ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCE

SCHOOL OF MEDICINE

DEPARTMENT OF CARDIOLOGY

ASSESSMENT OF PERIOPERATIVE FACTORS AND POSTOPERATIVE OUTCOMES ASSOCIATED WITH PROLONGED CARDIOPULMONARY BYPASS DURATION IN OPEN HEART SURGERY: A RETROSPECTIVE CROSS-SECTIONAL STUDY, AT TASH AND CCE HOSPITAL IN ADDIS ABABA, ETHIOPIA, 2025 G.C.

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THIS PROPOSAL Will BE SUMBITTED TO ADDIS ABABA UNVERSITY SCHOOL OF MEDICINE AND THE DEPARTMENT OF CARDIOLOGY, FOR PARTIAL FULFILMENT OF THE REQUIRMENTS FOR A MASTER'S IN CLINICAL CARDIOVASCULARE PERFUSION.

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COLLEGE OF MEDICINE AND HEALTH SCIENCE

DEPARTEMENT OF CARDIOLOGY

MASTER OF SCIENCE IN CARDIOVASCULAR PERFUSION

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Full title of the research project	**ASSESSMENT OF PERIOPERATIVE FACTORS AND POSTOPERATIVE OUTCOMES ASSOCIATED WITH PROLONGED CARDIOPULMONARY BYPASS DURATION IN OPEN HEART SURGERY**: a retrospective cross-sectional study, at Tash and CCE hospital in Addis Ababa, Ethiopia, 2025 G.C.
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Declaration

I, the undersigned, hereby certify that the research titled "Assessment of perioperative factors and postoperative outcomes associated with prolonged cardiopulmonary bypass duration in open heart surgery: a retrospective cross-sectional study, at TASH and CCE hospital in Addis Ababa, Ethiopia, 2025 G.C" is my original work, submitted in partial fulfilment of the requirements for the Master of Science degree in Cardiovascular Perfusion. I acknowledge that plagiarism is unacceptable, and all directly cited content has been properly referenced.

Investigator

Name: _____ Signature: _____Date _____

Approval of the Board of Examiners

Advisor

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Internal Examiner

2. Name _____ Signature _____ Date _____

External Examiner

3. Name _____ Signature _____ Date _____

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ABSTRACT

Background: Cardiopulmonary bypass (CPB) plays a crucial role in numerous cardiac surgeries, enabling surgeons to conduct very complicated procedures by taking over the functions of the heart and lungs. Although CPB has transformed cardiac surgery, the duration of bypass is associated with a range of postoperative complications that can affect morbidity and mortality rates. While the duration of CPB is a known risk factor for morbidity and mortality after cardiac surgery, this relationship is also influenced other risk factors. Recognizing the implications of CPB duration is essential for improving surgical outcomes and ensuring patient safety.

Objective: To investigate the association of cardiopulmonary bypass duration (CPB) on Perioperative factors and postoperative outcomes in patients undergoing open-heart surgery.

Method: This study was a retrospective, cross-sectional study involving all elective patients undergoing open-heart surgery. Data collection was conducted through direct chart reviews. Key **demographic parameters** (**Age, BMI & Sex), Clinical Comorbidities (LVEF, HTN, DM and CKD**), **Intraoperative factors** (such as **blood transfusion, CPB duration and hemofiltration**), **Postoperative outcome** (**length of stay in the intensive care, total hospital stays, duration of postoperative mechanical ventilation)** were assessed. These data were collected using a systematically structured questionnaire. Data entry was performed using EPI Info version 4.7 software by the research team, and subsequently analysis was conducted in STATA. Descriptive statistics were conducted for both categorical and continuous variables. A chi-square test was employed to assess the association between the outcome variables and the independent variables. Those variables that demonstrate significance in the bivariate analysis was included in the multivariable analysis to evaluate the strength of the associations and identify statically variables.

Result: According to a retrospective cross-sectional study carried out at the TASH and CCE hospitals in Addis Ababa, Ethiopia, adverse postoperative outcomes are substantially associated with prolonged cardiopulmonary bypass (CPB) duration (more than 120 minutes). According to the results, 38.36% of patients had prolonged CPB, and this condition was highly correlated with longer ICU hospitalizations—69.09% of patients who had ICU stays longer than 72 hours had prolonged CPB with p-value of 0.000. Furthermore, 55% of patients admitted for more than 10 days had prolonged CPB with p-value of 0.000 and 80.9% of patients who needed mechanical ventilation for 12 to 48 hours had prolonged CPB with p-value of 0.000.

Key Words: cardiopulmonary bypass duration, intensive care unit

ABBREVATIONS

ACCT	**Aortic Cross Clamp Time**
ASD	**Atrial Septal Defect**
BMI	**Body Mass Index**
CABG	**Coronary Artery Bypass Graft**
CCE	**Cardiac Center Ethiopia**
CPB	**Cardiopulmonary Bypass**
CPBT	**Cardiopulmonary Bypass Time**
DR	**Delayed Recovery**
ECC	**Extracorporeal Circulation**
ICU	**Intensive Care Unit**
ICULOS	**Intensive Care Unit Length of Stay**
LVEF	**Left Ventricle Ejection Fraction**
PCPBT	**Prolonged Cardiopulmonary Bypass Time**
TASH	**Tikur Anbessa Specialized Hospital**

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CHAPTER ONE INTRODUCTION

1.1 Background

During cardiac procedures, the cardiopulmonary bypass (CPB), a form of extracorporeal circulation (ECC), temporarily bypass the respiratory and circulatory functions of the heart and lungs to allow for blood and temperature stabilization. In order to guarantee adequate perfusion during cardiac surgeries, the CPB involves in rerouting blood from the heart and lungs to a CPB machine, where it is oxygenated, and carbon dioxide is eliminated, and then pumped back into the body in a precise and regulated manner(1).

The first application of cardiopulmonary bypass (CPB) in humans was performed by Dr. John Gibbon in 1952 for the closure of an atrial septal defect (ASD). Over the past fifty years, CPB has seen significant advancements driven by improvements in biomedical engineering and medical sciences. Although CPB has facilitated complex cardiovascular surgeries and benefited from numerous innovations in perfusion science, it continues to be associated with a range of adverse effects that remain a concern(1). Thus, the relationship between safety and duration of total CPB depends on a number of factors that have mitigated against a complete understanding of it. Duration of CPB has clearly been identified as a risk factor for poor outcome in a wide range of studies of open heart surgical procedures(2).

