%
Blood Group	O	82	67	62	58	269	46.9%
	A	49_{a}	38	26	30	143	24.9%
	B	33	22	25	24	104	18.1%
	AB	8	23	13	14	58	10.1%
Educational Level of operating Surgeon	Consultant	77	93	50	121	341	59.5%
	Fellow	61	21	29	1	112	19.5%
	Senior Resident	33	35	46	4	118	20.6%
	Junior Resident	1	1	0	0	2	0.3%
Type of anesthesia used	Nerve Block	3	0	0	1	4	0.7%
	Spinal/Epidural Anesthesia	59	52	76	46	233	40.6%
	General Anesthesia	110	98	50	79	337	58.7%

Table 4: Distribution of different elective surgeries at TASH, MH, GMH, LSH Ethiopia, 2024(N = 574).

Type of surgery done	TASH	MH	GMH	LGH	Frequency	Percentage
Pediatric surgery	15	30	0	6	51	8.9%
Orthopedic	34	19	0	13	66	11.5%
Obs/Gyn	34	40	126	40	240	41.8%
ENT	12	4	0	8	24	4.2%
Cardiothoracic surgery	25	26	0	8	59	10.3%
General and Trauma Surgery	23	13	0	37	73	12.7%
Neurosurgery	16	4	0	3	23	4.0%
Urology surgery	13	14	0	11	38	6.6%

Figure 1: Distribution of different elective surgeries, Ethiopia, 2024(N = 574).



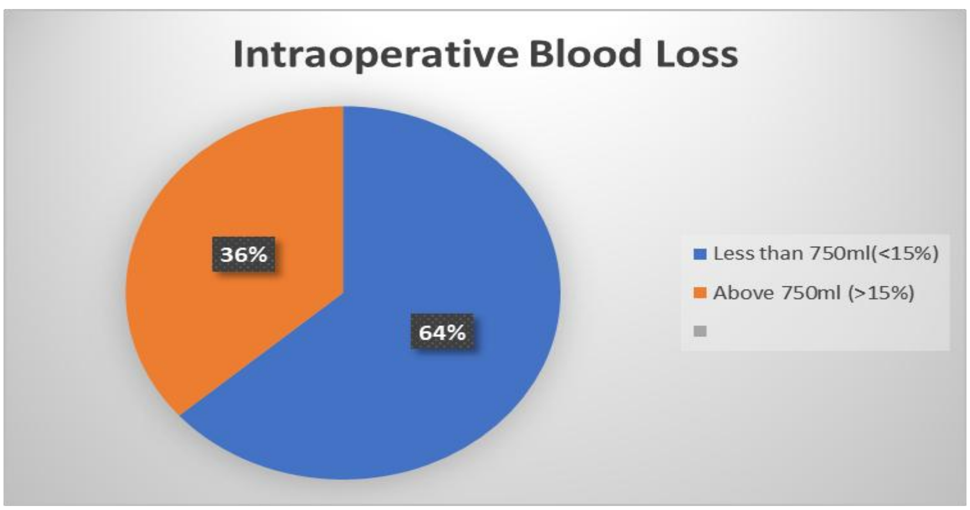


Figure 2 Magnitude of blood loss among surgical patients in all studied surgical patients from November 1, 2023 to April 30, 2024 (N=574)

Table 5: Clinical characteristics of surgical patients at TASH, MH, GMH, LGH Ethiopia, 2024(N = 574)

Clinical Characteristics		TASH	MH	GMH	LGH	Frequency	Percentage
Duration of Surgery	Less than 3 hour	109	90	111	115	425	74.0%
	Above 3 hours hour	63	60	15	11	149	26.0%
Intraoperative Blood Loss	Less than 750ml(<15%)	72	94	98	101	365	63.6%
	Above 750ml (>15%)	100	56	28	25	209	36.4%
Post operative patient disposal	Ward	146	137	119	115	517	90.1%
	ICU	26	13	7	11	57	9.9%
Patient. Condition in thefirst24hours of post opp	Stable	161	148	126	124	559	98.6%
	Unstable	5	1	0	2	8	1.4%

5.2. Blood Requisition and Utilization in Respective Departments

During the six-month study period, out of a total of 574 elective surgeries across various departments, blood requisitions were made for 469 cases (81.7%) in all studied hospitals. Of these, 170 cases (36.2%) were from the Gyn/Obs department, 43 cases (9.2%) from Pediatrics surgery, 23 cases (4.9%) from Neurosurgery, 59 cases (12.6%) from Cardiothoracic surgery, 65 cases (13.9%) from General surgery, 64 cases (13.6%) from Orthopedics, 15 cases (3.2%) from ENT, and 30 cases (6.4%) from Urosurgery. A total of 927 units of blood were requested, and 824 units of blood were prepared (103 units of blood were not prepared due to unknown reasons). 53.1% of blood was requested by Residents. 182 units of blood were utilized for 126 patients, making cross-match to transfusion ratio(C/T) of 4.53, transfusion probability (%T) of 26.9%, transfusion index (TI) of 0.39, Maximal Surgical Blood Order Schedule (MSBOS) of 0.59.

