PREOPERATIVE PREDICTORS FOR INTRAOPERATIVE BLOOD TRANSFUSION IN CROSSMATCHED ADULT PATIENTS UNDERGOING GENERAL, GYNAECOLOGIC AND ORTHOPAEDIC SURGERIES.

DR. WINNIE WARAU WAWERU
H58/11314/2018
MMED ANAESTHESIOLOGY

A RESEARCH THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE AWARD OF MASTER OF MEDICINE IN ANAESTHESIOLOGY AT THE UNIVERSITY OF NAIROBI

MAY, 2022

STUDENT'S DECLARATION

I hereby declare that this thesis is my original work and has not been presented for a degree in any other university.

Dr. Winnie Warau Waweru

Signed: ..... Date: 30/11/2022

2

SUPERVISOR'S DECLARARTION

This proposal has been submitted with our approval as the university supervisors:

Dr. Gacii Vernon Mark
Lecturer in Department of Anaesthesia,
Consultant Anaesthesiologist
Faculty of Health Sciences
University of Nairobi.

Signed:..... Date: 14-11-2022

Dr. Timothy M Mwiti
Lecturer in Department of Anaesthesia,
Consultant Anaesthesiologist
Faculty of Health Sciences
University of Nairobi.

Signed:..... Date: 11/11/2022

DEPARTMENTAL APPROVAL

Chairman
Dr. Patrick Olang
Senior Lecturer and Consultant Anesthesiologist,
Department of Anaesthesia
Faculty of Health Sciences
University of Nairobi.

Signed: ..... Date: 15/11/2022

LIST OF INVESTIGATORS/CO-INVESTIGATORS

Principal Researcher
Dr. Winnie Warau Waweru
Registrar, Department of Anaesthesia
Faculty of Health Sciences
University of Nairobi
P.O Box 4847-00100 Nairobi.
Tel. 0713470682
Email. wwarau22@gmail.com,
wwarau03@students.uonbi.ac.ke

Research Supervisors:
Dr. Gacii Vernon Mark
Lecturer in department of Anaesthesia
Faculty of Health Sciences
University of Nairobi
P.O Box 21586-00505
Nairobi, Kenya.
Tel: 0707958 251
email: vernon.gacii@uonbi.ac.ke

Dr. Timothy Murithi Mwiti
Lecturer in department of Anaesthesia
Faculty of Health Sciences
University of Nairobi
P.O Box 21586-00505
Nairobi, Kenya.
Tel: 0721366294
Email: tmwiti@uonbi.ac.ke

Research Assistant

Fred Ondieki Nyaaga
Health Records and Information Officer
Certified CITI Clinical Research
Tel: 0731052791

Bio- statistician

Dr. Neville Bonko
Email: nevillemenchs@gmail.com
Tel: 0790942971

LIST OF ABBREVIATIONS

ASA ……..AMERICAN SOCIETY OF ANAESTHESIOLOGISTS

B.T.U…...BLOOD TRANSFUSION UNIT

C: T ……CROSSMATCHED TO TRANSFUSED RATIO

g/dl ……...GRAMS PER DECILITER

GXM….. GROUP AND CROSSMATCH

Hb…….HAEMOGLOBIN

K.N.H…..KENYATTA NATIONAL HOSPITAL

RBC ……RED BLOOD CELL

R.C.T ……RANDOMISED CONTROLLED TRIAL

W.H.O…..WORLD HEALTH ORGANISATION

A & E…...ACCIDENT AND EMERGENCY

Table of Contents

ABSTRACT.

- **Background**: Transfusion of blood intraoperatively in general, gynaecological, orthopaedic surgeries can be lifesaving. At KNH, grouping and crossmatching for blood compatibility of donor blood is carried out for many of these patients as part of preoperative preparation. However, no standardized criteria have been applied for this blood ordering. This has resulted in high crossmatch to transfusion ratios, contributing to wastage of blood products. Development of hospital-based prediction tools and protocols for intraoperative blood transfusion would guide the efficiency of preoperative blood ordering.

- **Study objective**: To determine preoperative predictors for intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecologic and orthopedic surgeries at Kenyatta National Hospital.

- **Study design and site**: This study was a descriptive cross-sectional study, carried out at the Kenyatta National Hospital's main theatres and trauma theatres.

I. **Participants and Methodology:** It involved 226 crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries over a period of 3 months. Inclusion criteria- Crossmatched adult patients and patients who gave written informed consent undergoing general, gynaecological and orthopaedic surgery at KNH. Exclusion criteria- blood transfused to patients during transfer into theater/ blood that accompanied patient to theater, patient with documented blood disorder, patients who underwent multiple surgeries, patients scheduled for hemostatic surgery, and revision surgeries.

- **Data management:** Pre- and intraoperative data collected in the wards and A & E, was cross-checked, cleaned, categorized, and entered using the statistical analysis software package, SPSS version 22. Measures of central tendency such as mean and standard deviation was used to describe variables with normal distribution while skewed distributions was described in terms of medians and interquartile ranges. Descriptive

statistics such as frequencies and percentages were used to describe demographic characteristics like age and sex.

- **Expected results:** This required identification of patients who have been crossmatched and scheduled for surgery. Preoperative data were collected based on patient and operative factors and correlated to intraoperative transfusion. I expect to observe an association between preoperative factors and intraoperative transfusion among patients who had been grouped and crossmatched.

INTRODUCTION

Transfusion of blood intraoperatively is sometimes necessary during elective or emergency surgery and can be lifesaving. Due to this, a preoperative blood grouping and crossmatch (GXM) is a prerequisite for many patients scheduled to undergo several surgical procedures altogether (1)(2). This is based on clinical assessment such as medical history, nature and duration of surgery, estimated blood loss and fluid shifts, physical status of patient, supported by laboratory tests (3). After intraoperative transfusion, transfusion-related complications may arise. These increase the threat of perioperative morbidity and mortality and are categorized to immunological - allergic reactions, TRALI, graft-vs-host disease and non-immunological- sepsis, pneumonia, surgical site infection. (4)(5). Some of these complications have reduced due to improved selection and screening of donor blood. (6)(7)

Excessive surgical blood loss may occur intraoperatively and result in reduced volume status, hemodynamic instability and, anaemia compromising oxygen delivery to tissues(8)

Measures applied to minimize transfusion of blood and its products during surgical procedures involve optimizing patients preoperatively and minimizing blood loss during surgery. (9)(10)(11). There is a wide variation in practice among different populations, but relevant guidelines based on thresholds and clinical assessment (12) have been used to facilitate better use of this resource. But they have not been validated for use in all patient populations and their use has not resulted in more efficient surgical blood utilization, improved blood availability or reduction in patient and hospital costs.

Authors have reported a high global crossmatched to transfused ratio (C:T ratio) of 3:1. In K.N.H, the transfusion rate was reported at 64% , with a ratio of 1.42 : 1 of the crossmatched blood. (13) Several studies report significant association between preoperative factors and intraoperative blood transfusion in different surgical procedures. Practice guidelines for perioperative blood management categorized their factors interpatient factors from medical records, interviews and surgical procedures planned (14). Morton L. J et al found preoperative haemoglobin had significant influence on risk of transfusion perioperatively in patients undergoing general surgical procedures (15). Kyei M. et al conveyed a prospective study in

Ghana in patients undergoing prostatectomy, found patient factors including age, preoperative haemoglobin, comorbidities, ASA classification; operative factors including type of surgery, indication of surgery, surgeons expertise and anaesthetic method all had influence on transfusion rate intraoperatively (16). (17) Aderinto et al, also revealed similar factors that could predict necessity for perioperative blood transfusion in patients undergoing hip replacement surgeries.

A study has revealed that using a simple prediction rule, unnecessary preoperative blood GXM can be avoided in up to 50% of procedures, significantly reducing patient burden and hospital cost. (18)

This study aimed to identify predictors of intraoperative blood transfusion amongst patients undergoing surgery at KNH, with the purpose of guiding future development of simple predictive methods and tools that will improve the efficiency of preoperative blood preparation in this institution.

LITERATURE REVIEW

As part of preoperative assessment, group and crossmatching is carried out for many patients undergoing surgery. Great efforts have been made to reduce consumption of blood transfusion in patients undergoing surgical procedures (19)(20)(21). But for those patients who are grouped and cross-matched not all receive the blood prepared for them (22) (23). The capability to predict the need for intraoperative blood transfusion preoperatively has been challenging but several studies have provided insight in associating preoperative factors and increased risk of transfusion as enumerated below. (24)(17)

With high C: T ratio and transfusion rates as shown in several studies (13) (25)(26), there's need to identify preoperative factors that influence probability of transfusion in patients providing a guide as to which patients wasnefit from GXM. This contributed to reduction of wastage of resources at KNH.

PATIENT DEPENDENT FACTORS

AGE AND COMORBIDITIES

Patients undergoing general, gynaecological and orthopaedic procedures can present at any age. Different authors have attempted to demonstrate the relationship between age at surgery and rates of intraoperative transfusion in their populations, with various differing findings.

Luca Salvatore De Santo et al studied 1765 consecutive patients undergoing elective surgery. They found that older patients received blood more than younger patients with a 1.3-fold rise in the relative risk for transfusion. Of note was those patients' receiving transfusion had more comorbidities including diabetes, acute kidney injury, pulmonary disease, and chronic hypertension, regardless of age. They concluded that age alongside comorbidities further increased the risk of transfusion.(27) Cheng-Qian Dai et al, in a retrospective study on patients undergoing orthopaedic procedures established elderly patients could predict the need for perioperative blood transfusion. (28)

In contrast to the above investigators however, Niv Ad et al in a study examining age as a predictor of blood transfusion found that older age significantly predicted postoperative but not intraoperative blood transfusion.(29)

The relationship between age, comorbidities and risk for intraoperative blood transfusion has been disputed in literature especially because neither has been found to be an independent predictor of perioperative transfusion. Kim J et al examined general surgical patients undergoing colorectal surgery, to recognize predictive factors for perioperative blood transfusion. They established that those with greater number of comorbidities -including diabetes, pulmonary disease, morbid obesity, malignancy- and those greater than 65 years tend to have a lesser preoperative haematocrit compared to the younger patients. This suggests that they observed higher relative risk for perioperative transfusion associated with older age and comorbidities in addition to preexisting preoperative anaemia. (30)

GENDER AND PREOPERATIVE HAEMOGLOBIN LEVELS

Females are generally understood to have lower haemoglobin levels than men. According to the W.H.O, the cut off for normal Hb is lower in females at 12g/dl as compared to men at 13 g/dl.(31). A study done in Kenya revealed Hb reference interval for females is between 12-16.5 g/dl and males between 14.5-18.7 g/dl for adults between 18-65 years of age. (32) These findings have led various investigators to try and establish whether the female gender is associated with a higher intraoperative transfusion risk.