Numerous studies and literature have shown that an extended duration of cardiopulmonary bypass (CPB) is an independent predictor of postoperative morbidity and mortality following cardiac surgery(1). Extended durations of cardiopulmonary bypass (CPB) have been linked to several complications, including acute renal injury, prolonged mechanical ventilation, and extended stays in intensive care. Moreover, longer CPB times have also correlated with a higher embolic burden in the brain after surgery and increased postoperative mortality. Consequently, it is crucial to conduct efficient and timely procedures when using CPB to achieve the best possible outcomes(3).

Therefore, the link between safety and the length of total cardiopulmonary bypass (CPB) is influenced by several factors that hinder a comprehensive understanding. Numerous studies on open-heart surgeries have clearly identified the duration of CPB as a significant risk factor for negative outcomes(2).

There is currently no consensus on a definitive cut-off value for the safe or optimal duration of cardiopulmonary bypass (CPB). Madhavan et al. identified that a CPB time exceeding 180

minutes is a significant predictor of mortality. In contrast, Hu et al. suggested that an optimal CPB duration is less than 160 minutes to reduce ICU and in-hospital mortality rates. Additionally, Nadeem et al. demonstrated that longer CPB durations negatively impact clinical outcomes and are linked to extended postoperative mechanical ventilation(1).

In this study, we will examine how the duration of CPB affects various clinical outcomes, including postoperative mechanical ventilation, blood loss, blood transfusion needs, length of ICU stay, surgical complications, overall hospitalization duration, and in-hospital mortality.

1.2 Statement of problem

The evolution of cardiovascular surgery was made possible by cardiopulmonary bypass (CPB), which is also essential to cardiac and macrovascular surgery. However, it can also result in a number of consequences, including kidney or lung damage, delayed recovery, etc (4). These problems are made worse by the disparities in surgical techniques, patient demographics, and healthcare facilities in underdeveloped nations, which result in uneven recovery outcomes.

In addition to being associated with poor postoperative outcomes, a longer duration of cardiopulmonary bypass (CPB) is also a risk factor for increased mortality rates in the intensive care unit (ICU) (5).

Delayed recovery (DR) caused by prolonged cardiopulmonary bypass duration, often leads to prolonged mechanical ventilation duration and longer stay of intensive care unit (ICU). Increasing the incidence of other systemic complications and even causing the death of patients also puts a huge financial burden on patients and their families(4). Therefore, it is very important for patients undergoing cardiac surgery to clearly identify the risk factors that relates to CPB duration and its effect on patients' DR and to help them to recover safely.

Therefore, the duration of cardiopulmonary bypass (CPB) is an important open heart surgery variable that influences patient outcomes, particularly in developing countries where both medical resources and post-surgical care may be limited. The aim of this study is to analyze CPB duration and its influence on patients undergoing recovery from open heart surgery in Addis Ababa, Ethiopia. Understanding the effect of CPB duration on patient recovery specifically may help healthcare organizations simplify surgical procedures, allocate resources more effectively, and improve patient care. This study is to fill the knowledge gap on the influence of CPB duration and recovery outcomes in developing countries such as Adiss Ababa, Ethiopia, for the sake of promoting clinical practice and patient safety.

1.3 Justification of the studies

In Addis Ababa, Ethiopia, healthcare resources tend to be limited. A knowledge of the effect of cardiopulmonary bypass (CPB) time on recovery can optimize surgical procedures and resource management, ultimately improving patient outcomes and the effectiveness of the healthcare system.

By creating the correlation between CPB time and recovery outcomes, this research can determine areas of intervention, which can decrease complications and mortality and ultimately improve the level of care for open-heart surgery patients.

This study attempts to close up health gaps through investigating recovery influences in Addis Ababa, Ethiopia environments, such that advances in cardiac surgery reach all parts of society, not selectively based on socioeconomic status. The research conducted at Tikur Anbessa Specialized Hospital and Cardiac Centre Ethiopia, the research will serve as a foundation for subsequent studies of patient care and surgical procedure for these hospitals, leading to ongoing investigation of the factors that influence recovery and overall health outcomes for cardiology patients.

In addition, results of this study have the potential to inform clinical best practices and guidelines for cardiac operations in Adiss Ababa, Ethiopia, and enhance surgery techniques and postoperative care protocols. Much of what has been reported previously on CPB time has focused on developed countries that do not necessarily reflect developing countries' issues. This study will, therefore, provide vital insights particular to the healthcare settings and patient populations of Ethiopia.

CHAPTER TWO LITERATURE REVIEW

Cardiopulmonary bypass (CPB) is a type of extracorporeal circulation (ECC) that temporarily takes over the heart's circulatory function and the lungs' respiratory function, while also enabling temperature regulation of the blood during cardiac surgeries(1).

2.1 Factor affecting Postoperative Outcome

In May 2024, a study at Queen Alia Heart Institute (QAHI) in Amman, Jordan analysed data from 202 consecutive adult cardiac surgical patients (34 females and 168 males) treated between September 2023 and February 2024. The patients' mean age was 57.1 years. The patients' mean cardiopulmonary bypass (CPB) time was 109.9 minutes, and the range was 29 to 300 minutes. Fifty percent of the patients (50.5%) received CPB support for one to two hours. Notably, patients with CPB time <1 hour (17.3% of patients) also received the lowest blood transfusion (37.1%), hemofiltration (8.6%), and use of IABP (11%). In addition to that, the group also had the lowest rate of re-opening of the chest for the operation (5.7%), and the lowest postoperative times on mechanical ventilation (13 hours), in the ICU (4.1 days), and the total hospital stay (8.5 days). Postoperative sternal re-opening and mortality were seen to rise considerably when CPB exceeded three hours (1). In general, shorter CPB time is associated with better postoperative outcomes, including less complication and fewer recovery days. However, longer CPB time is at risk for serious postoperative complications and higher mortality.

A retrospective single-centre comparative study in Egypt 2024, 450 cases were scheduled for open heart surgery with three groups like Group A: bypass time less than 60 minutes, Group B: bypass time from 60 to 120 minutes, Group C: bypass time more than 120 minutes and there was a significant difference between the 3 groups in favour of Group A with the least bypass time regarding post operative renal complications [p-value = 0.002], respiratory complications [p-value = 0.013], neurologic complications [pvalue = 0.001], multiple blood transfusions [p-value = 0.04], infections [p-value = 0.04] and mortality [p-value = 0-001]((6). This implies that bypass time is a significant predictor of outcome and is most directly associated with morbidity and mortality in cardiac surgery. The safest duration of bypass is between 60 minutes with the lowest morbidity and mortality. The implication of this study is that cardiopulmonary bypass time is a significant predictor of patient outcome following cardiac surgery. Specifically, a bypass time of up to 60 minutes is connected with the least postoperative complication and mortality. This emphasizes the importance of optimizing surgical strategy and technique to minimize the CPB time, which directly influences patient morbidity and mortality.