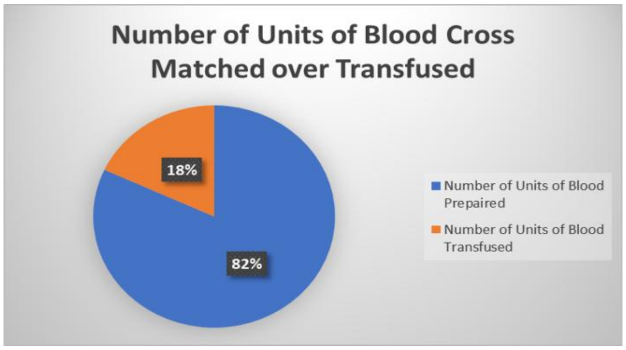
When examining each hospital's transfusion indices (Table Three), Tikur Anbessa Specialized Hospital had a crossmatch to transfusion ratio (C/T) of 3.98, a transfusion probability (%T) of 29.9%, a transfusion index (TI) of 0.51, and a Maximal Surgical Blood Order Schedule (MSBOS) of 0.76. Menelik II Hospital showed a C/T ratio of 5.59, a %T of 21.3%, a TI of 0.29, and an MSBOS of 0.43. Gandhi Memorial Hospital recorded a C/T ratio of 3.72, a %T of 32.6%, a TI of 0.40, and an MSBOS of 0.6. Finally, Lancet General Hospital had a C/T ratio of 6.04, a %T of 23.3%, a TI of 0.28, and an MSBOS of 0.42.

When examining the cross-match to transfusion ratio (C/T) of each hospital, all exhibit less efficient blood requisition and utilization, with C/T ratios of 3.98 at TASH, 5.59 at MH, 3.72 at GMH, and 6.04 at LGH. Among the studied hospitals, TASH demonstrated relatively efficient blood utilization with a transfusion probability (%T) of nearly 30%, second only to GMH's %T of 32.6%. In contrast, MH and LGH had lower %T values of 21.3% and 23.3%, respectively. Regarding the transfusion index (TI), TASH showed a more efficient blood usage with a TI of 0.51, compared to MH, GMH, and LGH, which had TIs of 0.29, 0.40, and 0.28, respectively (Table Six).

In neurosurgery, from a total of 23 cases, 82.6% had hemoglobin levels above 12g/dl, indicating the lowest percentage of anemic patients among all surgical units. Despite this, neurosurgery exhibited the highest transfusion probability at 65.3% (29 units transfused for 15 patients out of 63 units cross-matched), primarily due to significant intraoperative blood loss (over 80% of patients experienced more than 15% blood loss). This resulted in the lowest cross-match to transfusion (C/T) ratio of 2.17 among all departments. Craniotomy for brain tumor excision was the most frequently performed procedure, demonstrating encouraging blood usage. Neurosurgery also showed relatively efficient blood ordering and utilization, with a transfusion index (TI) of 1.26 (Table Four).

In cardiothoracic surgery, out of 61 surgeries, 46 cases (75%) had hemoglobin levels above 12g/dl. Additionally, 35 patients (57%) had comorbidities, predominantly hypertension. Over 54.1% experienced more than 15% intraoperative blood loss, and more than 57% had surgeries lasting over 3 hours. Despite the high preoperative hemoglobin levels, significant intraoperative blood loss, longer surgery durations, and comorbidities contributed to higher blood usage with relatively efficient blood ordering and utilization. Out of 59 cases with 127 units cross-matched, 20 cases received 33 units of blood, resulting in a transfusion probability of 34%, a C/T ratio of 3.85, and a TI of 0.56 (Table Four).

In all surgical units except for Cardiovascular and Neurosurgery, there was a trend of over-ordering with less efficient blood utilization. The transfusion indices (C/T, %T, and TI) for these departments were as follows: Pediatrics (9.6, 14%, 0.12), Orthopedics (8.6, 17.2%, 0.22), Ob/Gyn (4.05, 28.8%, 0.4), ENT (3.38, 26.6%, 0.53), General and Trauma surgery (5.52, 26.2%, 0.32), and Urosurgery (11.5, 13.3%, 0.13) (Table Seven)



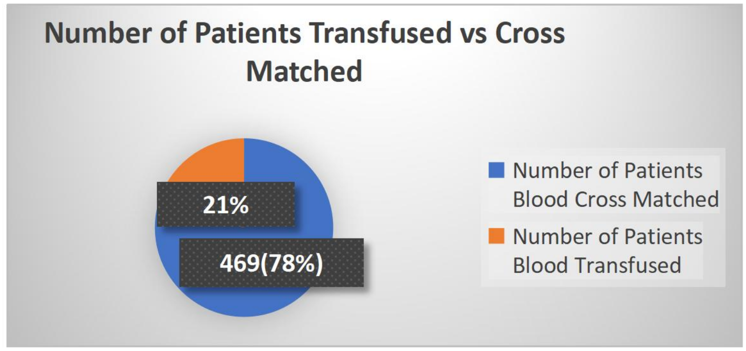


Figure 3 Comparison of units of blood cross-matched and transfused at different hospitals of Addis Ababa, Ethiopia, 2024(= 574).