Stammers et al in their study, established that female patient had a lower preoperative haematocrit at 32.9% compared to men at 37.2 %. They went on to establish that women had 3 fold higher transfusion rates than men at 45.1% vs13.7%, therefore a significantly higher transfusion risk among the female gender was a significant finding in this study. (33) Desai et al, in a retrospective study on factors affecting transfusion requirement following hip fracture, corroborated these findings. They found a relationship between need for blood transfusion and female gender. They also established a relationship between need for intraoperative blood transfusion and a lower preoperative haemoglobin level.(34)

But, Hans Gombotz et al, in a multicenter cohort study found the prevalence of preoperative anaemia to be similar in both genders in patients undergoing non cardiac surgeries. (35)

Preoperative anaemia has also been quoted in standard text as an independent predictor for intraoperative blood transfusion(3), and therefore is generally used to direct pre-operative blood GXM. Kim et al examined a group of general surgical patients to identify predictors for perioperative blood transfusion and found a haematocrit < 30% to be an independent risk factor for perioperative blood transfusion requirement. (30)

Josephine et al studied orthopaedic surgical patients at a tertiary hospital in Australia to predict perioperative transfusion and found preoperative haemoglobin to be a predictor of transfusion, along with females older than 65years of age. (36)

PREOPERATIVE MEDICATIONS

There are classes of drugs that are known to have effects on the coagulation system and therefore may cause increased bleeding or thrombosis. The commonest of these classes of drugs are the anticoagulants and antiplatelets. Wolf et al conducted a study on the safety of aspirin therapy in pancreatic operations perioperatively. They found that aspirin treatment did not correlate with increased rates of perioperative hemorrhage or transfusion requirement. (37) RCTs done on perioperative aspirin use report equivocal findings, similar to Wolf et al.

Existing protocol on perioperative management of patients on long term warfarin anticoagulation involves substitution of warfarin with injectable low molecular weight heparin preoperatively and early resumption of warfarin therapy postoperatively(38)(39).

Similar conclusions were reported by Matsuoka et al in 2019 in a retrospective review of 1555 patients who underwent emergency gastrointestinal operation. 170 of these patients were taking antithrombotic drugs. The study found no significant increase in risk of blood loss or need for transfusion despite lack of offsetting drug effect. (40) In contrast, a meta-analysis of the effect of antithrombotic drugs on perioperative bleeding in BPH surgery, that included 20 studies, established that compared to interfered use of these drugs, uninterrupted usage of antithrombotic

medications contributed to more frequent post-TURP bleeding and higher perioperative transfusion rate. (41)

However, a recent meta-analysis study questioned the longstanding practice of heparin bridging for patients on chronic oral anticoagulants.(42) Illias N. et al concluded that bridging protocol did not significantly lower the risk of bleeding or reduce thromboembolic episodes post procedure. They recommended that patients with a high thromboembolic risk would benefit from heparin bridging. Those with low- and moderate-risk required simple discontinuation before and restart postoperatively.

ASA CLASSIFICATION

American Society of anesthesiologists physical status classification system was established to guide clinicians in assessing patients physiological status to aid in predicting potential risks perioperatively. (43)

Sathiyakumar et al, In 2016 published their findings on the use of air Cisco as a predictive tool to improve blood ordering for orthopedic trauma patients at a level 1 trauma center. Is it class four patients were found to be 14.71 times more likely to get into operative blood transfusion than ASA class one patients. With this finding that correlated ASA class with need for transfusion, institutional recommendation was made that maximum surgical blood order schedule algorithms to incorporate patients preoperative ASA classification to govern necessity of intra operative blood transfusion. (44)

Other studies in an African populations have also recognized ASA classification as a predictor of transfusion. (45)

BODY MASS INDEX

With improved socioeconomic environments, more people have developed obesity. The World Health Organization has described obesity as body mass index (BMI) > $30m^2$/kg and has subdivided into 3 categories.(44) It is acknowledged that obesity is associated with increased morbidity and mortality perioperatively (46)(47)

Nolan et al carried out a retrospective chart review to determine BMI as an indicator for intraoperative transfusion. They reported those with higher BMI had less risk of transfusion. (48) Another cohort study by Pandya et al, assessed using the national surgical quality improvement program (NSQIP), found that over 5 years, overweight and obese participants were less likely to receive a transfusion. (49)

Contrary to the above findings, Raphael Sun et al carried out a multivariate analysis, multicenter review, on patients undergoing pancreatectomy to determine which risk factors were predictive of transfusion. They observed, among other factors, increasing body mass index (BMI) increased the risk of blood transfusion peri operatively. (50).

Additionally, Huimin et al (51) investigated the influence of obesity on surgical complications in patients with ovarian cancer. Of a total of 362 patients, intraoperative blood loss and blood transfusion amount was highest in patients in the obesity group followed by overweight group.

OPERATIVE FACTORS

TYPE OF ANAESTHESIA

When both options are available, choosing epidural and spinal Anaesthesia over general Anaesthesia has the advantage of decreased blood loss and transfusion requirements. J dig et al confirmed this observation in orthopaedic patients undergoing hip arthroplasty. (52)

Rashiq et al in their study on regional Anaesthesia in arthroplasty also found a reduced odds ratio for transfusion in patients undergoing regional Anaesthesia compared to general Anaesthesia. (53)

Many other authors confirm that indeed preoperative choice of mode of Anaesthesia may in association with other factors affect the risk for intraoperative blood transfusion requirement in patients undergoing surgery. Regional and spinal anesthesia is associated with less blood loss and need for blood transfusion. (54)(55)(10)

SURGEON EXPERTISE, EXPERIENCE OR LEVEL OF TRAINING

Teaching hospitals, such as K.N.H serve as training facilities for resident surgeons, who participate in undertaking surgical procedures either alone or with consultant supervision. Locally, there has been no data comparing surgical outcomes for procedures based on trainee level or levels of experience and expertise.

In north America, using the American College of Surgeons-National Surgical Quality Improvement Program (NASQIP) database, Iannuzi et al conducted a study evaluating the influence of trainee involvement on surgical results, and one of their findings was a significant increase in intraoperative transfusion in resident cases therefore concluding that resident contribution was related to higher risk for intraoperative transfusion. (56)

Additionally, a meta-analysis study by Bougie et al, demonstrated Obstetrics and Gynecology residents, had increased risk of blood transfusion.(57) Overall, there is a paucity of information regarding the consequence of experience of a surgeon on intraoperative blood transfusion need.

STUDY JUSTIFICATION

Many surgical patients undergo routine preoperative GXM at KNH though a significant proportion are not transfused perioperatively. A study done locally found a transfusion rate of 64% , a ratio of 1.42: 1 among patients previously grouped and cross-matched. (13) This indicates unnecessary GXM leading to waste of blood and blood products and severe shortage of blood. This leads to unavailability of blood when required for emergency transfusion procedures in the hospital. Worldwide, to improve efficiency of blood ordering and usage, institutions have attempted to generate algorithms and prediction rules based on their patient and surgical characteristics that can aid in predicting patients' risk for intraoperative blood transfusion. In some centers, this has led to avoidance of unneeded preoperative GXM in up to 50% of patients, reducing patient burden and overall hospital costs. (58)

In K.N.H, the surgical department is the second highest utilizer of blood and blood products. (59)

Findings of this study aided in identifying patient and surgical characteristics associated with intraoperative blood transfusion requirement in surgical patients. This was utilized in guiding more efficient preoperative blood ordering for surgical patients. This would reduce wastage of blood products in K.N.H and hopefully resolve the acute shortage of blood. (60)(61)

RESEARCH QUESTION

What are the preoperative predictors for intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries at Kenyatta National Hospital?

STUDY OBJECTIVES

BROAD OBJECTIVE

To determine preoperative predictors for intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries at Kenyatta National Hospital.

SPECIFIC OBJECTIVES

I. To determine the prevalence of intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries at Kenyatta National Hospital.
II. To determine the crossmatch to transfusion ratio for adult general, gynaecological, and orthopaedic surgeries at Kenyatta National Hospital.
III. To determine patient factors predictive of intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries at KNH
IV. To determine operative factors predictive of intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries at KNH.

MATERIALS AND METHODS

Study design

This study was a prospective descriptive cross-sectional study

Study area

The study site was Kenyatta National Hospital's main theatre and trauma theatres. Kenyatta National Hospital is the largest public hospital in Kenya with the following services: Accident and Emergency, Outpatient clinics, medical units, Paediatric and Newborn units, Maternity and Gynecological units, Renal units, Cancer care center, Critical care units and Surgical units both general and specialized units

Study Population

All crossmatched adult patients undergoing general, gynaecological and orthopaedic surgeries at Kenyatta National Hospital

Inclusion criteria

I. Crossmatched adult patients undergoing general, gynaecological and orthopaedic surgery at Kenyatta National Hospital.

II. Patients who gave written informed consent

Exclusion criteria

II. Blood and its products administered to patients during transfer into theater.

III. Patient with documented blood disorder

IV. Patients undergoing multiple surgeries

V. Patients scheduled for hemostatic surgery

VI. Revision surgeries

Sample size calculation

Sample size was calculated using the Cochrane's formula

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

N=sample size

Z= statistic value for a desired level of confidence=1.96

P=expected prevalence or proportion. From a previous study, P=17.9

d= precision, set at 0.05

Substituting in the formula gives a sample size of 226 participants

Sampling technique

Stratified random sampling technique. This study entailed participants from three surgical specialties providing 3 strata that demonstrate patients with similar surgical features. This assisted in obtaining a sample population that fully represents the population under study.

STUDY PROCEDURE AND DATA COLLECTION

Consenting procedure

Participants were recruited in the wards and casualty prior to transfer to the main theater and trauma theater to alleviate duress . The study was explained to the eligible patient by the researcher or the research assistant. Informed and written consent was requested from the patient. Data points collected were indicated in the data collection tool (questionnaire), including patient and surgical factors preoperatively and intraoperative blood and blood products usage in main and trauma theater as shown in Appendix VII. The research assistant was trained on acquisition of consents, questionnaire and was instructed on how to fill in the data collected.