There was a cross sectional study in Department of Cardiac Surgery, PIC, Jail Road, Lahore (Pakistan) in 2022 where 182 participants were distributed into two groups with, Group A: patients who underwent surgery for short duration of CPB < 90 minutes and Group B: patients who underwent surgery for long duration of CPB ≥ 90 minutes which a result shows that there was a difference between post-operative in-hospital renal outcomes of on pump CABG in patients with shorter CPB duration vs. patients with longer CPB duration. The mean Baseline Creatinine recorded for Group A was 0.92±0.19 and for Group B was 0.91±0.21. Mean urine output value recorded for Group A after 6 hours of CABG was 1.05±0.25 and for Group B after 6 hours of CABG was 0.85±0.24. It was found to be significantly related in the occurrence of acute renal Injury in both groups (7). The study determines the effect of CPB duration on postoperative renal function in on-pump CABG patients. Group A patients with CPB durations of less than 90 minutes had better urine output and potentially better kidney function after the procedure than Group B patients with CPB durations of more than 90 minutes. And longer CPB time was associated with greater risk of acute renal damage, which indicated that shorter CPB time could be crucial to maintaining renal function in cardiac surgery. Overall, these findings emphasize the importance of controlling CPB time for improving postoperative outcomes, that is, kidney status, in patients undergoing cardiac surgery.

In the National Institute of Cardiovascular Diseases, in Karachi, Pakistan, 104 patients with congenital heart disease who were operated an open-heart surgery, had a mean of cardiopulmonary bypass time (CPBT) was 74.6±42.9 minutes and a mean of aortic cross-clamp time (ACCT) of 43.5±29.5 minutes. The findings proved that longer CPBT and ACCT times were significantly related to higher post-surgical morbidity ($p<0.001$). Hence, a longer cardiopulmonary bypass time and aortic cross-clamp time were correlated with poor post-operative outcomes in such patients undergoing such procedures for congenital cardiac disease(8). The findings of this study highlight the importance of keeping CPBT along with ACCT as short as possible in open-heart surgery for congenital heart disease. Protracted durations of these intervals correlate directly with unfavourable postoperative results, a fact which supports the need for surgical techniques and procedures that reduce these intervals to maximize patient recovery and safety.

A retrospective study done in Aga Khan University Hospital, Karachi, Pakistan in 2021 shows that a total of 58 patients (34.9%) experienced a prolonged cardiopulmonary bypass time (PCPBT). Postoperative complications were observed in 38.6% of the patients. In a multivariable analysis adjusting for age, gender, and RACHS-1 categories, mild preoperative left ventricular dysfunction was found to be associated with PCPBT (OR = 3.137 [95% CI: 1.003–9.818]), while obesity was identified as a protective factor (OR = 0.530 [95% CI: 0.130–0.923]).PCPBT was also related to longer ventilation time (OR = 1.298 [95% CI: 1.005–1.676]), longer cardiac ICU stay (OR = 1.204 [95% CI: 1.061–1.367]), and longer hospital stay (OR = 1.120 [95% CI: 1.005–1.247]).Postoperatively, longer CPBT was related to longer ventilation time, longer cardiac ICU stay, and longer hospital stay. Conducting surgeries with reduced CPBT will help in reducing the chance and extent of such postoperative complications, particularly in poor developing countries (9). The research explains the negative effect of longer cardiopulmonary bypass time on cardiac surgery outcome among patients. PCPBT has a strong association with excess risk for postoperative complication, ventilation time, ICU stay time, and total hospital length of stay. Reduced CPBT may potentially lead to improved surgical outcomes, particularly in low-resource settings where prolonged hospital days will be expensive to healthcare resources.

A retrospective review study done in united kingdom 2003 examining risk factors for extended ICU stays following cardiopulmonary bypass (CPB) in children reveals that CPB duration is a significant factor contributing to delayed recovery and the occurrence of complications in the ICU after open-heart surgery, with a statistical significance level of $p < 0.01$(10). The study found that duration of CPB is a determining variable for recovery times and complications in the ICU. With the statistical significance level, $p < 0.01$, there is a confirmation that the existence of a very strong relationship, and therefore longer durations of CPB lead to higher risks for unfavourable outcomes.

A retrospective review conducted at Beijing Anzhen Hospital from January 2005 to December 2015 categorized patients into three groups based on the median duration of cardiopulmonary bypass (CPB). The findings indicated that patients with prolonged CPB time (≥173 minutes) experienced longer ICU stays ($P = 0.011$), higher rates of ICU mortality ($P < 0.001$), and increased in-hospital mortality ($P = 0.002$) compared to patients without CPB (CPB = 0). Furthermore, for each ten-minute increase in CPB duration, the risk of outcomes rose by 13.3% for ICU mortality and 9.3% for in-hospital mortality, after adjusting for potential confounding factors(5).