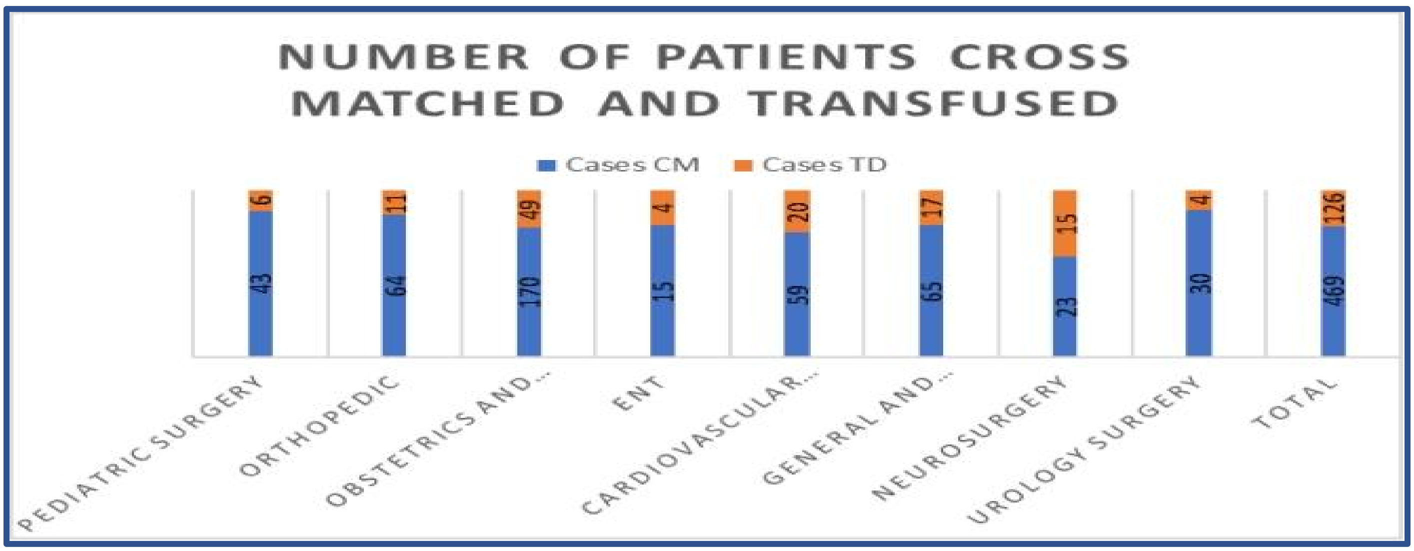


Figure 4 Comparison of the number of Patients cross-matched and transfused at different surgical units of Addis Ababa, Ethiopia, 2024(N= 574).

Table 6. Blood ordering and utilization indices at each Hospitals from December 2023 to May 2024(N=574).

Department	Cases CM	Cases TD	Units CM	Units TD	C/T	%T	TI
TASH	167	50	338	85	3.98	29.9	0.51
MH	127	27	207	37	5.59	21.3	0.29
GMH	89	29	134	36	3.72	32.6	0.40
LGH	86	20	145	24	6.04	23.3	0.28
Total	469	126	824	182	4.53	26.9	0.39