The data collected were cross-checked, cleaned, categorized, and entered using the statistical analysis software package, SPSS version 23. The folder containing the data were password-protected and uploaded to a cloud storage drive and backup was done daily to prevent missing entries.

Access to data were granted only to statistician and no third party. Data deidentification was achieved through use of special codes that bear no relationship to participants names or other means of identification. After analysis and results presentation, data were immediately destroyed including all soft and hardcopy back-ups.

Data analysis and presentation

Measures of central tendency such as mean and standard deviation was used to describe variables with normal distribution while skewed distributions was described in terms of medians and interquartile ranges. Descriptive statistics such as frequencies and percentages were used to describe demographic characteristics like age and sex. Prevalence of intraoperative blood transfusion was the proportion of cross matched patients transfused to the total population. Patient and operative factors predictive of blood transfusion was analyzed by use of chi squared test through establishment of odds ratios, and 95% confidence intervals.

Correlation between continuous variables like age and number of units transfused and other categorical variables like type of surgery was assessed by use of independent sample T test. Paired sample T test was used to correlate two continuous variables like age and number of units transfused. The cut off for statistical significance was a P value of <0.05 for a 95% confidence interval

Quality Assurance

Design of the study questionnaire permitted compilation of significant data for this study. This was simple and well-defined to allow ease of use by the principal investigator / research assistant. The research assistant was trained on request of consent, how to fill in the data collection tool and revision on missing entries. Study assistance will get retrained where gaps are noted.

Data collection was closely supervised from the beginning of the study to the end. This ensured that data collection tool is correctly and completely filled. I managed to check the forms done by myself and the research assistant and upload the data daily to avoid missing entries.

Important data variables were monitored to ensure that they are filled correctly for both preoperative data and intra operative data. Preoperative data included patient factors and surgical factors while intra operative data included type and number of units transfused.

Challenges encountered throughout data collection was solved immediately to prevent inaccuracies from emerging in successive forms, more importantly at the start of data collection.

ETHICAL CONSIDERATION

Informed Consent: The patients were well-versed by the researcher on the basis and rationale of the study. Involvement was voluntary, and the participants were permitted to leave the study at any stipulated time according to their preference. A consent form was signed by the patient and the researcher.

Confidentiality: All participants remained anonymous, and identification was done by a unique patient identification number. Confidentiality and privacy were ensured throughout the length of the study.

Research Approval: Institutional consent was requested from the Ethics and Research committee of UON/KNH.

STUDY RESULTS

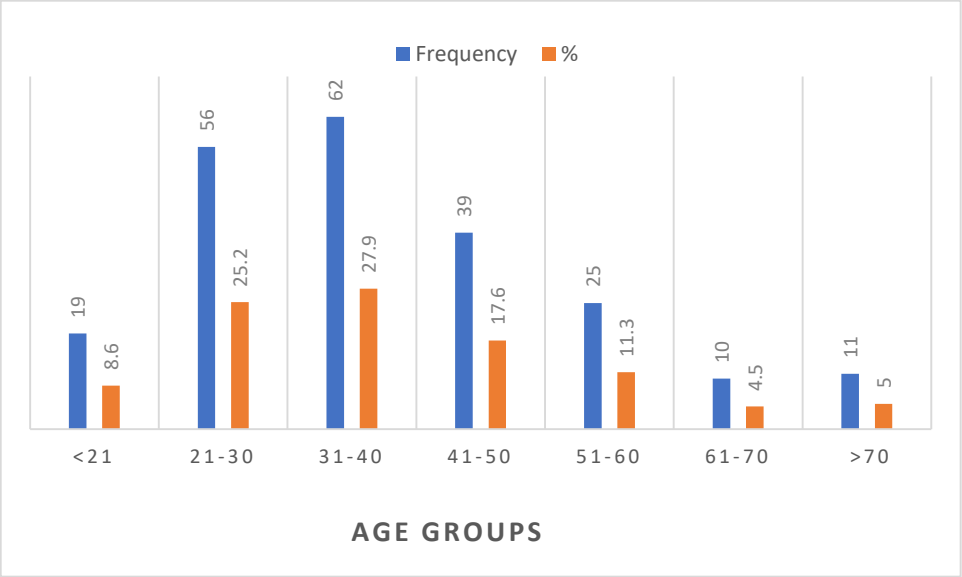
I: DEMOGRAPHICS

A total of 226 participants were approached, 4 were excluded from the study as they did not give consent to participate in the study. A total of 222 were recruited into the study and were taken through the study procedure.

Age and Comorbidities

Mean age of patients was 39.4yrs ± 15.3yrs (SD 15.3) ranging from 18 to 86yrs.

Figure I: population by broad age groups



Thirty-eight (17.1%) of the patients had associated comorbidities compromising of hypertension 20 (9%) [including one patient with Tuberculosis]; HIV with other comorbidities including PTB, Hypertension, Diabetes, 8 (3.6%); diabetes alone 4 (1.8%), hypertension with diabetes 4 (1.8%), and Epilepsy 1 (0.4%).

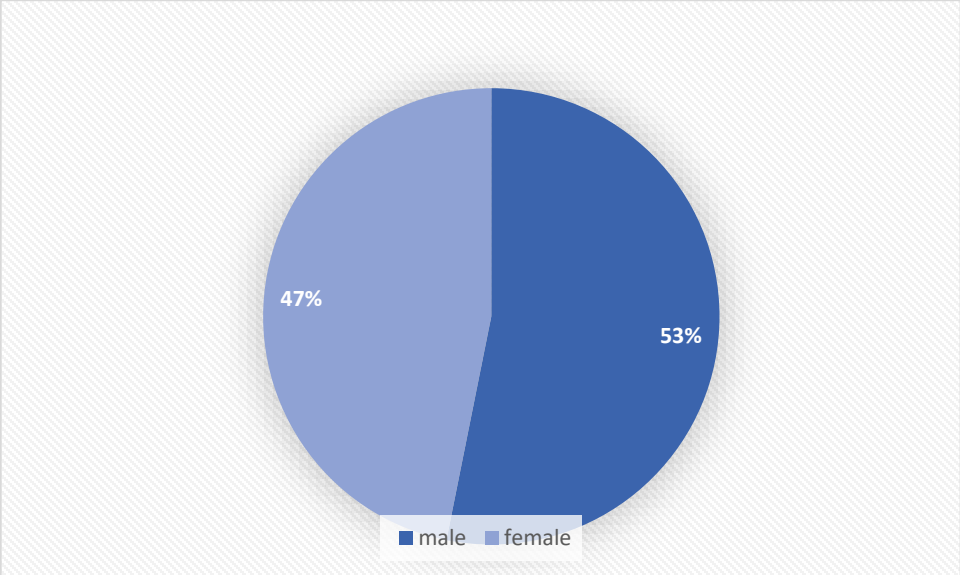
Table I: Frequency of common comorbidities among patients

Variable		**Frequency**	**%**
Comorbidities	No	184	82.9
	Yes	38	17.1

Gender category

104 participants (46.8%) were female, and the majority were male 118 participants (53.1%)

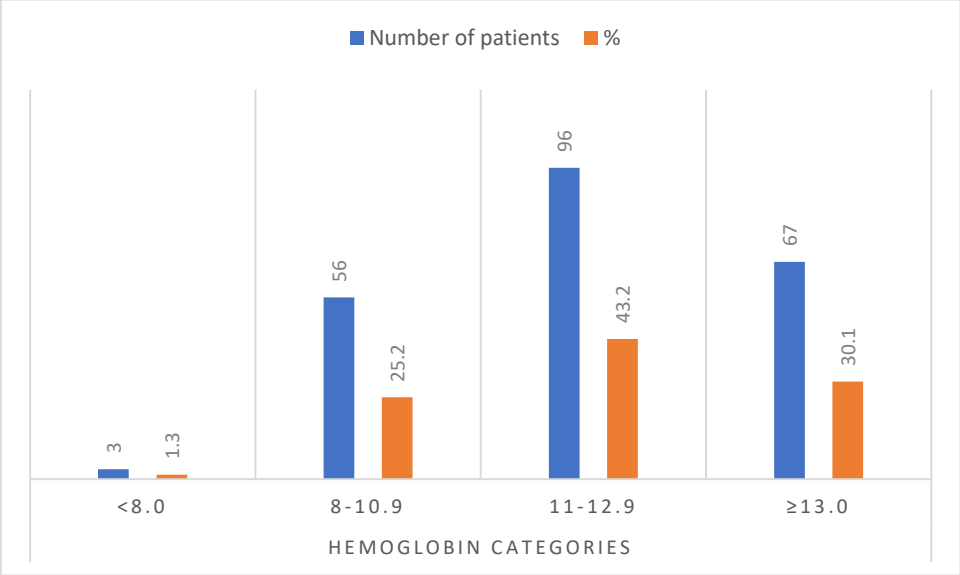
Figure II: Pie chart demonstrating population by gender



Preoperative Hemoglobin category

Overall mean preoperative haemoglobin level was 12.0 g/dL. Those with normal hemoglobin levels accounted for 30.1% (n=67). Conversely, participants with low hemoglobin levels accounted for 69.9 % (n= 155)

Figure III: bar chart demonstrating distribution of hemoglobin in different levels



ASA Classification

Ninety-three patients were ASA I (41.9%), ninety-five (42.8%) were ASA II, thirty-one (14.0%) contributed of ASA III, with one patient in ASA IV classification.