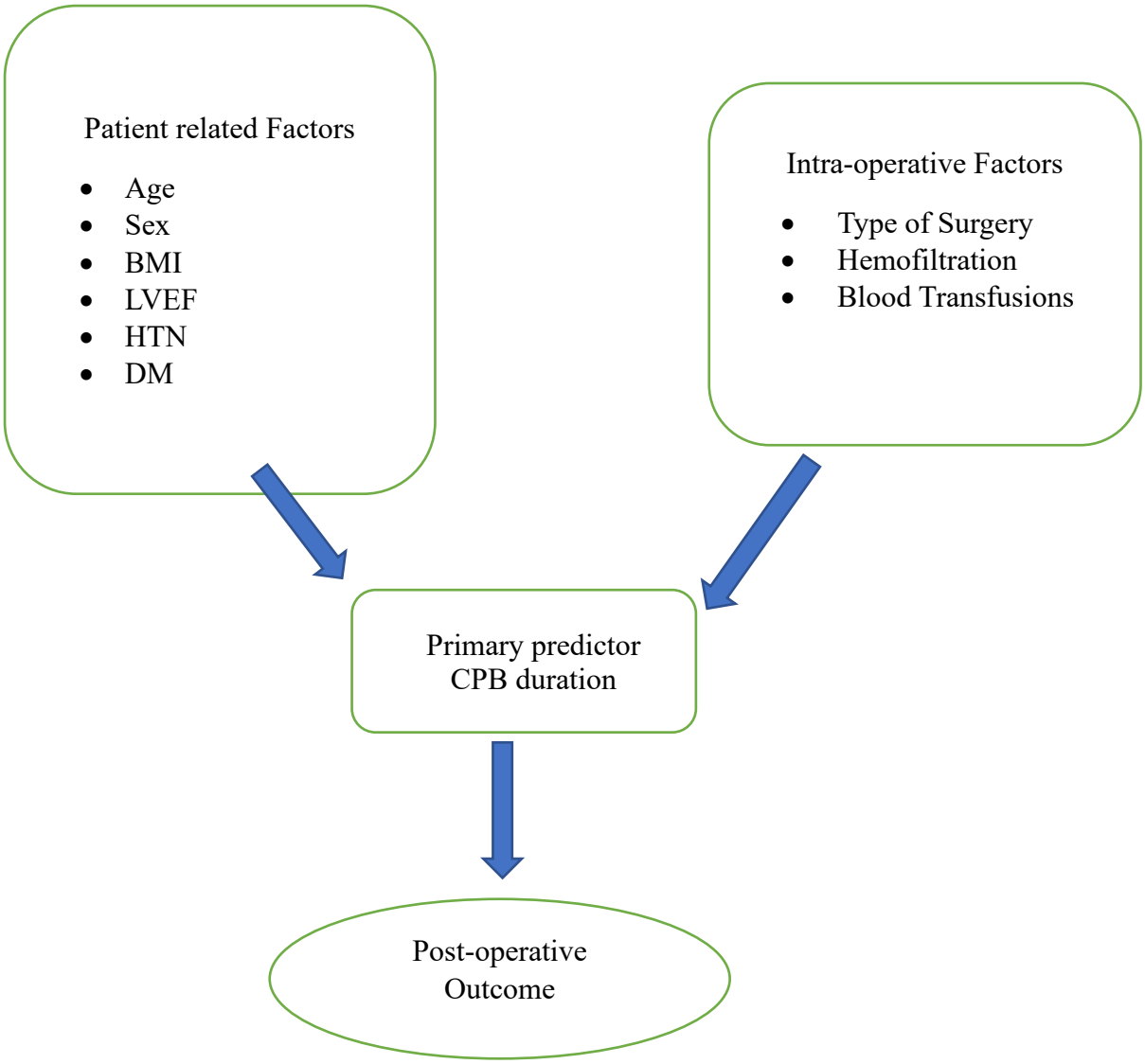
A Retrospective review of 3,889 patients who underwent cardiac surgery with CPB without circulatory arrest between 2011 and 2017 in the USA was conducted to evaluate the influence of prolonged CPB on postoperative acute renal failure. The findings indicate that postoperative renal failure risk increases slowly as bypass time is progressively extended, especially in preoperative kidney dysfunction patients. Specifically, for every 10-minute extension in CPB time, the risk of renal failure was increased by an odds ratio of 1.06 (P = 0.04)(11). A Retrospective review of 3,889 patients who underwent cardiac surgery with CPB without circulatory arrest between 2011 and 2017 in the USA was conducted to evaluate the influence of prolonged CPB on postoperative acute renal failure. The findings indicate that postoperative renal failure risk increases slowly as bypass time is progressively extended, especially in preoperative kidney dysfunction patients. Specifically, for every 10-minute extension in CPB time, the risk of renal failure was increased by an odds ratio of 1.06 (P = 0.04)

A retrospective analysis of 693 children admitted to the paediatric Intensive Care Unit of the Polish Mother's Memorial Hospital Institute between January 1, 2007, and July 31, 2008, assed predictors of prolonged length of ICU stays following cardiac surgery. The study established that the cardiopulmonary bypass (CPB) duration is a significant determinant of ICU hospital stay length. Notably, the relationship between ICU length of stay (ICULOS) and CPB time is non-linear; that is, CPB times in excess of 60 minutes were associated with a steep increase in ICU stay duration. The ICULOS for those with a CPB time of under 60 minutes was a mean of 4.6 days (SD 8.26), and in those with a CPB time of 60 minutes or greater, the ICULOS was a mean of 6.9 days (SD 13.8), with p = 0.012, which was statistically significant(12). The results validate the necessity to minimize the duration of CPB during paediatric cardiac surgery to improve patient outcomes and shorten ICU in-patient stay duration. Clarification of this correlation will help clinicians tailor surgical technique and postoperative care strategy based on bed-side monitoring data with ultimate aims of maximizing recovery and resource utilization within the ICU.

A prospective observational study of 374 open-heart surgery patients in Iraq from January 1, 2018, to January 1, 2019, assessed the impact of prolonged cardiopulmonary bypass (CPB) and operative exposure time on the occurrence of surgical site infections. The findings indicated that longer CPB times were directly associated with a higher occurrence of surgical site infections. Notably, patients who developed infections had a longer operative exposure time (4.88 hours compared to 4.27 hours) and a significantly greater CPB time (161.59 minutes versus 56.53 minutes).

2.2 Conceptual framework

Figure 1: Conceptual framework for Postoperative Outcome



CHAPTER THREE. OBJECTIVE OF THE STUDY

3.1 General objective

The primary objective is to evaluate the relationship between perioperative factors and prolonged cardiopulmonary bypass duration, and its association with postoperative outcomes in patients undergoing open heart surgery at TASH and CCE hospitals in Addis Ababa, Ethiopia, from Jan 2021 to Dec 2024.

3.2 Specific objectives

- To identify perioperative factors associated with prolonged cardiopulmonary bypass duration in open heart surgery.
- To examine the association between prolonged cardiopulmonary bypass duration and postoperative outcomes.

CHAPTER FOUR. METHODOLOGY

4.1 Study area and period

As of 2014 G.C, Addis Ababa, the capital city of Ethiopia, had over 52 hospitals, of which 12 were governmental and over 40 were private. Of them, Tikur Anbesa Specialized Hospital (TASH), and the Children's Heart Fund Ethiopia Surgical Centre stand out for their specialization in open-heart surgery and related cardiac procedures to serve the needs of the community.