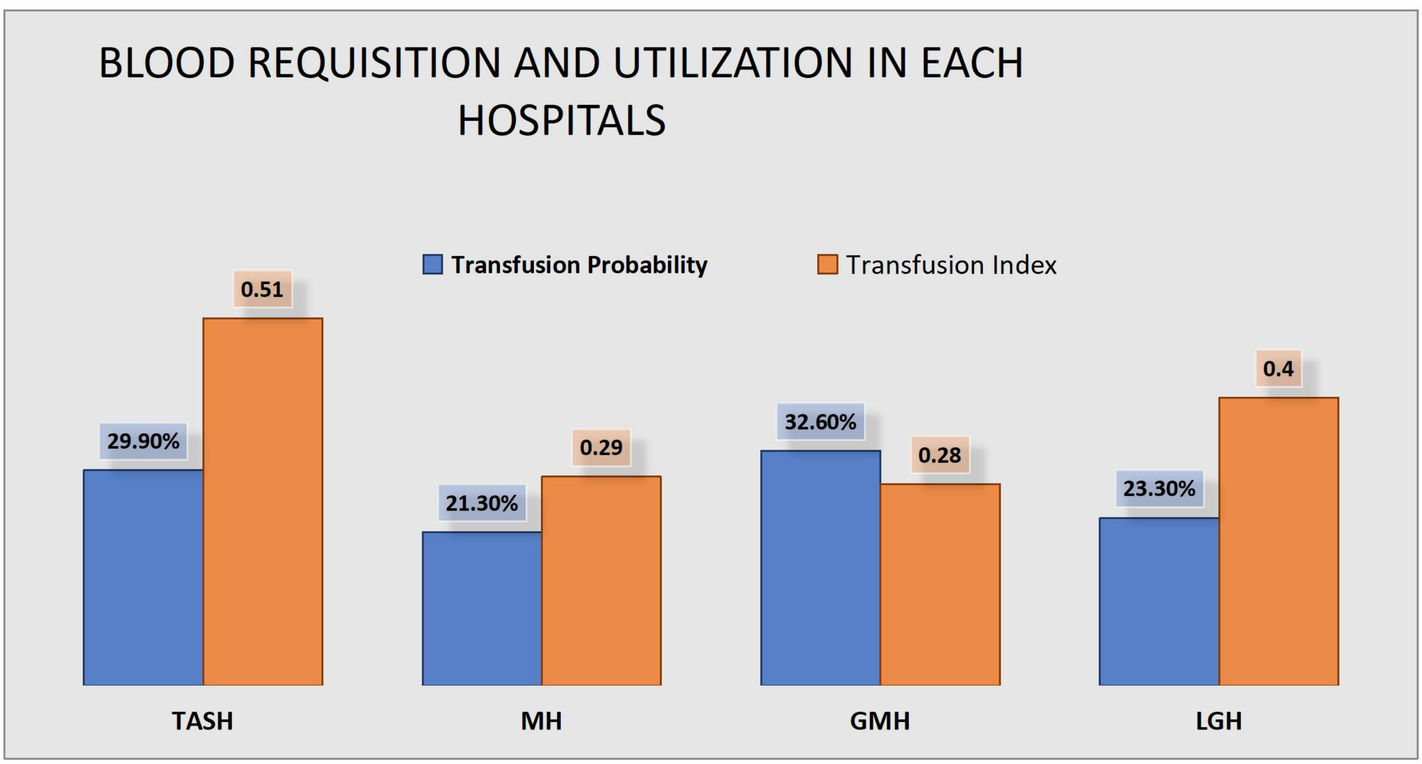


Figure 5: Blood ordering and utilization indices of different hospitals from November 1, 2023 to April 30, 2024 G.C. (N=574).

Table 7. Blood ordering and utilization indices of different surgical departments from November 1, 2023 to April 30, 2024 G.C. (N=574). *CM=cross-matched, TD=Transfused

Surgical Units	Cases CM	Cases TD	Units CM	Units TD	C/T	%T	TI
Pediatric	43	6	48	5	9.60	14%	0.12
Orthopedic	64	11	121	14	8.64	17.2%	0.22
Obs/Gyn	170	49	276	68	4.05	28.8%	0.4
ENT	15	4	27	8	3.38	26.6%	0.53
Cardiovascular	59	20	127	33	3.85	33.9%	0.56
General and Trauma	65	17	116	21	5.52	26.2%	0.32
Neurosurgery	23	15	63	29	2.17	65.3%	1.26
Urology	30	4	46	4	11.50	13.3%	0.13
Total	469	126	824	182	4.53		

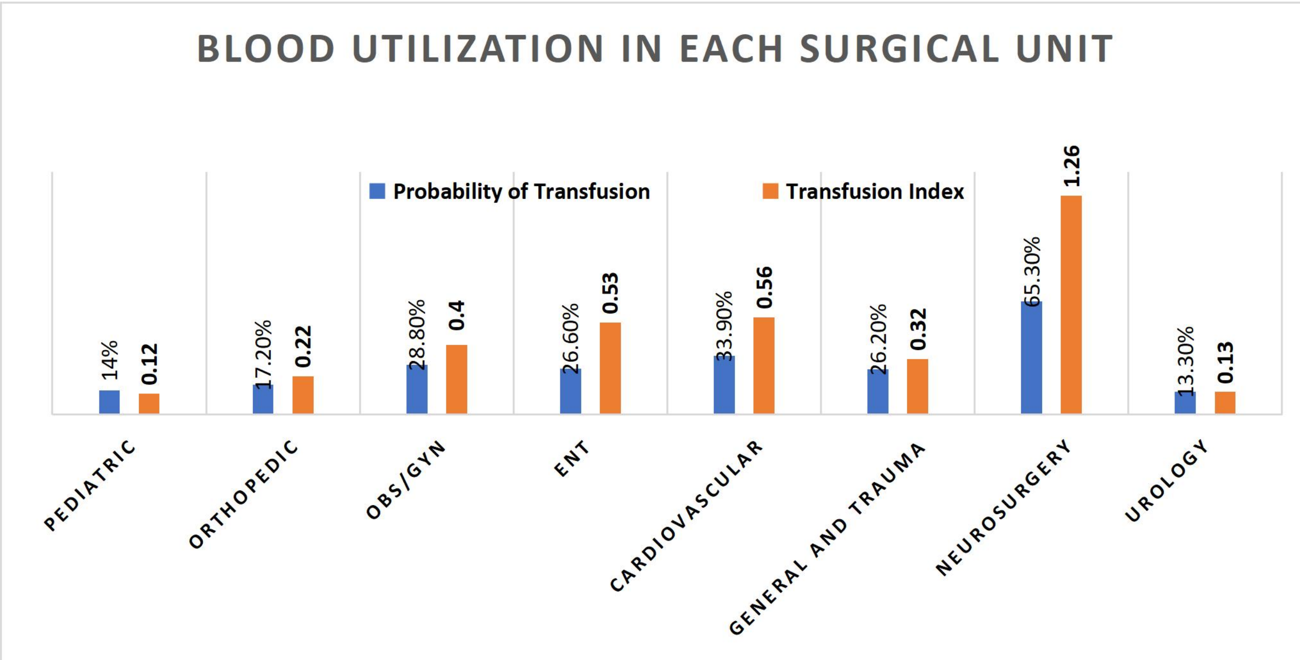


Figure 6: Bar graph showing Blood ordering and utilization indices of different surgical departments from November 1, 2023 to April 30, 2024 G.C. (N=574).