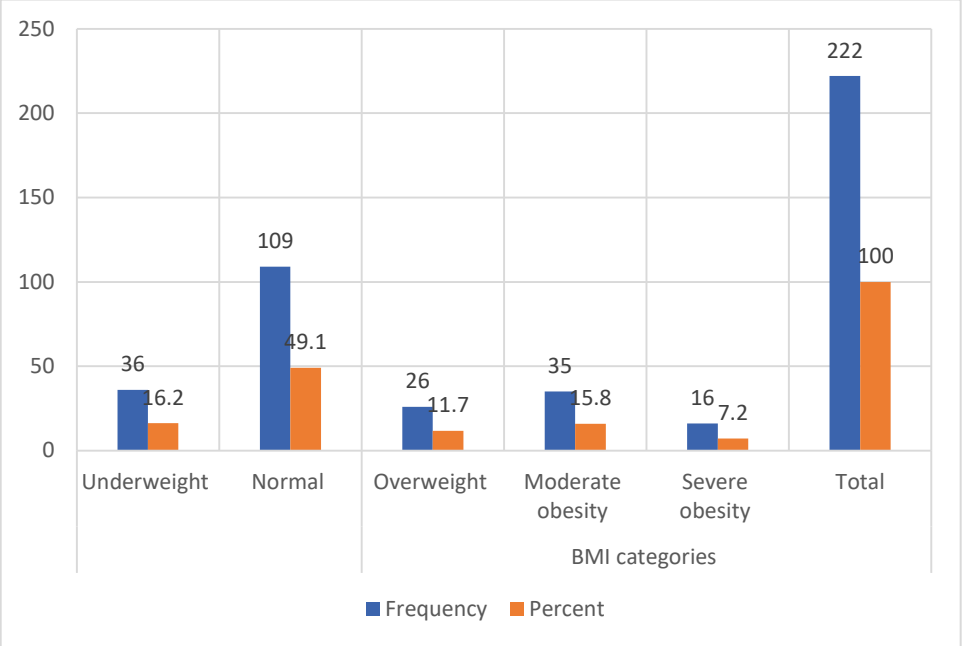
Table II: demonstrating distribution of ASA physical status classification

Variable		**Frequency**	**%**
ASA class	I	93	42.8
	II	95	42.8
	III	31	14.0
	IV	1	0.5

Body mass index

Mean body mass index was 22.0, with a range of 16.7 to 34.1. Majority (n =109) within normal category.

Figure IV: distribution of Body Mass Index in the population

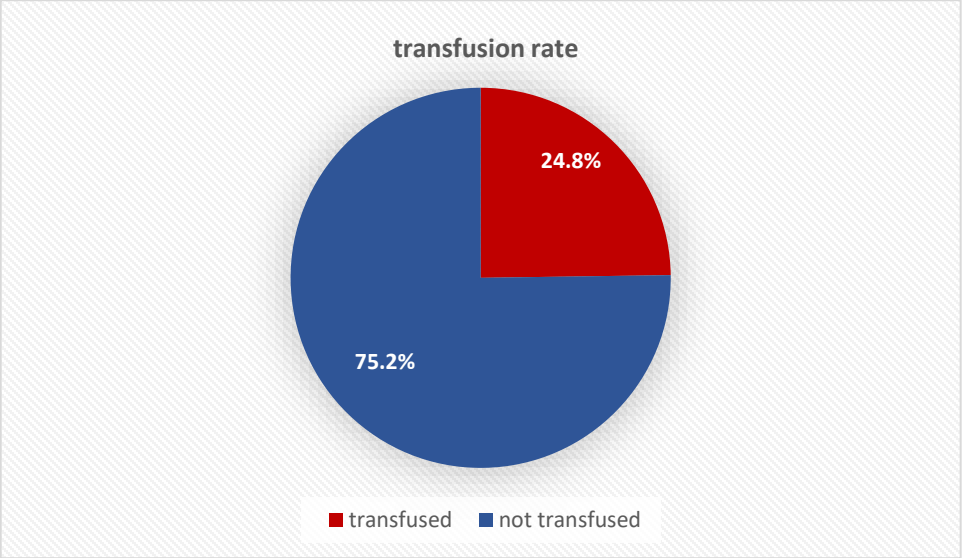


II: TRANSFUSION DETAILS

Prevalence:

A total of 55 participants were transfused intraoperatively. This determined prevalence of intraoperative blood transfusion in crossmatched adult patients undergoing general gynecological and orthopedic surgeries at KNH at 24.8%.

Figure V: pie chart showing blood and its products intraoperative transfusion rate



C/T ratio:

All 222 participants were crossmatched preoperatively and a total number 426 units of blood requested were with a total of seventy-nine units of blood and its products administered. The crossmatch: transfusion ratio was therefore 3.12: 1

Table III: total units of blood and products ordered and utilized

	Total Units	**Ratio**
Blood requested (crossmatched)	426	3.12: 1
Blood transfused	79	

Majority (41) of the patients (18.5%) received 1 unit of blood and blood products, while 14 (6.3%) received 2 units of blood. Only one patient received 3 units of blood plus blood products. Certain particular factors had varied influence on the transfusion rate.

Table IV: Number of units of blood transfused

Units of blood products transfused	**number of patients**	**(%)**
0	167	75.2
1	41	18.5
2	14	6.3
3	1	0.05

III:Relationship between the blood transfusion rate and patient characteristics

Age- the mean age of those transfused was 38.5 (SD 16.0) and mean age of those not transfused was 39.7 (SD 15.1). This this demonstrated there was no statistically significant difference between the two groups . (p= 0.61) Therefore, age cannot independently predict intra operative transfusion requirement.

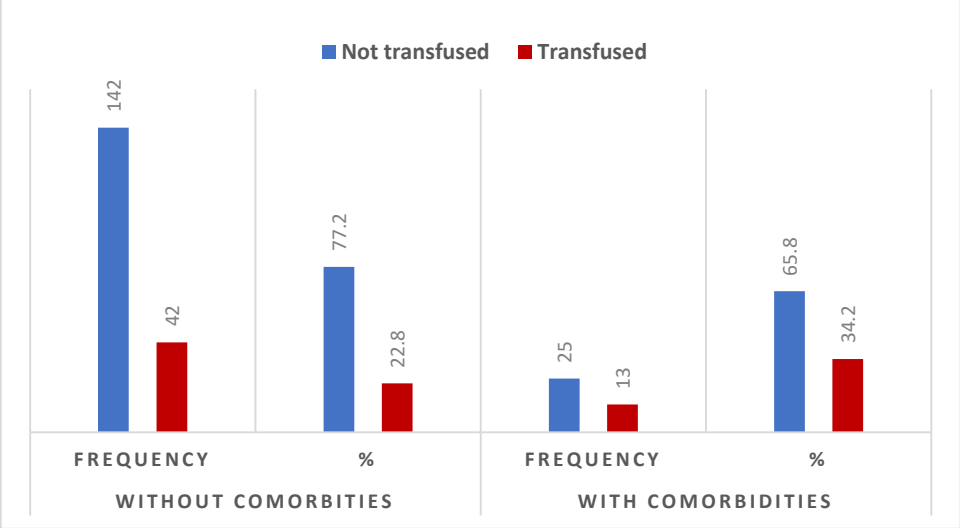
Table V: demonstrating mean ages between transfused and non-transfused groups

Patient transfused or not	**Not transfused**			**Transfused**			**P-value**
	Mean	**N**	**SD**	**Mean**	**N**	**SD**	
Age	39.7	167	15.1	38.5	55	16.0	0.61

Comorbidities- it was observed that among patients with comorbidities, intraoperative transfusion requirement was higher (34.2%) than in the group of patients without comorbidities (22.8%). However, this difference was not statistically significant (p = 0.15) to predict intraoperative transfusion requirements among patients with comorbidities.

Table VI: transfusion rate in those with or without comorbidities

Comorbidities	Not Transfused	Transfused
NO	142(77.2%)	42(22.8%)
YES	25(65.8%)	13(34.2%)



Gender- it was determined in the female group, 26% required intraoperative transfusion while in the male group 35.7% required blood transfusion intraoperatively. This difference was not statistically significant (p= 0.76)

Table VII: transfusion rate among the different genders in the population

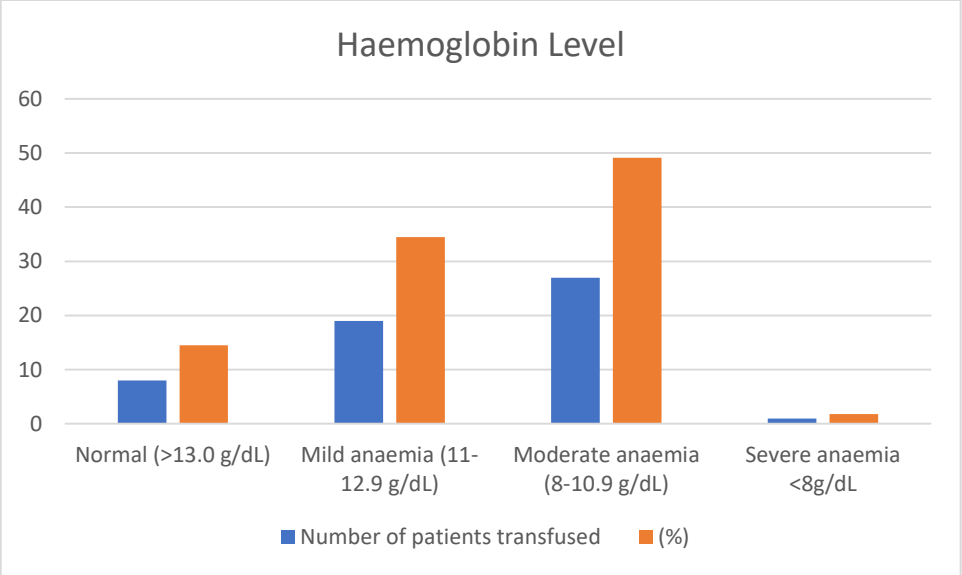
		Not Transfused	Transfused	P-value
Gender	Female	77 (74.0%)	27 (26.0%)	0.76
	Male	90 (76.3%)	28 (35.7%)	

Preoperative HB- intraoperative Transfusion requirement was higher in patients with preoperative anaemia. (Hb < 12.0 g/dL). It was determined, in the group of patients who required intraoperative transfusion the mean Hb was 10.9g/dL. Compared to a mean Hb of 12.4 in the group that didn't require intraoperative transfusion. This difference was statistically significant (p= <0.001, AOR 0.65, 95% CI 0.53-0.79) as a predictor of intraoperative blood transfusion in this study.

Table VIII: mean hemoglobin levels and association with intraoperative blood transfusion

	Not transfused			Transfused			P-value
	Mean	**N**	**SD**	**Mean**	**N**	**SD**	
Pre-operative Hb	12.4	167	2.1	10.9	55	1.6	**<0.001**

Figure VII: bar chart demonstrating hemoglobin levels in this population



ASA- in this study it was determined that there was no statistically significant difference in interpretive transfusion requirement among the four ASA class of patients (p= 0.16) However, an increase in transfusion rate was noted with higher ASA class patients.