Tikur Anbessa Hospital is among the best-known specialist hospitals in Addis Ababa, Ethiopia. Established in 1964, it is a major teaching hospital affiliated with the School of Medicine at Addis Ababa University. The hospital offers a broad range of specialist clinical services and is a major training institution for medical students and health professionals from Ethiopia and throughout Africa. It is well known for its broad medical training programs and research. With various departments, including a cardiothoracic unit, Tikur Anbessa has specialized services not found at any other public or private hospital in the country. The hospital admits over 500,000 outpatients and accommodates more than 21,000 inpatients annually, making it the largest referral hospital in Ethiopia. It has over 15 large operating theatres and 2 Post-Anaesthesia Care Units (PACUs).

The Children's Heart Fund Foundation (CHFE) was established in 1989 when Dr. Belay Abegaz founded it in view of the compelling need for advanced cardiac care in Ethiopia. CHFE established the nation's first independent cardiac center in Addis Ababa in 2009, a step toward long-term cardiac care solutions in the country. More than 4,000 children have received treatment from specialists since the establishment of the center. In addition, the organization looks to the future by training Ethiopian cardiologists and nurses, hence empowering local capacities. The centre comprises two operating theatres and one Post-Anaesthesia Care Unit (PACU).

The study was conducted from December 2024 to June 2025 G.C at private and TASH and CCE hospital, Addis Ababa, Ethiopia.

4.2 Study design

A retrospective cross-sectional study was conducted.

4.3 Source and study population

4.3.1 Source of population

All patients who undergone for elective open cardiac surgery under CPB at Tikur Anbesa Specialized Hospital (TASH) and the Children's Heart Fund Ethiopia.

4.3.2 Study population

All patients who undergone for elective open cardiac surgery under CPB and those who fulfil inclusion criteria will be included in the study period.

4.4 Study variable

4.4.1 Dependent Variable

Postoperative outcome

- Length of Stay in the Intensive Care Unit (ICU)
- Total Hospital Stay
- Duration of Postoperative Mechanical Ventilation

4.4.2 Independent variable

- Age
- Sex
- BMI
- Blood Transfusions
- Hemofiltration
- Cpb duration
- Type of surgery
- LVEF
- Hypertension
- DM
- CKD

4.5 Operational definition

Hemofiltration: is a medical procedure used to remove waste products and excess fluid from the blood.

Postoperative Outcomes: refer to the results or effects of surgical interventions on patients' ICU stay, total hospital stay, duration of postoperative mechanical ventilation and mortality.

Blood transfusion: is a medical procedure that involves the transfer of blood or blood components intraoperatively during open cardiac surgery.

Prolonged cardiopulmonary bypass duration: is a duration if the patient stays on cardiopulmonary bypass machine greater than 120 minutes.

Type of surgery: a surgical procedure that is performed on a patient for example (ASD, TOF, VSD, MVR, AVR, CABG...etc).

4.6 Inclusion and Exclusion Criteria

4.6.1 Inclusion Criteria

- ❖ All patients who have undergone elective open-heart surgery involving CPB

4.6.2 Exclusion Criteria

- ❖ Patients undergoing reoperations.
- ❖ Patients who experience major postoperative complications (e.g., stroke, severe infections) that could skew recovery metrics.

4.7 Sampling Technique and Sample Size Determination

4.7.1 Sample Size Determination

Since there have been no studies conducted in Ethiopia on this case, we proceeded with the following assumptions: a significance level of 5%, a Z-score corresponding to a 95% confidence level (standard value of 1.96), and a desired precision of ±5%.

The formula for calculating the required sample size (n) is:

$$n = \frac{\boldsymbol{Z^2 P(1-P)}}{\boldsymbol{e^2}}$$

where,

- n = required sample size
- Z = Z-score corresponding to the desired confidence level
- P = estimated proportion of the attribute
- E = margin of error (as a decimal)

$$\boldsymbol{n = \frac{(1.96^2) \times 0.5(1-0.5)}{0.05^2}}$$

$$\boldsymbol{n = \frac{(1.96^2) \times 0.5(0.5)}{0.05^2}}$$

$$\boldsymbol{n = 384.16 \approx 385}$$

Since the study population was less than 10,000, sample size reduction was used.
Nf = ni/(1+ni/N);

Where: -
nf= final Sample Size
ni= initial Sample Size
N= total population

Nf = 385/ (1+ 385/420)
Nf = 385/1.92
Nf = 200.52≈201
Nf = 201
nadjusted=201+(201*0.10) = 221 participants
nadjusted ≈ 221 participants.
After adding 10% non-response rate the final sample size was 221.

4.7.2 Sampling Technique

Tikur Anbesa Specialized Hospital (TASH) and the Children's Heart Fund Ethiopia Surgical Centre were selected as the study location since they are the primary facilities where most of the cardiac open-heart surgeries are performed. To minimize the impacts of seasonality, the four-year average prevalence was used.

A total of 420 patients underwent open-heart surgery in these two hospitals over the past four years, the sample interval was calculated by the formula Kth = N/n, where N (420) is the entire study population and n (221) is the entire sample size. Here the sample interval will be

approximately Kth = 420/221 i.e., 2. To select the first subject (random start) to enter the study, a lottery method was utilized. This implies that a single patient was chosen randomly from the daily operating schedule list. Once the first subject was identified, successive every-second patient was recruited into the study until the desired sample size of 221. This method of sampling is a systematic sampling in which every nth member (every second patient) is chosen from the population. This ensures that the sample will be representative of the population and reduces bias. Using this systematic sampling method, the research was able to describe a heterogeneous population of patients that are going through open-heart surgery in the two selected hospitals and exploring the description and outcome of the cardiac surgery patients.

4.8 Data collection technique

To collect data for the study, a comprehensive questionnaire was developed in English to ensure that it is accessible to all participants. Before data collection, training was given for data collectors about the variables that to be documented. Chart reviews were used to collect the appropriate data.

The questionnaire was designed to capture a wide range of data, including demographic information, clinical characteristics, and postoperative parameters. Demographic data was collected to provide a general overview of the patients' backgrounds, including their age, sex, BMI and other relevant demographic characteristics. This information will help to identify any potential biases or variables that may affect the outcomes of the study.

Clinical characteristics was be collected to provide a detailed understanding of the patients' medical histories, including any pre-existing conditions, allergies, and medications. This information was essential in identifying any potential risks or complications that may arise during or after the cardiac surgery.

Postoperative parameters were collected to assess the patients' vital signs, and other postoperative outcomes. This information was help to evaluate the effectiveness of the cardiac surgery and identify any potential areas for improvement. To collect the data, one method was employed, which was patient chart reviews. Patient Chart reviews were used to collect data on demographic, intraoperative, and postoperative factors.