Table eight: Transfusion indices in terms of blood loss, comorbidity, Anesthesia Type and Duration of Surgery at TASH, MH, GMH, LGH Hospitals, Addis Ababa, Ethiopia from November 1, 2023, to April 30, 2024. *CM=cross-matched, TD=Transfused *CM=cross-matched, TD=Transfused

Intraoperative blood loss (%)	Cases CM (%)	Cases TD(%)	Units CM	Units TD	C/T	%T	TI
<15%	278	18	442	18	24.56	6.5%	0.06
15-30%	191	108	382	164	2.33	56.5%	0.86
DurationSurgery< 3 hr	322	54	503	62	7.74	16.8%	0.19
DurationSurgery> 3 hr	147	72	321	120	2.68	49%	0.82
No Comorbidity	314	86	548	114	4.81	27.4%	0.36
Has Cmorbidity	155	40	276	68	4.06	25.8%	0.44
Nerve block	4	1	8	1	8.00	25%	0.25
Spinal Anesthesia	168	24	263	27	9.74	14.3%	0.16
General+/spinalAnesthesia	297	101	553	154	3.60	34.0%	0.52

5.3. Factors associated with intraoperative blood transfusion

Age, Platelet count, ASA Class of the patient, Preoperative transfusion, Type of anesthesia, Type of surgery, Intraoperative blood loss (ml/%), and Duration of Surgery were selected for Multivariate logistic regression analysis, with P-value less than 0.25 in bi-variate binary logistic regression. In multivariate regression analysis, six variables; Intraoperative blood loss > 15% (p=0.000), ASA class III and above (p=0.000), ASA Class II (p=0.018), Patient Transfused Preoperatively (p=0.000), Duration of surgery greater than three hours (p=0.017), Type of Anesthesia (General) (p=0.000) were significantly associated with intraoperative blood transfusion in the presence of other confounding factors.

Those who develop intraoperative blood loss >15% blood volume of the patient are 20 times more likely to have intraoperative transfusion than those who had <15% blood volume (AOR=20.499; CI 10.778-38.990)] (p= 0.000). Those who are ASA class III and above are 3 times (AOR=3.926; CI 1.825-8.442] (p= 0.000) and those who are ASA II are 2 times (AOR=2.303; CI 1.153-4.600] (p= 0.018) more likely to be transfused intraoperatively than those who are ASA I. Those duration of surgery was more than three hours have 2 times more likely to have intraoperative blood transfusion than those whose duration of surgery was less than three hours (AOR=2.041; CI 1.139-3.658)] (p= 0.017).

Preoperative transfusion history [AOR= 0.204; CI 0.056-0.743)] (P=0.016) and General anesthesia than other type of anesthesia [AOR= 0.312; CI 0.164-0.594)] (P=0.000), had more association with intraoperative blood transfusion.

Age, platelet count and type of surgery were not statistically significant for intraoperative transfusion on multivariate binary logistic regression analysis. (Table nine)

Table 9. Logistic regression for independent variables as factors for intraoperative blood transfusion at TASH, MH, GMH, and LSH from November 1, 2023, to April 30, 2024. (N=574).

	sig	COR	Sig.	AOR	95% C.I.for EXP(B) Lower	Upper
Age	0.035					
Age (65 years and above)	0.015	13.895				
ASA class	0.000		.002			
ASA class II	0.119	1.510	.018	2.303	1.153	4.600
ASA class III and above	0.000	3.744	.000	3.926	1.825	8.442
Platelet count (<150,000)	0.202	0.635				
Patient transfused preoperatively	0.000	5.285	.000	.078	.024	.249
Duration of surgery above 3 hours	0.000	6.424	.017	2.041	1.139	3.658
Type of Surgery (Neurosurgery)	0.000	19.125				
Type of Surgery (Cardiovascular surgery	0.009	4.725				
Intraoperative Blood loss >15% ABL	0.000	20.614	.000	20.499	10.778	38.990
What type of anesthesia used	0.000		.002			
What type of anesthesia used (General Anesthesia)	0.000	0.266	.000	.312	.164	.594
Constant			.038	.289		

CHAPETR SIX

DISCUSSION

In our study, it was determined that most elective surgical patients (78%) did not require blood transfusion, aligning closely with findings from a previous study at TASH in Ethiopia in 2017, where 77.3% of operations did not necessitate intraoperative blood preparations. Furthermore, our investigation revealed that almost one fifth of cross-matched blood was utilized which is comparable with previous studies conducted at TASH in Ethiopia in 2017 (20.4%)(7) and in Nepal in 2009 (17.24%) (33), where utilization rates of cross-matched blood were lower.

Nevertheless, the findings of this study reveal a lower blood utilization rate compared to other regions. For instance, in Zambia in 2015, blood utilization stood at 23.8%(28) while in India in 2012 it was 26%(2) and in Egypt, in 2011 it reached 25.2% (34) Moreover, in Nigeria in 2014, blood utilization was notably higher at 34.51%(33) and in the University of Gondar Hospital in Ethiopia in 2013, it was even higher at 36%(7)

Despite variations in the extent of blood utilization across different regions, these statistics collectively indicate a common challenge worldwide, particularly in developing countries like Ethiopia.