Figure VIII: bar chart demonstrating intraoperative transfusion rate in ASA classification

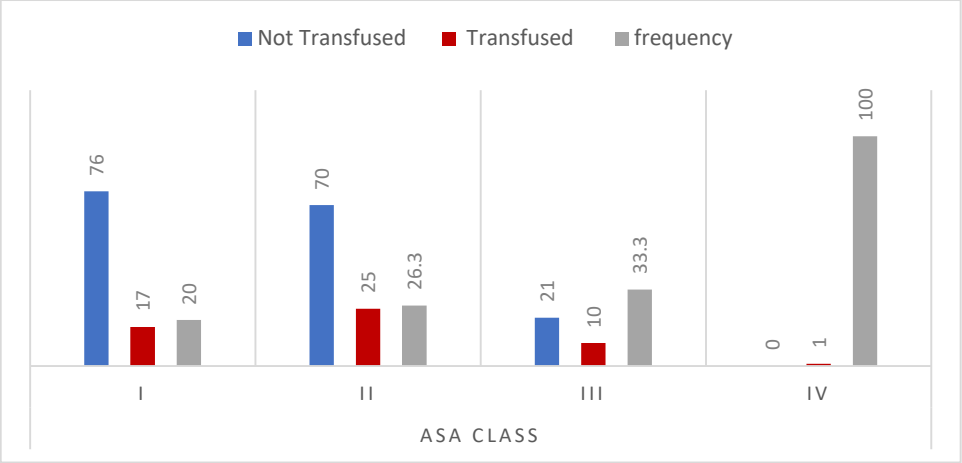


Table IX: demonstrating intraoperative transfusion rate in ASA classification

		Not Transfused	**Transfused**	**P-value**
ASA class	I	76 (80%)	17 (20%)	0.16
	II	70 (73.7%)	25 (26.3%)	
	III	21 (67.7%)	10 (33.3%)	
	IV	00	1 (100%)	

BMI- mean BMI of those who were transfused was 21.3 (SD 6.9) compared to the mean of those not transfused (22.3). this difference was not statistically significant (p= 0.23)

Table X: demonstrating intraoperative transfusion rate in Body Mass Index classification

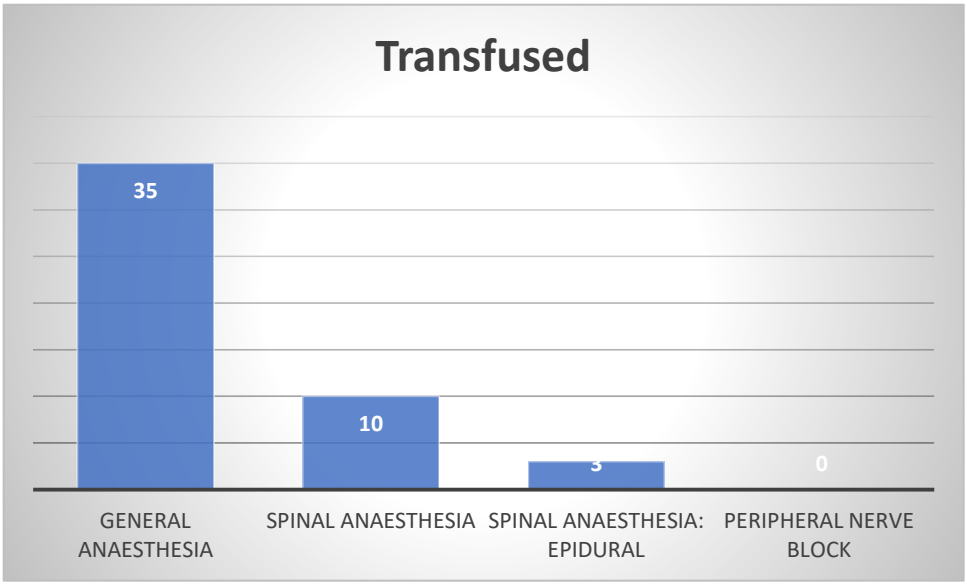
		NOT TRANSFUSED	**TRANSFUSED**
BMI CATEGORIES	underweight	23	13
	normal	90	19
	overweight	16	10
	Moderate obesity	26	9
	Severe obesity	12	4

V: Relationship between the blood transfusion rate and various operative factors

Type of anaesthesia

General anaesthesia [including two combined with epidural], Spinal anaesthesia, spinal combined with epidural anaesthesia [including those who received peripheral nerve blocks] , peripheral nerve block alone was used in 129 (58.1%), 67 (30.2%), 21 (9.5%), 5 (2.3%) of the operations respectively. Majority of those who received intraoperative blood transfusion received general anaesthesia (n= 35). However, there was no statistically significant difference between the group under general anaesthesia and those under neuraxial anaesthesia (p = 0.08).

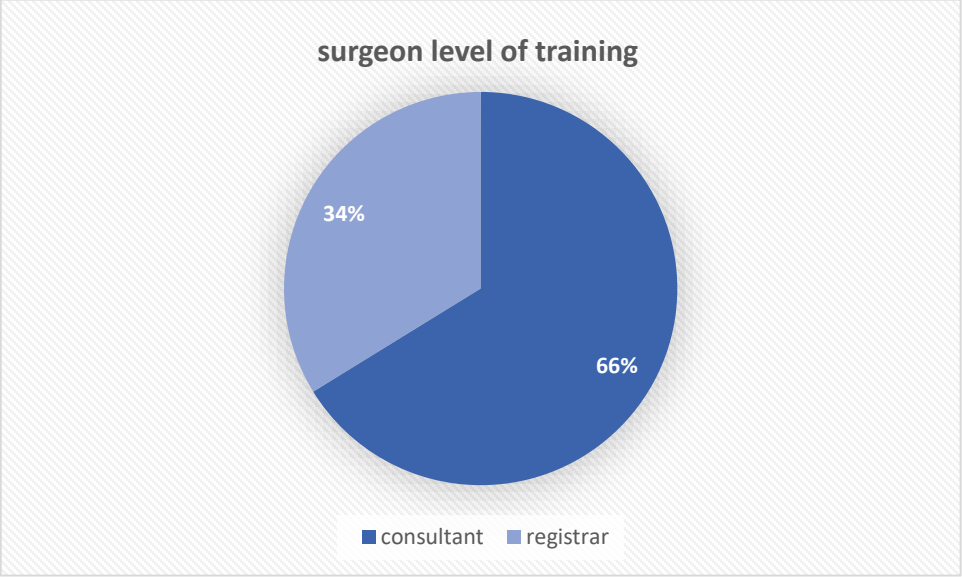
Figure IX: modes of anaesthesia and association with intraoperative blood transfusion



Surgical expertise

One hundred and forty-seven (66.2%) cases were performed by consultants including cases done by registrars under supervision while seventy-five (33.8%) were carried out by both senior and junior residents alone.

Figure X: pie chart demonstrating surgical expertise in this population



There was no statistically significant difference demonstrated with intraoperative blood transfusion requirement between the group managed by registrars and the group managed by consultants (p= 0.14).

Table XI: association of blood transfusion in different surgical expertise

		Not Transfused	**Transfused**	**P-value**
Surgeon specialty	Registrar	61(81.3%)	14(18.7%)	
	Consultant	106(72.1%)	41(27.9%)	0.14

DISCUSSION

Preoperative blood ordering (GXM) is frequently done for patients scheduled to undergo surgical procedures. Due to lack of standardized guidelines reproducible to all populations and institutions, most physicians determine whether a transfusion was necessary based on their clinical experience*(*62*)*. This has led to inefficient blood ordering, wastage of blood products with some studies showing up to 60-70% of prepared blood products going unused.(Asian study). Development of hospital-based prediction tools for intraoperative blood transfusion would guide the efficiency of preoperative blood ordering by enhancing the prediction accuracy of whether an intraoperative blood transfusion is necessary, and this may effectively resolve this challenge. Previous studies in other institutions mainly in the United States and Europe have utilized statistical analyses of patient related variables such as age, sex, weight, medications, comorbidities, and others to predict intraoperative blood transfusion (14)(15)(16)(18). No such study has addressed patients of Kenyan population, despite studies showing high cross- matched to transfused ratios. This study therefore aimed to determine the preoperative predictors for intraoperative blood transfusion among cross-matched patients undergoing general, gynecological and orthopedic surgeries at KNH. A cross-sectional study was thus conducted at the KNH Main Theater and Trauma Theater where 222 participants were recruited. Consenting participants were recruited in the wards where data were collected and filled in the questionnaire provided. Data were entered using SPSS (version 23). On completion of collection, data were analyzed and presented as figures, tables, graphs, and texts.

In this study, the prevalence of intraoperative transfusion in cross-matched patients was 24.8 %, indicating a non-utilization in 75.2% of patients. This result is similar to findings from a study in a tertiary hospital in Ethiopia that showed non utilization in 84.7% of the cross-matched patients. (25). Studies from Egypt and India have also found high non utilization of cross-matched blood at (74.8%) and (83.9%) respectively, similar to findings in this study.*(citation 15, 18 of Ethiopian study)*. These results confirm over ordering and inefficient utilization of blood products at Kenyatta National Hospital.

The cross match to transfusion ratio was determined in this study as an objective index for evaluation of efficiency of blood utilization. Ratios of 2.5:1 and below indicate appropriate usage of crossmatched blood but ratios above indicate usage of less than 40%. The C/T ratio was high at 3.12:1 in this study. Similarly, in a descriptive prospective survey of transfusion status at an orthopaedic trauma center in Iran, high C/T ratio of 6.4 was determined (63). A study from a tertiary hospital in Ethiopia also shows a high C/T ratio of 7.6 (26). Studies across the world showed inappropriate blood usage (C/T ratio > 2.5) including developing countries like Malaysia, Egypt, Tanzania and Zambia with C/T ratios 5.0, 3.9, 3.7 and 2.8 respectively, while relatively better usage was reported from Ethiopia and Nepal with C/T ratio of 2.3 and 2.5 respectively.*(get citations from Ethiopian study).* Our findings, while indicating better results than other developing countries, still confirm inefficient utilization of blood and blood products in general surgical, orthopaedic and gynaecolopgical surgeries at Kenyatta National Hospital.