4.9 Data Quality Control

During data collection the completed questionnaire was submitted and reviewed daily to avoid loss of data. Data consistency and completeness was made throughout the data collection, data entry and analysis.

4.10 Data Analysis and Interpretation

Data was checked manually for completeness and then coded and entered into Epi-Info version 4.7. Data was cleaned and analysed with the Stata version 17 computer program. Comparison of numerical variables within the study group and between study groups was done with paired student t-test and unpaired student t-test, respectively. Categorical data was analysed by using Chi-square tests. P value <0.05 was considered statistically significant for all analyses. Descriptive statistics was used to summarize data, tables, and figures for display results.

4.11 Ethical Consideration

The study was performed following approval from the Department of Cardiology at Addis Ababa University's ethical committee. permission was granted; a letter of official backing was sent to Tikur Anbessa Specialized Hospital and the Children's Heart Fund Ethiopia Surgical Centre for the sake of acquiring permission to collect the data from the hospital authorities. The purpose and significance of the study was clarified to participants. Confidentiality during the study was ensured by applying an anonymous questionnaire whereby all responses remain confidential and anonymous.

CHAPTER FIVE. RESULT

5.1 Socio-demographic and Clinical characteristic

A total of 420 open cardiac surgeries with cardiopulmonary bypass were performed at TASH and CCE between 2021 and 2024. Systematic random sampling selected 221 of these patients. 219 patients had complete medical records, and 2 were omitted due to incomplete records. This yielded a response rate (completeness rate) of 99.09%. From the data 57 (26.03%) of the patients were from TASH, while 162 (73.97%) were from CCE. Nearly half of the patients were female (56.62%), while the remaining 43.38% were male. There were also 145 patients who were aged below 18 years, representing 66.21% of the total study population.

Table 1: Distribution of socio-demographic and clinical characteristics of patients that undergone open heart surgery under cardiopulmonary bypass

Variables	Characteristics	Frequency	Percentage
Gender	MALE	95	43.38
	FEMALE	124	56.62
Age	<18 years	145	66.21
	18-45 years	61	27.85
	>45 years	13	5.94
Body Mass index	<18.5 kg/m^2	159	72.60
	18.5-24.9 kg/m^2	49	22.37
	> 25 kg/m^2	11	5.02
Left Ventricle Ejection Fraction	<40%	16	7.31
	40-50%	11	5.02
	>50%	192	87.67
Hypertension	YES	6	2.74
	NO	213	97.26
Diabetes Mellitus	YES	3	1.37
	NO	216	98.63
Chronic kidney disease	YES	2	0.91
	NO	217	99.09
Interop blood transfusion	YES	96	43.84
	NO	123	56.16
Intraoperative Hemofiltration	YES	108	49.32
	NO	111	50.68

Understanding the impact of prolonged CPB duration is critical for healthcare professionals. It highlights the need for careful monitoring and management during surgical procedures, aiming to reduce CPB time and mitigate associated risks, thereby enhancing patient recovery and survival rates.

The data on ICU length of stay reveals three distinct time frames related to patients' cardiopulmonary bypass (CPB) durations. In the category of less than 48 hours, a total of 95 patients (43.38%) were admitted, with 9 having a CPB duration greater than 120 minutes and 86 having a duration of less than 120 minutes. During the 48-72 hours interval, 69 patients (31.51%) were observed; among them, 37 had CPB durations exceeding 120 minutes, while 32 had shorter durations. Finally, for those staying more than 72 hours, 55 patients (25.11%) were documented, with 38 experiencing CPB durations greater than 120 minutes and 17 with shorter durations.

Table 2: Distribution of post operative outcomes over cardiopulmonary bypass duration

Variables	Characteristics	Frequency	Percentage	CPBD %	
				Yes	No
Length of Stay in the Intensive Care Unit (ICU)	<48 hrs.	95	43.38	9.47	90.53
	48-72 hrs.	69	31.51	53.6	46.38
	>72 hrs.	55	25.11	69.09	30.90
Duration of Postoperative Mechanical Ventilation	<12 hrs.	194	88.58	33.5	66.5
	>12 hrs.	25	9.59	76	24
Hospitalization from the day of surgery until discharge	0-4 Days	56	25.57	16.07	83.9
	5-9 days	143	65.30	44.75	55.24
	>10 days	20	9.13	55	45

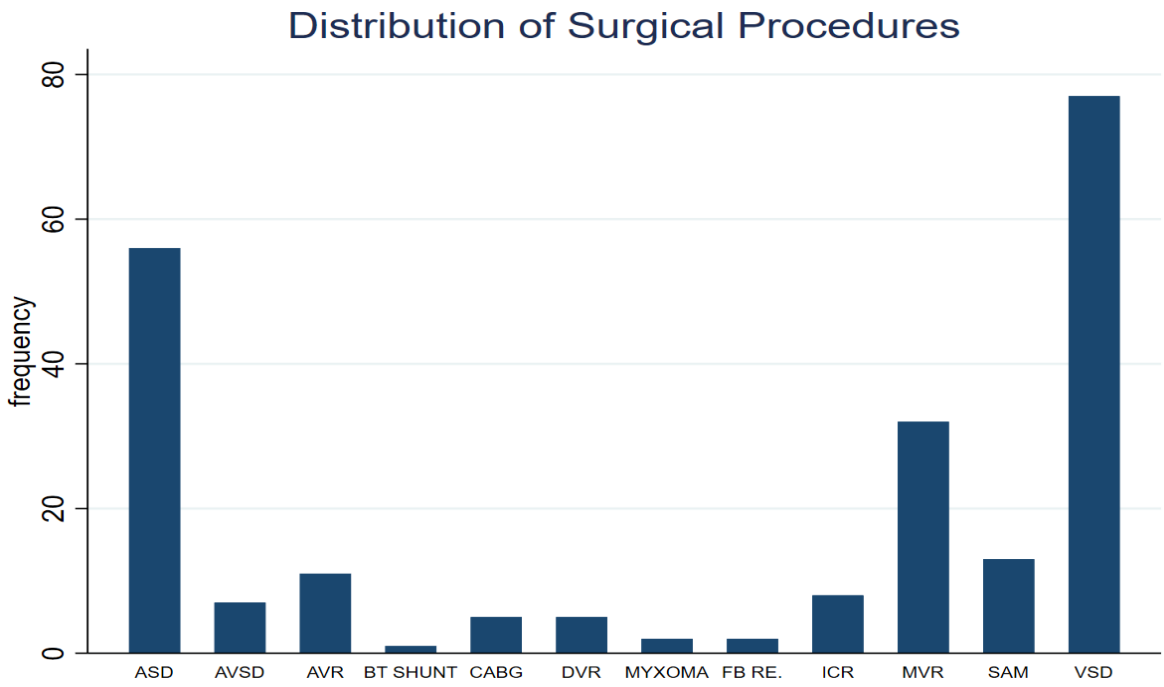


Figure 2: Distribution of surgical procedures among patients who had open heart surgery under cardiopulmonary bypass

This study assessed the prevalence of cardiopulmonary bypass (CPB) duration among patients who underwent open-heart surgery. In a cross-sectional analysis of 219 patients, a significant proportion (38.36%; 95% CI 31.8–45.1) experienced an extended CPB duration.