Various transfusion indices are employed to assess the effectiveness of blood utilization systems. Boral Henry proposed the cross-match to transfusion ratio (C/T ratio) in 1975 as a metric for this purpose (35). Since then, numerous researchers have utilized the C/T ratio to evaluate blood transfusion practices, with a ratio of 2.5 or below considered indicative of efficient blood usage. Ideally, this ratio should be 1.0, signifying a one-to-one correlation between cross-matched blood and actual transfusions(36)

This study revealed a concerning cross-match to transfusion (C/T) ratio of 4.53, which exceeds the recommended threshold of ≤ 2.5, indicating inefficient blood usage. However, this finding is consistent with previous studies at TASH in Ethiopia in 2017 (4.9) and in Malaysia in 2002 (5.0). Compared to studies in Nepal in 2009 (11.7) and India in 2000 (6.6), which reported even higher C/T ratios, the Rajouri study shows relatively better efficiency. Nevertheless, it also highlighted significant blood wastage when compared to regions like Egypt (C/T ratio of 3.9), Zambia (C/T ratio of 2.8), and Gondar Hospital in Ethiopia (C/T ratio of 7 for elective surgical patients), which demonstrate more efficient blood utilization practices. Recent studies from India and Western countries, such as Aga Khan University Hospital, Pakistan in 2001 (where 97.56% of patients had C/T ratios higher than 2.5) and Leicester, UK in 2013 (C/T ratio of 2.1), have shown near-standard transfusion indices achieved through continuous auditing and the formulation of maximum surgical blood ordering schedules (MSBOS). The findings suggest a need for similar strategies to improve blood utilization efficiency in Rajouri, focusing on both awareness campaigns for blood donors and systematic auditing.

The probability of a transfusion (%T) was suggested by Mead et al. in 1980(12). A value of 30% and above is suggested as appropriate(36). Based on what is recommended in the above literature, the results of the present study showed an overall probability of transfusion (%T) of 26.9% which was still indicative of inappropriate utilization compared to units of blood crossmatched.

But this study shows better than the previous study done at TASH Ethiopia (2017) which was %T of 22.7%(20) and in other countries like Zambia (20%)(28) and Nepal (13.5%)(37), Indian tertiary care hospitals where %T ranged from (11.1% to 25%)(15)

Transfusion index (TI) one of the measurements for efficient utilization of blood, which is the average number of units used per patient cross-matched is indicated by and signifies the appropriateness of several units cross-matched. A value of 0.5 or more is indicative of efficient blood usage(35,36)

The findings from the study underscore a critical issue in blood utilization practices within the healthcare system. It appears that there is a prevailing culture of over-ordering blood supplies for surgical patients, leading to inefficiencies and wastage of valuable resources. This practice not only contributes to an artificial shortage of blood reserves but also consumes technical time and expensive reagents unnecessarily.

Moreover, the study highlights the broader challenge of blood supply shortages, with the healthcare system collecting less than half of the national requirement. In the face of limited blood availability, it becomes imperative to prioritize the judicious use of blood and blood products to ensure that the available supply is utilized efficiently and effectively.

To address these challenges, healthcare institutions may need to implement strategies aimed at optimizing blood utilization and conserving resources. This could involve developing evidence-based guidelines for blood ordering and transfusion, enhancing communication and collaboration between clinicians and transfusion services, and implementing measures to reduce unnecessary blood wastage during surgical procedures.

Additionally, efforts to increase blood donation rates and improve blood collection practices could help alleviate supply shortages over the long term. By promoting a culture of responsible blood management and implementing targeted interventions, healthcare systems can work towards ensuring that blood resources are utilized in a manner that maximizes patient benefit while minimizing waste.

Contrary to the wealth of research and inquiry into the effectiveness of blood usage, there remains a significant challenge in delineating which surgical patients genuinely require blood transfusions and the appropriate quantity needed preoperatively. This difficulty stems from the diverse array of patient variables and healthcare environments.

In response to this complexity, clinicians have embraced continuous auditing of blood transfusion services and the stratification of surgical patients based on their risk profiles. By continuously assessing blood usage practices, clinicians can identify trends and areas for improvement in blood management protocols. Clinical research has identified several factors that may predict the necessity for perioperative blood transfusions, including low hemoglobin levels (<11g/dl), the type of surgical procedure, and factors that increase intraoperative blood loss, such as advanced age (over 70) and prior use of anticoagulants. By carefully considering these predictive factors and implementing evidence-based blood management strategies, clinicians aim to refine blood transfusion practices. This approach not only seeks to preserve valuable blood resources but also prioritizes patient safety and enhances overall clinical outcomes. (24,26)

Corroborating these findings, our research identified statistically significant independent predictive factors for intraoperative transfusion. These factors include Intraoperative blood loss > 15%, ASA class III and above, ASA

Class II, Patient Transfused Preoperatively, Duration of surgery greater than three hours, and General Anesthesia.

We observed no statistically significant association between transfusion rates and factors such as age, preoperative anticoagulant usage, preoperative hemoglobin, platelet count, and type of surgery, despite numerical percentage differences. Although the type of surgery showed no statistical significance in our study, neurosurgery and cardiovascular surgery had notably higher transfusion probabilities.. However, logistic regression analysis indicated that these differences were not statistically significant.