Existing literature on the effect of age and comorbidities on intraoperative transfusion rates has shown a difference in findings by different investigators and therefore no consensus. Some

authors including Luca Salvatore de Santo et al found an association between older age and increased risk of intraoperative transfusion (27). Others found no statistically significant correlation. Kim j et al found that the prescence of comorbidities occurring together with age above 65 years had an association with a higher relative risk for perioperative transfusion (30). In this study, it was determined that neither age nor presence of comorbidity could independently predict intraoperative transfusion requirement, and this findings were further confirmed on multivariate regression analysis. This findings are therefore consistent with findings of Niv Ad et al's study that age, specifically older age did not predict intraoperative blood transfusion. (29)

In this study, gender was not found to be a predictor for intraoperative transfusion (p= 0.76). However, preoperative haemoglobin level was found to be a significant predictator for intraoperative blood transfusion, (p = <0.001), with patients in the transfused group having a mean haemoglobin of 10.9 g/dl. In contrast, Stammers et al established that female patients had a lower preoperative haematocrit than men and a 3 fold higher transfusion rate (45.1% vs 13.7%) (33). Desai et al corroborated this findings of higher transfusion rates associated with female gender (34). Unlike this study, Stammers et al's study was specific to patients undergoing Coronary artery bypass graft surgery and their sample size was 54,122 patients. These differences could explain the insignificant gender association to intraoperative transfusion observed in this study. Desai et al also found an association between need for intraoperative blood transfusion and a lower preoperative haemoglobin, similar to findings in this study(34). Kim J et al studied a group of general surgical patients to identify predictors for preoperative blood transfusion and found haematocrit less than 30% to be an independent risk factor for operative blood transfusion (30). Similarly, this study found preoperative haemoglobin less than 10.9 to significantly predict intraoperative transfusion requirement and therefore need for preoperative GXM in group of patients undergoing orthopaedic, gynaecological or general surgical procedures at K.N.H. At a tertiary hospital in Australia, Josephine et al studied orthopaedic patients to predict perioperative transfusion and similar to findings of this study, they found preoperative haemoglobin to be a predictor of operative transfusion (36). However, unlike our findings, they also found that female gender and age above 65 years was predictive of operative transfusion.

Sathiyakumar et al in 2016 published findings from their study on use of A.S.A class as a predictive tool to improve blood ordering for orthopaedic patients at a level 1 trauma centre. They found ASA class IV patients 14.7 times more likely to get intraop transfusion than ASA class I and therefore incooperated ASA classification in their instituitional surgical blood ordering schedule (49).Similarly, studies from African population have also shown ASA classification as a predictor of perioperative transfusion requirement (45). In this study, as much as there was an increase in transfusion rate noted with higher ASA class patients, similar to the above studies by Sathiyakumar et al and other African authors, it did not meet the statistical threshold to predict intraoperative transfusion requirement. This can likely be explained by the larger sample size of 1819 patients in Sathiyakumar et al's study as compared to this study which had a sample size of 222 patients**.**

Nolan et al did a retrospective review to determine B.M.I as an indicator of intraoperative transfusion and reported a higher B.M.I being associated with less risk of transfusion (48). Pandya et al did a cohort study and similarly found overweight and obese participants having less likelihood of receiving a transfusion (49). In contrast, Raphael sun et al (citation lit review)and Huimin et al (citation in lit review) in their studies in general surgical and gynaecological patients respectively found intraoperative blood transfusion was highest in patients with higher B.M.I . These contrasting findings could mean that B.M.I could have variable association with perioperative transfusion requirements in different populations and institutions. In this study, B.M.I was not shown to correlate with either lower or higher risk of intraoperative blood transfusion and therefore is not an independent predictor of intraoperative blood transfusion requirement in our institution.

In this study, the resident group and the consultant group did not show a statistically significant difference in intraoperative blood transfusion requirement. Overall there is a paucity of information regarding the consequence of surgeon experience on intraoperative blood transfusion need. In Bougie et al's meta-analytical study, Residents in obstetrics and gynaecology were demonstrated to have increased risk of blood transfusion in their procedures(cite from lit review). Iannuzi et al, using the North American College of Surgeons National Quality Improvement Program Database, concluded that Resident involvement in surgeries was related to higher risk for intraoperative transfusion.(citation from lit review)

DISSEMINATION PLAN

The study results were disseminated to the UON repository and the KNH/ UON research ethics committee.

The study results were disseminated to the Anesthesiology unit of KNH and UON.

The study results were disseminated to the study participants.

The research paper was submitted for publication to relevant journals.

STUDY LIMITATIONS

1) The study required data collected from multiple sites; that required extra research assistants that widened the financial burden.
2) Another limitation was unmeasured confounders, including but not limited to duration between admission and operative time, intraoperative blood loss, operative time
3) Larger sample size for the involved surgical specialties would have resulted in a different outcome.
4) To minimize the confounders, I recommend a follow-up study to review if the factors would have an independent influence on the dependent variable- intraoperative transfusion.

RECOMMENDATIONS

Larger sample size and a multicenter approach to the same study will give a more powerful result, generalizable to our population.

A similar study focusing on specific surgical specialties or specific factors patient and preoperative factors.

CONCLUSION

Prevalence of intraoperative transfusion was established at 24.8 %, with a crossmatch to transfused ratio of 3.12 :1, higher than the recommended less than 2:1. Preoperative anaemia of HB less than 10.9 g/dl was established as an independent predictor of intraoperative blood transfusion requirement. Follow up studies with a larger sample size is recommended to further strengthen results of this study and provide the threshold needed to inform establishment of hospital based guidelines and tools that prevent uneccesary preoperative group and crossmatch at K.N.H.

REFERERENCES

1. Singh JK, Singh P. Routine pre-operative cross-match for elective colorectal resections: an appropriate use of resources? Surgeon. 2011 Feb;9(1):8–12.

2. Ghirardo SF, Mohan I, Gomensoro A, Chorost MI. Routine preoperative typing and screening: a safeguard or a misuse of resources. JSLS. 2010 Sep;14(3):395–8.

3. Miller's Anesthesia, 2-Volume Set - 9th Edition [Internet]. [cited 2021 Oct 21]. Available from: https://www.elsevier.com/books/millers-anesthesia-2-volume-set/gropper/978-0-323-59604-6

4. Bernard AC, Davenport DL, Chang PK, Vaughan TB, Zwischenberger JB. Intraoperative Transfusion of 1 U to 2 U Packed Red Blood Cells Is Associated with Increased 30-Day Mortality, Surgical-Site Infection, Pneumonia, and Sepsis in General Surgery Patients. Journal of the American College of Surgeons. 2009 May;208(5):931-937.e2.

5. Musumari PM, Mbikayi SM, Srithanaviboonchai K, Techasrivichien T, Tangmunkongvorakul A, Tshilolo L. Symptoms of acute transfusion reactions at a general referral hospital in Kinshasa, Democratic Republic of Congo: a cross-sectional study. BMJ Open. 2021 Jul 21;11(7):e045081.

6. Sahu S, Hemlata null, Verma A. Adverse events related to blood transfusion. Indian J Anaesth. 2014 Sep;58(5):543–51.

7. Cohen R, Lima A, Escorcia A, Tasmin F, Lin Y, Lieberman L, et al. Serologic assessments in acute transfusion reactions: practices and yields. Vox Sang. 2019 Oct;114(7):749–61.

8. Mahdy AM, Webster NR. Perioperative systemic haemostatic agents. British Journal of Anaesthesia. 2004 Dec;93(6):842–58.

9. Santos AA dos, Silva JP da, Silva L da F da, Sousa AG de, Piotto RF, Baumgratz JF. Therapeutic options to minimize allogeneic blood transfusions and their adverse effects in cardiac surgery: a systematic review. Rev Bras Cir Cardiovasc. 2014 Dec;29(4):606–21.

10. Shah A, Palmer AJR, Klein AA. Strategies to minimize intraoperative blood loss during major surgery. British Journal of Surgery. 2020 Jan 5;107(2):e26–38.

11. Theusinger OM, Felix C, Spahn DR. Strategies to reduce the use of blood products: a European perspective. Curr Opin Anaesthesiol. 2012 Feb;25(1):59–65.

12. Roback JD, Waxman DA. Guidelines for Patient Blood Management and Blood Utilization. 2011;3.

13. Gatheru AP. Blood requests, crossmatch and transfusion practices for elective surgery in Kenyatta National Hospital. :59.

14. Practice Guidelines for Perioperative Blood Management: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Blood Management*. Anesthesiology. 2015 Feb 1;122(2):241–75.

15. Morton LJ, Konrad KL, Xu TJ, Lightfoot NJ. The interaction between pre-operative anaemia and peri-operative blood transfusion on patient outcomes following general surgical procedure: a retrospective review. N Z Med J. 2019 Oct 4;132(1503):13–24.

16. Kyei MY, Klufio GO, Mensah JE, Gepi-Attee S, Ampadu K, Toboh B, et al. Determinants of peri-operative blood transfusion in a contemporary series of open prostatectomy for benign prostate hyperplasia. BMC Urol. 2016 Mar 28;16:17.

17. Aderinto J, Brenkel IJ. Pre-operative predictors of the requirement for blood transfusion following total hip replacement. The Journal of Bone and Joint Surgery British volume. 2004 Sep;86-B(7):970–3.

18. van Klei WA, Moons KGM, Rheineck Leyssius AT, Knape JTA, Rutten CLG, Grobbee DE. A reduction in Type and Screen: preoperative prediction of RBC transfusions in surgery procedures with intermediate transfusion risks †. British Journal of Anaesthesia. 2001 Aug;87(2):250–7.

19. Varghese R, Jhang J. Blood Conservation in Cardiac Surgery: In Need of a Transfusion Revolution. Semin Cardiothorac Vasc Anesth. 2015 Dec;19(4):293–301.

20. Basora M, Tió M, Martin N, Lozano L, Salazar F, Sánchez-Etayo G, et al. Should all patients be optimized to the same preoperative hemoglobin level to avoid transfusion in primary knee arthroplasty? Vox Sang. 2014 Aug;107(2):148–52.

21. Practice Guidelines for Perioperative Blood Management: An Updated Report by the American Society of Anesthesiologists Task Force on Perioperative Blood Management*. Anesthesiology. 2015 Feb 1;122(2):241–75.