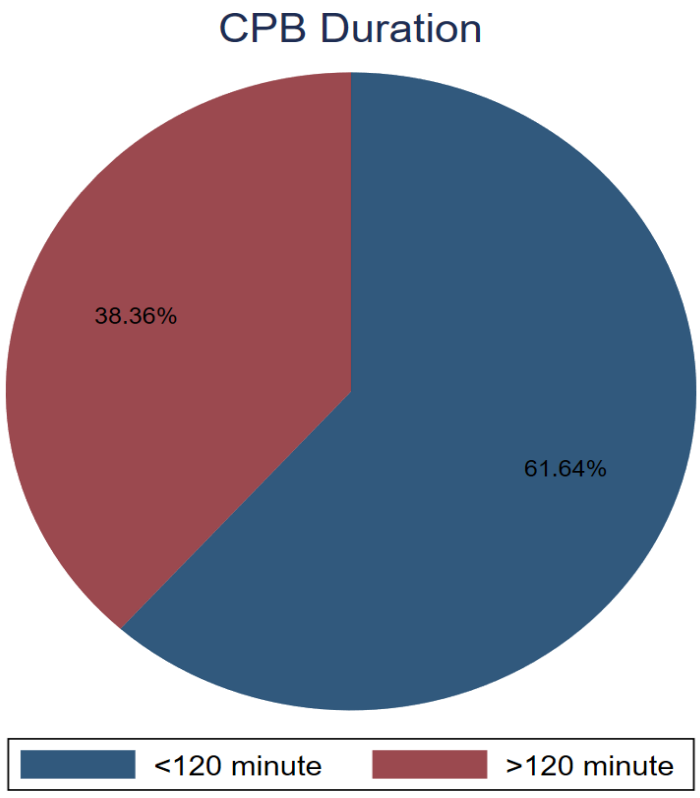


Figure 3: Description of cardiopulmonary bypass classification

There were 145 patients under 18 years old, representing 66.21% of the total study population. Additionally, there were 61 patients aged 18 to 45, making up 27.85%, and 13 patients over 45 years old, accounting for 5.94%.

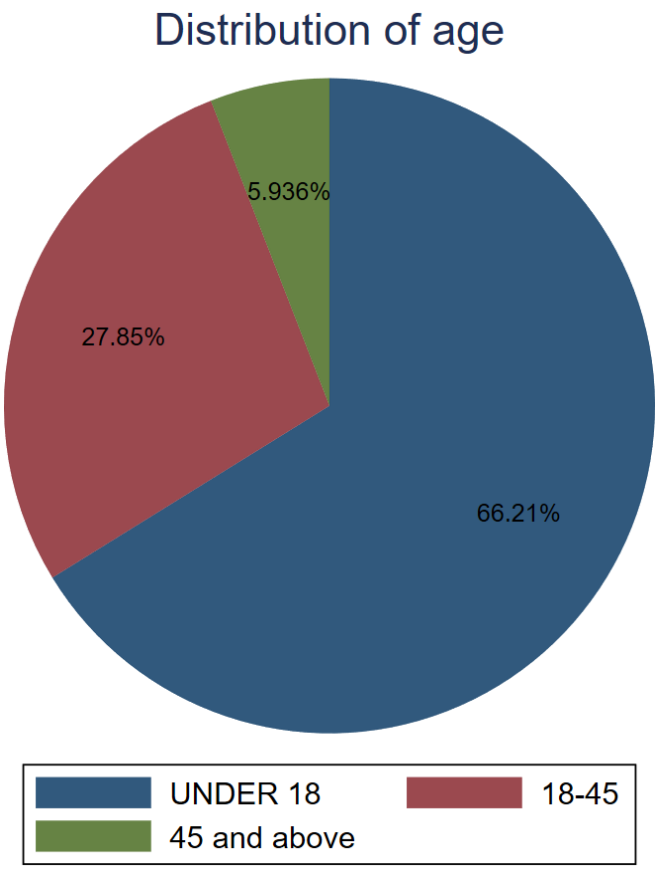
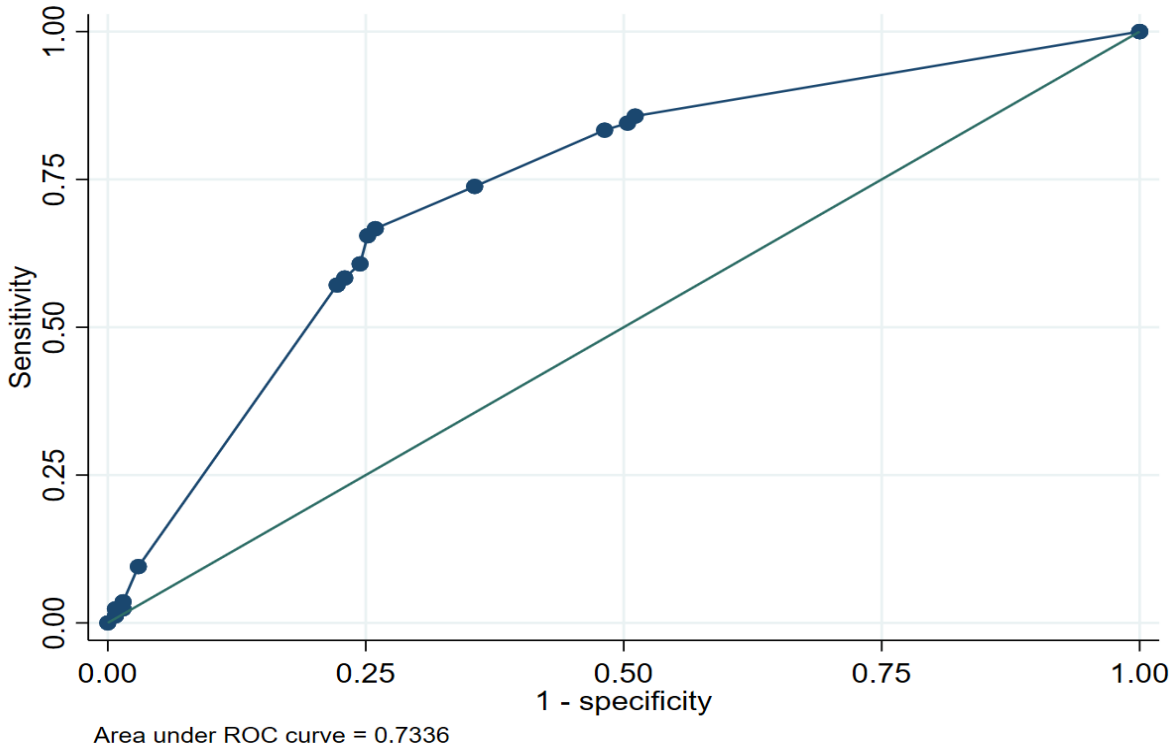