While other studies have identified old age, preoperative anticoagulant intake, and hemoglobin levels as independent predictors of transfusion, our logistic regression analysis did not find these factors to be statistically significant. Therefore, it is advisable to consider these factors and conduct further assessments with a representative sample to ascertain their true significance.

Having identified the primary determinants influencing the rate of intraoperative blood transfusions in surgery, including intraoperative blood loss greater than 15%, ASA class III and above, ASA class II, preoperative transfusion, surgery duration greater than three hours, and general anesthesia, it is imperative to incorporate additional factors into developing a comprehensive policy for the judicious and rational use of blood perioperatively. Strategies such as timely and thorough preoperative risk assessment, identifying the ASA status of patients, planning the type of anesthesia, and implementing intraoperative techniques aimed at minimizing blood loss and reducing the duration of surgery should be introduced to enhance patient care and resource utilization

CHAPTER SEVEN

STRENGTH AND LIMITATION OF THE STUDY

7.1 Strength of the Study

This study stands out as the first multicenter study in our study area to comprehensively assess the efficiency of blood ordering, utilization, and identify predictors of transfusion in elective surgical patients. As such, it serves as invaluable baseline data for researchers and policymakers, providing a foundation for future investigations and informed decision-making.

7.2. Limitation of the Study

Study Limitations While this study is multicentered, the number of study subjects is insufficient due to limitations in budget and time. Consequently, this constraint hinders the generalizability of our results to all centers that may follow different transfusion and technical protocols for various surgical procedures. Additionally, time constraints prevented the conduct of a large-scale prospective study, limiting our ability to formulate a maximum surgical blood ordering schedule (MSBOS) for all types of surgery.

CHAPTER EIGHT

8. CONCLUSION AND RECOMMENDATION

8.1. Conclusion

In our study hospitals, there's was a concerning disparity between the quantity of blood requested and cross-matched for elective surgery patients and the actual amount utilized. This excessive cross-matching results in resource wastage, heightened workload, and increased financial burden. Moreover, it poses potential challenges to blood supply, prompting a need to revise our blood requisition protocols.

In this study, several factors emerged as independent predictors of perioperative blood transfusion. These include Preoperative hemoglobin <10 g/dl, Intraoperative blood loss > 15%, ASA class III and above, Patient Transfused Preoperatively, Duration of surgery greater than three hours, Female gender, Age of patients 65 years and above, Thyroid disease patients, General Anesthesia, Neurosurgery and Cardio thoracic surgery. Considering these factors when ordering blood cross-matches is essential for effective perioperative management.

8.2. Recommendation

To optimize blood utilization for elective surgery patients, it is recommended to revise the current blood ordering practices and minimize over-ordering. This can be achieved by implementing an updated, institution-specific Maximum Surgical Blood Order Schedule (MSBOS) alongside an emergency blood release system.

The Cross match-to-Transfusion (C/T) ratio and Transfusion Index (TI) for each procedure should serve as guiding parameters for determining the MSBOS. The TI values obtained from this study can inform the recommendation of a Group Save and Hold (GSH) for procedures with low TI.

For ongoing improvement of transfusion practices, regular surveillance of utilization patterns and periodic feedback are essential.

In surgeries with minimal blood loss, it is advisable to perform only patient blood grouping without cross matching. This approach is both rational and cost-effective, and it reduces the waiting time for surgery. Nonetheless, it is essential to verify blood availability for emergency situations before commencing surgery.

Conducting a large-scale prospective study will help the blood bank and hospitals alleviate the scarcity of blood and help develop a comprehensive blood utilization policy and guidelines

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Annexes I

Date ____/___/__

Code __________

9.1 Annex 1:

English Version Questionnaire Consent

Information Sheet and Informed Consent

Extracted and completed patient records regarding socio-demographic factors and other pertinent risk elements affecting blood utilization and patient outcomes at TASH, MH, GMH and LSH

Hello Dear respondent:

My name is Dr Yidersal Demsie an Anesthesiology Critical Care and Pain Medicine resident. Today I am here to collect data on the efficiency of blood utilization in elective surgical patients. The information I gathered from your card will be very useful in the realization of this study, and it will be kept confidential. The Name and Address will not be recorded and your participation in this research is entirely voluntary.

Are you willing to participate in this study? Yes _____ No ___________ Sign ______________

Thank you for your acceptance on giving data from your card/medical registration book.

Instructions:

1. Fill the blank space provided.
2. Encircle the alternatives when necessary.
3. Check the questions for completeness.

Part 1. Identification:

1.0. Hospital Name: A. TASH B. MH C. GMH D. LSH

1.1. Sex: A. Male B. Female

1.2. Age:_______

1.3. BMI_______

Part 2. Part 3. Preoperative Evaluation

2.1. Blood group of the patient ______

2.2. Was blood requested? A. Yes B. No

2.3. How many units of the requested blood were prepared? ______________________

2.4. Type of surgery________________________________

2.5. Coexisting disease: A. Yes B. No

2.5. If yes to above question, what type of coexisting disease:

A. DM B. Hypertension C. Cardiac disease D. B. Asthma/COPD E. Sepsis

F. Other (Specify) _______________

2.6. Preoperative Hgb ______g/dL or Hct_____% and platelet count_____________

2.7. Did the patient on antiplatelet and/or anticoagulant drugs? A. yes_____ B. No_______

2.8. If the answer to the above question is yes, was the drug discontinued inappropriate time? A. yes_____ B. No_______

2.9 ASA status: A. I B. II C. III D. IV and above

2.10 Was the patient transfused preoperatively? A. Yes B. No

2.13 Maximum Alowable blood loss (in ml) MABL= EBV(Patient HCT-Target HCT)/ Patient HCT

Part 3. Intraoperative evaluations:

3.1 What type of anesthesia is used? A. Nerve Block B. Spinal Anesthesia and/or Epidural Anesthesia C. General Anesthesia with/out Spinal Anesthesia

3.2 Educational level of the operating surgeon

A. Consultant B. Fellow C. Senior Resident D. Junior Resident

3.3 Does the patient transfused intraoperatively? A. Yes B. No

3.4. If the above question is yes how money unit of blood______________________

3.5. The primary trigger for transfusion: A. low hemoglobin B. hypovolemia C. Bleeding

D. Other(specify)________________

3.5. Duration of the procedure (per hour) ___________________________

3.6. Intraoperative blood loss (ml) ______________or ___________% of EBV

3.7 Transfusion Reaction Yes_______ No__________

8.8 If the above question is yes, choose the system/sign involved? (more than one answer can be possible)

A. Dermatologic (rash/urticaria) B. Constitutional symptom (Fever, itching Flushing) C. Respiratory (Dyspnea, increase in Peek inspiratory pressure, wheezing) D. Cardiovascular (Tachycardia, Hypotension) D. If Others, specify__________

4.9 What intervention was done? specify_______________________

Part 5. Postoperative evaluations:

5.1. How was the patient in the first 24hrs of post opp.? A. Stable B. Unstable

5.2. Does the patient transfuse postoperatively? A. Yes B. No

5.3. If the above question is yes, where and how much unit of blood_________________________

5.6. Where was the disposal of the patient? A. to ward B. To ICU

Stable=patient is hemodynamically stable Unstable = Patient is in shock with MAP≤65mmHg and/or Tachycardic with Pulse rate increased by 20% from baseline

Name of data collector_______________________________ Status/profession ____________________

Signature_____________ Thank you!!!

Annex I: Amharic Version Questionnaire Consent

በአዲስ አበባ ዩኒቨርስቲ ህክምና እና ጤና ሳይንስ ት/ቤት በሰመመን እና ፅኑ ህሙማን ትምህርት ክፍል በ አድስ አበባ ውስጥ ባሉ አራት ሆስፒታሎች ማለትም

በጥቁር አንበሳ ፣ ምንሊክ ፣ ጋንዲ እና ላንሴት ሆስፒታሎች የደም ልገሳ የአገልግሎት ጥራት ለማጥናት የተዘጋጀ መጠይቅ፤

መለያ ኮድ፡

የጤና ድርጅቱ ስም ________________________ የጤና ድርጅቱ ኮድ ቁጥር ______________

ቀን____________________

የሚስጥር አጠባበቅ ስምምነት

የተከበሩ ውድ ተሳታፊ

ስሜ____________________________ይባላል፡ ፡ በአዲስ አበባ ዩኒቨርስቲ ህክምና ፋክልቲ የሰመመን እና ፅኑ ህሙማን ትምህርት ክፍል speciality ተማሪ ስሆን

በቀጠሮ ለሚሰሩ ቀዶ ጥገና ታማሚዎች ላይ ጥናታዊ ዳሰሳ እና መረጃ ለመሰብሰብ ነው የመጣሁት፡፡ በሆስፒታሉ ውስጥ ስላለው የደም አሰጣጥ ሂደት እና ተያይዘው ስለሚገጥሙት ችግሮች ከካርዲዎ ላይ የምዎሲድ ሲሆን ፡ የደም አሰጣጥ ጥራቱን ለማሻሻል እና እቅዶችን ለመቅየስ የሚጠቅም መረጃ ለማቅረብ ሲሆን የመረጃው ምስጢርነት የተጠበቀ ነው፡፡ የምዎስደው መረጃ የእርሶን ስም አድራሻ እና ማንነት የሚገልፅ ማንኛውም መረጃ የማይጠቀስ ሲሆን መረጃውን አለመስጠት ወይም በማንኛውም ሰአት ማቋረጥ ይችላሉ፡፡

መረጃውን በመስጠት የጥናቱ አካል ለመሆን ተስማምተዋል ? አዎ___________________ አልተስማማሁም_____________

መረጃዉን የሰበሰበው ስም_____________________________________ መረጃው የተዎሰደበት ቀን እና ሰአት_________________________

መጠይቁን/መረጃውን ያረጋገጠው ተቆጣጣሪ ሰው ስም____ፊርማ______________________________

ስላደረጉልን ትብብር እጂግ በጣም እናመሰግናለን፡፡

ANNEX II

ASSURANCE OF PRINCIPAL INVESTIGATOR

The undersigned agrees to accept responsibility for the scientific ethical and technical conduct of the research project and provision of required progress reports as per terms and conditions of the Research Publications Office in effect at the time of Grant is forwarded as the result of this application.

Name of the student: ____

Address: email yideasamsung@gmail.com

Phone number: +251911601829/+251921136929

Date: ____________________ Signature: _________________

Approval of the primary Advisor

Name of the primary advisor: _________________________________

Date: ____________________ Signature _________________