22. Yazer MH, Alcantara R, Beizai P, Draper NL, Harm SK, Kutner JM, et al. The Crossmatch/Issue Ratio: Use of a Novel Quality Indicator and Results of an International Survey on RBC Crossmatching and Issuing Practices. Am J Clin Pathol. 2016 Aug;146(2):238–43.

23. Woodrum CL, Wisniewski M, Triulzi DJ, Waters JH, Alarcon LH, Yazer MH. The effects of a data driven maximum surgical blood ordering schedule on preoperative blood ordering practices. Hematology. 2017 Oct;22(9):571–7.

24. Ogbemudia AE, Yee SY, MacPherson GJ, Manson LM, Breusch SJ. Preoperative predictors for allogenic blood transfusion in hip and knee arthroplasty for rheumatoid arthritis. Arch Orthop Trauma Surg. 2013 Sep;133(9):1315–20.

25. 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.

26. Zewdie K, Genetu A, Mekonnen Y, Worku T, Sahlu A, Gulilalt D. Efficiency of blood utilization in elective surgical patients. BMC Health Serv Res. 2019 Nov 6;19(1):804.

27. De Santo LS, Romano G, Mango E, Iorio F, Savarese L, Numis F, et al. Age and blood transfusion: relationship and prognostic implications in cardiac surgery. J Thorac Dis. 2017 Oct;9(10):3719–27.

28. Dai CQ, Wang LH, Zhu YQ, Xu GH, Shan JB, Huang WC, et al. Risk factors of perioperative blood transfusion in elderly patients with femoral intertrochanteric fracture. Medicine. 2020 Apr;99(15):e19726.

29. Ad N, Massimiano PS, Burton NA, Halpin L, Pritchard G, Shuman DJ, et al. Effect of patient age on blood product transfusion after cardiac surgery. The Journal of Thoracic and Cardiovascular Surgery. 2015 Jul 1;150(1):209–14.

30. Kim J, Konyalian V, Huynh R, Mittal R, Stamos M, Kumar R. Identification of predictive factors for perioperative blood transfusion in colorectal resection patients. Int J Colorectal Dis. 2007 Dec;22(12):1493–7.

31. Chaparro CM, Suchdev PS. Anemia epidemiology, pathophysiology, and etiology in low- and middle-income countries. Annals of the New York Academy of Sciences. 2019 Aug;1450(1):15.

32. Omuse G, Maina D, Mwangi J, Wambua C, Radia K, Kanyua A, et al. Complete blood count reference intervals from a healthy adult urban population in Kenya. Nagler M, editor. PLoS ONE. 2018 Jun 7;13(6):e0198444.

33. Stammers AH, Tesdahl EA, Mongero LB, Stasko A. Gender and intraoperative blood transfusion: analysis of 54,122 non-reoperative coronary revascularization procedures. Perfusion. 2019 Apr 1;34(3):236–45.

34. Desai SJ, Wood KS, Marsh J, Bryant D, Abdo H, Lawendy AR, et al. Factors affecting transfusion requirement after hip fracture: can we reduce the need for blood? Can J Surg. 2014 Oct;57(5):342–8.

35. Gombotz H, Schreier G, Neubauer S, Kastner P, Hofmann A. Gender disparities in red blood cell transfusion in elective surgery: a post hoc multicentre cohort study. BMJ Open. 2016 Dec 1;6(12):e012210.

36. To J, Sinha R, Kim SW, Robinson K, Kearney B, Howie D, et al. Predicting Perioperative Transfusion in Elective Hip and Knee ArthroplastyA Validated Predictive Model. Anesthesiology. 2017 Aug 1;127(2):317–25.

37. Wolf AM, Pucci MJ, Gabale SD, McIntyre CA, Irizarry AM, Kennedy EP, et al. Safety of perioperative aspirin therapy in pancreatic operations. Surgery. 2014 Jan 1;155(1):39–46.

38. null null. Bridging Anticoagulation. Circulation. 2012 Mar 27;125(12):e496–8.

39. Thiessen L, Grabowski D, Siragusa L, Young RS. Bridging Protocol for Surgical Patients: One Clinic's Experience Facilitating a Safe Anticoagulation Intervention. Journal of PeriAnesthesia Nursing. 2015 Dec 1;30(6):476–86.

40. Matsuoka T, Kobayashi K, Lefor AK, Sasaki J, Shinozaki H. Antithrombotic drugs do not increase intraoperative blood loss in emergency gastrointestinal surgery: a single-institution propensity score analysis. World J Emerg Surg. 2019 Dec;14(1):63.

41. He Q, Yu Y, Gao F. Meta-analysis of the effect of antithrombotic drugs on perioperative bleeding in BPH surgery. Exp Ther Med. 2020 Oct;20(4):3807–15.

42. Nikolakopoulos I, Spyropoulos AC. Heparin Bridging Therapy for Patients on Chronic Oral Anticoagulants in Periprocedural Settings. Semin Thromb Hemost. 2020 Feb;46(1):26–31.

43. Doyle DJ, Goyal A, Bansal P, Garmon EH. American Society of Anesthesiologists Classification. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 [cited 2021 Oct 29]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK441940/

44. Kim SY. The Definition of Obesity. Korean J Fam Med. 2016;37(6):309.

45. Daabiss M. American Society of Anaesthesiologists physical status classification. Indian Journal of Anaesthesia. 2011 Apr;55(2):111.

46. Kadia BM, Chichom-Mefire A, Halle-Ekane GE. Exploring the role of obesity and overweight in predicting postoperative outcome of abdominal surgery in a sub-Saharan African setting: a prospective cohort study. BMC Res Notes. 2018 Dec;11(1):742.

47. Ri M, Aikou S, Seto Y. Obesity as a surgical risk factor. Ann Gastroenterol Surg. 2018 Jan;2(1):13–21.

48. Nolan H, Davenport D, Ramaiah C. pandya. Int J Angiol. 2013 Feb 5;22(01):031–6.

49. Pandya LK, Lynch CD, Hundley AF, Nekkanti S, Hudson CO. The incidence of transfusion and associated risk factors in pelvic reconstructive surgery. American Journal of Obstetrics and Gynecology. 2017 Nov;217(5):612.e1-612.e8.

50. Sun RC, Button AM, Smith BJ, Leblond RF, Howe JR, Mezhir JJ. A comprehensive assessment of transfusion in elective pancreatectomy: risk factors and complications. J Gastrointest Surg. 2013 Apr;17(4):627–35.

51. Lv H, Wu S. Influence of obesity on surgical complications of patients with ovarian tumors. Oncol Lett. 2019 May;17(5):4590–4.

52. Modig J. Regional anaesthesia and blood loss. Acta Anaesthesiol Scand Suppl. 1988;89:44–8.

53. Rashiq S, Shah M, Chow AK, O'Connor PJ, Finegan BA. Predicting allogeneic blood transfusion use in total joint arthroplasty. Anesth Analg. 2004 Oct;99(4):1239–44, table of contents.

54. Mauermann WJ, Shilling AM, Zuo Z. A comparison of neuraxial block versus general anesthesia for elective total hip replacement: a meta-analysis. Anesth Analg. 2006 Oct;103(4):1018–25.

55. Richman JM, Rowlingson AJ, Maine DN, Courpas GE, Weller JF, Wu CL. Does neuraxial anesthesia reduce intraoperative blood loss? A meta-analysis. J Clin Anesth. 2006 Sep;18(6):427–35.

56. Iannuzzi JC, Chandra A, Rickles AS, Kumar NG, Kelly KN, Gillespie DL, et al. Resident involvement is associated with worse outcomes after major lower extremity amputation. Journal of Vascular Surgery. 2013 Sep 1;58(3):827-831.e1.

57. Bougie O, Zuckerman SL, Switzer N, How J, Sey M. Influence of Resident Involvement in Obstetrics and Gynaecology Surgery on Surgical Outcomes: Systematic Review and Meta-Analysis. Journal of Obstetrics and Gynaecology Canada. 2018 Sep;40(9):1170–7.

58. van Klei WA, Moons KGM, Rheineck Leyssius AT, Knape JTA, Rutten CLG, Grobbee DE. A reduction in Type and Screen: preoperative prediction of RBC transfusions in surgery procedures with intermediate transfusion risks†. British Journal of Anaesthesia. 2001 Aug 1;87(2):250–7.

59. Owiti A. Study of the patterns of utilisation of blood and blood products, and (b) the status of subgroups of blood group A (A1) and A 2) at the Kenyatta National Hospital [Internet] [Thesis]. 1987 [cited 2021 Jun 4]. Available from: http://erepository.uonbi.ac.ke/handle/11295/107455

60. Muriithi MP. Blood Transfusion In Elective Orthopaedic Surgeries At The Kenyatta National Hospital [Internet] [Thesis]. University of Nairobi; 2013 [cited 2021 Jun 16]. Available from: http://erepository.uonbi.ac.ke/handle/11295/58680

61. The blood supply in Sub-Saharan Africa: needs, challenges, and solutions - PubMed [Internet]. [cited 2021 Oct 29]. Available from: https://pubmed.ncbi.nlm.nih.gov/23871466/

62. Hall TC, Pattenden C, Hollobone C, Pollard C, Dennison AR. Blood Transfusion Policies in Elective General Surgery: How to Optimise Cross-Match-to-Transfusion Ratios. Transfus Med Hemother. 2013 Feb;40(1):27–31.

63. Soleimanha M, Haghighi M, Mirbolook A, Sedighinejad A, Mardani-Kivi M, Naderi-Nabi B, et al. A Survey on Transfusion Status in Orthopedic Surgery at a Trauma Center. Arch Bone Jt Surg. 2016 Jan;4(1):70–4.

APPENDIX I: STUDY TIMELINE

	Dec-June 2021	Jul/Aug 2021	Sept-Nov2021	Dec/Feb 2022	Mar 2022	April 2022
proposal the development						
protocol presentation						
ethical approval						
data collection						
data analysis						
results presentation						

APPENDIX II: BUDGET

CONCEPT/ ITEM	**QUANTITY**	**UNIT COST**	**TOTAL (KSH.)**
KNH/UON ethics & research processing fee	1	2000	2000
Research assistants	2	20,000	40,000
Statistician	1	30,000	30,000
Contingency			30,000
Stationery			35,000
TOTAL			**137,000**

APPENDIX III: CONSENT EXPLANATION FORM (ENGLISH VERSION)…

I am Dr Winnie Warau Waweru, a post graduate student in the department of anesthesia at the university of Nairobi.

I would like to invite you to participate in our study that I am conducting on preoperative predictors of intra operative transfusion in general surgery gynecology and orthopedics in crossed matched adults at KNH. This informed consent includes the information sheet and a certificate of consent if you agree to take part.

Study Background

Intraoperative blood transfusion is necessary when indicated during surgeries. But not all crossmatched patients require the units prepared for the surgeries. Preoperative factors may influence the probability of intraoperative transfusion and serve as a guide in determining which patients wasnefit from GXM.

Study objective

To determine preoperative predictors for intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecologic and orthopedic surgeries at Kenyatta National Hospital.

Voluntariness of participation

Your participation in this study is entirely voluntary. You reserve the right to withdraw from the study at any stage. No treatment was withheld from nonconsenting patients. Moreover, there was no additional treatment or drugs given because of this study.

Confidentiality

I will not use your name for confidentiality purposes. This will guarantee that the data collected will remain confidential

Benefits

This study will help health care providers improve the management of patients undergoing surgery for the respective specialty.

Risks

You are not exposed to any risks as a result of this study. I will contribute to the care given to you as a healthcare provider.

CONSENT FORM

I …… do confirm but I have read stroke been explained to the above study coma understood the information presented to me and have had the opportunity to ask questions. I understand that my participation is voluntary in that I am free to withdraw from this study at any time without giving reason.

I agree to take part out of my own free will and no cohesion or incentive has been offered.

Signature of participant…… Date ……..

Signature of investigator …… Date ……..

List of investigators/co-investigators

Principal Researcher
Dr. Winnie Warau Waweru
Registrar, Department of Anaesthesia
College of Health Sciences
University of Nairobi
P.O Box 4847-00100 Nairobi.
Tel. 0713470682
Email.wwarau03@students.uonbi.ac.ke

Research Supervisors:
Dr. Gacii Vernon Mark
Lecturer in department of Anaesthesia
College of Health Sciences
University of Nairobi
P.O Box 21586-00505
Nairobi, Kenya.
email: vernon.gacii@uonbi.ac.ke

Dr. Timothy Murithi Mwiti
Lecturer in department of Anaesthesia
College of Health Sciences
University of Nairobi
P.O Box 21586-00505
Nairobi, Kenya.
Email: tmwiti@uonbi.ac.ke

APPENDIX IV: CONSENT EXPLANATION FORM (SWAHILI VERSION) IDHINI YA KUSHIRIKI

Jina langu ni Daktari Winnie Warau Waweru, ninafanya uatfiti wa shahada ya juu katika anaesthesia kwenye Chuo Kikuuu cha Nairobi.

Kama sehemu ya masomo yangu nahitajika kufanya utafiti wa hospitalini, nautafiti wangu ni juuya: '***preoperative predictors for intraoperative blood transfusion in crossmatched adult patients undergoing general, gynaecologic and orthopaedic surgeries.***'

Maelezo

Huu utafiti unahusu kujua jinsi wagonjwa wanapata damu kulingana na mahitaji ya mgonjwa inayolingana na tathmini ya ustawi ya ayfa ule muda ambao wanafaa kufanyiwa upasuaji. Utafiti huu utasaidia wauuguzi kuboresha huduma wagonjwa wanapata kwenye Hospitali Kuu ya Kenyatta.

Nia

Nia yangu ni kuweza kutathmini idadi ya wagonjwa wanao pokea damu wakati wanafanywa upasuaji.

Hatari

Utafiti huu hauhusishi kuongezewa madawa yeyote au upasuaji mwingine isipokuwa ule ulikuwa unahitaji. Hii inafanya kusikuwe nahatari yotote kwa mgonjwa anaposhiriki utafiti huu.

Faida ya utafiti

Matokeo ya utafiti huu utasaidia kuboresha huduma za afya wagonjwa wapewa wakiwa katika vyumba vya upasuaji.

Kushiriki

Kushiriki utafiti huu ni kwa hali ya kujitolea. Hakuna malipo kushiriki wala fidia yoyote utakayo pata kwa kushiriki utafiti. Kutokubali kushiriki hakuta kuwa na madhdara yoyote kwa matibabu yako. Matibabu yata endelea kama vile yalikuwa yamepangiwa. Uko na ruhusa ya kutoka katika utafiti huu wakati wowote bila kukatiza matibabu yako.

Usiri

Baadaye nitafanya uchambuzi wa takwimuna taarifa hii itachapishwa katika kitabu ambacho kitakuwa chini ya mamlaka Chuo Kikuu cha Nairobi. Taarifa zote zitawekwa kwa usiri.

Naomba kukupa fursa ya kuuliza maswali yoyote yanayo husiana na utafiti huu. Ikiwa umekubali kushiriki, tafadhali sahihi kwenye nafasi iliyotolewa.

Asante.

SHAHADA YA IDHINI

Mimi……naitikia ya kwamba nimesoma na nimeelezwa kuhusu utafiti hu una nimeelwa. Nimepata nafasi ya kuuliza maswali niliyokuwa nayo. Naelewa kushiriki ni kwa hiari yang una nikona ruhusa ya kusimamisha kushiriki kwangu wakati wowote ule bila madhara kwangu. Nimeelewa pia hakuna malipo au fidia kushiriki kiutafiti huu.

Sahihi ya mgonjwa……..
Tarehe…….

Sahihi ya mtafiti…….
Tarehe……..

Orodha ya wachunguzi

Mtafiti Mkuu
Dr. Winnie Warau Waweru
Registrar, Department of Anaesthesia
College of Health Sciences
University of Nairobi
P.O Box 4847-00100 Nairobi.
Tel. 0713470682
Email. wwarau22@gmail.com, wwarau03@students.uonbi.ac.ke

Wasimamizi wa Utafiti:
Dr. Gacii Vernon Mark
Lecturer in department of Anaesthesia
College of Health Sciences
University of Nairobi
P.O Box 21586-00505
Nairobi, Kenya.
email: vernon.gacii@uonbi.ac.ke

Dr. Timothy Murithi Mwiti
Lecturer in department of Anaesthesia
College of Health Sciences
University of Nairobi
P.O Box 21586-00505
Nairobi, Kenya.
Email: tmwiti@uonbi.ac.ke

APPENDIX V: DATA COLLECTION FORM

RESEARCH QUESTIONNAIRE

Patient code ……

PATIENT FACTORS

DEMOGRAPHICS

Age ……. (years)

Sex (M/F)

Weight ……kg. Height……cm

BMI ……. (kg/m^2)

Preop HB…… (g/dl)

INR…….

Number of blood/blood products units

requested…….

Comorbidities NO ( ) YES ( )

If yes, list the comorbidities.

……

……

……

……

……

Preoperative coagulant medications

……

……

ASA classification …….

ANAESTHESIA FACTORS:

1) Mode of anaesthesia

a) General anaesthesia

b) Regional anaesthesia (specify)

……

……

c) Combine GA and RA

……

2) Intraoperative fluid management

a) Crystalloids …….. (mls)

b) Colloids …….. (mls)

3) Anaesthetic homeostatic methods

a) permissive hypotensive anesthesia ( )

b) blood products e.g., FFPs, platelets. ( )

c) pharmacologic e.g., tranexamic, Vit K, protamine ( )

SURGICAL FACTORS

1) History of previous surgery: yes ( ) no ( )

If yes give details

……

……

……
……

2) History of blood transfusion

YES ( ) NO ( )

If yes give reasons,

……
……

3) Current surgical procedure

a) Procedure type
b) Elective ( ) Emergency ( )
c) Level of specialization: Consultant ( ) Registrar ( )
d) Duration of surgery …….(hrs.) ……(mins)
e) Estimated blood loss ……..
f) Surgical homeostatic procedures
    i) ligation of blood vessels ( )
    ii) surgical cauterization ( )
    iii) torniquet use ( )
    iv) topical agents e.g., surgical ( )
g) type of transfusion
    i) allogenic ( )
    ii) autologous ( )

4) Blood products transfused

a) Whole blood ( )
b) Packed cells. ( )
c) FFPs ( )
d) Platelets ( )

5) How many pints of blood product(s) were transfused?

……
……
……..

UNIVERSITY OF NAIROBI
FACULTY OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
Tel:(254-020) 2726300 Ext 44355

KNH-UON ERC
Email: uonknh_erc@uonbi.ac.ke
Website: http://www.erc.uonbi.ac.ke
Facebook: https://www.facebook.com/uonknh.erc
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC

KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/421

8th November 2021

Dr. Winnie Warau Waweru
Reg. No.H58/11314/2018
Dept.of Anaesthesia
Faculty of Health Sciences
University of Nairobi

KENYATTA NATIONAL HOSPITAL APPROVED 08 NOV 2021 KNH/UON-ERC

Dear Dr. Waweru

RESEARCH PROPOSAL: PREOPERATIVE PREDICTORS FOR INTROPERATIVE BLOOD TRANSFUSION IN CROSSMATCHED ADULT PATIENTS UNDERGOING GENERAL, GYNAECOLOGIC AND ORTHOPAEDIC SURGERIES (P688/08/2021)

This is to inform you that KNH-UoN ERC has reviewed and approved your above research proposal. Your application approval number is **P688/08/2021.** The approval period is 8th November 2021 – 7th November 2022.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by KNH-UoN ERC
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to KNH-UoN ERC 72 hours of notification
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH-UoN ERC within 72 hours
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to KNH-UoN ERC.

PREOPERATIVE PREDICTORS FOR INTROPERATIVE BLOOD TRANSFUSION IN CROSSMATCHED ADULT PATIENTS UNDERGOING GENERAL, GYNAECOLOGIC AND ORTHOPAEDIC SURGERIES.

ORIGINALITY REPORT

13%	6%	8%	5%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to University of Dundee Student Paper	3%
2	www.ncbi.nlm.nih.gov Internet Source	1%
3	Submitted to Liverpool John Moores University Student Paper	1%
4	erepository.uonbi.ac.ke Internet Source	<1%
5	fcd.mcw.edu Internet Source	<1%
6	worldwidescience.org Internet Source	<1%
7	Ji Hoon Sim, Hye-Mee Kwon, In-Gu Jun, Sung-Hoon Kim, Bomi Kim, Sehee Kim, Jun-Gol Song, Gyu-Sam Hwang. "Association Between Red Blood Cell Distribution Width and	<1%