Figure 4: Distribution of age group among patients who undergone open cardiac surgery under cardiopulmonary bypass

We employed the Hosmer-Lemeshow test and the area under the receiver operating characteristic curve (ROC-AUC) to examine the discrimination and calibration of the logistic regression model. The model is calibrating properly, according to the Hosmer-Lemeshow test (χ^2 (8) = 4.87, p = 0.6898), since predicted risks by the model are highly close to observed outcomes. Also, 73.3% of pairs correctly discriminated between event and non-event outcomes, with a ROC-AUC measure of 0.7336 reflecting extreme separation. The result shows that the model is valid, well-calibrated, and effective, and thus it can be applied in clinical risk prediction and research. With a high AUC, it implies that the model is very accurate and above the threshold level (AUC > 0.7).



To find independent variables of cardiopulmonary bypass (CPB) duration, a logistic regression model was utilized. To pre-screen possible candidate variables for the multivariable analysis, we first performed a univariate logistic regression. Variables that had p-values less than 0.25 were investigated further. Blood transfusion, hemofiltration, diabetes mellitus (DM), hypertension (HTN), age, gender, BMI, left ventricular ejection fraction (LVEF), chronic kidney disease (CKD), and type of operation were all considered in the univariable analysis. In the multivariate logistic regression, LVEF, hemofiltration, and blood transfusion were the variables linked to CPB duration.

The odds of experiencing a prolonged cardiopulmonary bypass (CPB) duration among patients with a left ventricular ejection fraction (LVEF) of greater than 50% are 60% (AOR=0.40, CI 0.23, 0.71) lower compared to those with an LVEF less than 40%. This means that patients with a lower LVEF are high likely to have a long CPB duration.

The odds of experiencing a prolonged cardiopulmonary bypass (CPB) duration for patients who don't receive intraoperative blood transfusion are 30% (AOR=0.70, CI 0.56, 0.88) lower compared to those who do receive blood transfusion during surgery. This means that patients who do not receive intraoperative blood transfusion are 30% less likely to experience a prolonged cardiopulmonary bypass (CPB) duration compared to those who do receive blood transfusion during surgery.

The odds of experiencing a prolonged cardiopulmonary bypass (CPB) duration for patients undergoing intraoperative hemofiltration are 60% (AOR=0.40, CI 0.21, 0.78) lower compared to those who do not receive hemofiltration during surgery. This means Patients undergoing intraoperative hemofiltration are 60% less likely to have a prolonged cardiopulmonary bypass (CPB) duration compared to those who do not receive hemofiltration during surgery.

CHAPTER SIX. DISCUSSION

Heart surgery is unique in the sense that it employs a cardiopulmonary bypass (CPB) device. While CPB has been employed to advantage millions of patients with cardiac operations, it creates a non-physiologic condition that can trigger many significant complications affecting a wide range of body systems and organs. We chose to investigate the influence of CPB time on variables of recovery and overall outcomes of cardiac surgery(1). Increased cardiopulmonary bypass time is a significant factor in surgical operations, particularly in cardiothoracic operations. As the duration of CPB increases, it results in a series of complications that adversely affect the recovery of the patient.

Over a four-year period at Tikur Anbessa Hospital and Cardiac Centre in Ethiopia, 84 patients (38.3%) were found to have prolonged cardiopulmonary bypass (CPB) durations. Comparatively, the incidence of long CPB durations in various regions and timeframes includes 41.9% in China (2020), 34.9% in Pakistan (2021), and 49.5% in Jordan (2024). Additionally, within the context of CPB lasting more than 120 minutes, there is a significant gender imbalance among patients, with females constituting 58.3% of those affected, whereas males account for 41.6%.

In this 219-participant research, the results show that a higher Left Ventricular Ejection Fraction (LVEF) is significantly associated with reduced chances of having cardiopulmonary bypass (CPB) time longer than normal, with an adjusted Odds Ratio (AOR) of 0.40 (95% CI: 0.232–0.713) and a p-value of 0.002. This indicates that among patients having LVEF > 50%, there are 60% reduced chances of having extended CPB (1 - 0.40). These results agree with the study on risk factor and outcome of increased cardiopulmonary bypass time in adult congenital heart disease surgery in Pakistan (2021) that found mild left ventricular (LV) dysfunction, expressed as decreased LVEF, to be a strong predictor for increased CPB with an OR of 3.137 (95% CI: 1.003–9.818; p=0.049(9). This indicates that mildly dysfunctional LV patients are more than three times more likely to have a long CPB than normally functioning LV patients. Overall, these findings indicate that a strong correlation exists between LVEF and risk of prolonged CPB. A higher LVEF is associated with a very low risk of prolonged CPB, but lower LVEF, indicating mild LV dysfunction, substantially increases the risk. Hence, preservation or improvement of LVEF is necessary to avoid complications of long-standing CPB in surgeries.

This research, with 219 participants, demonstrates strong correlation between intraoperative blood transfusions and prolonged cardiopulmonary bypass (CPB) times. The adjusted odds ratio (AOR) of 0.705 (CI: 0.563, 0.883) suggests that for greater than 120 minutes CPB time, the likelihood of not being transfused is decreased by approximately 30%. The AOR of less than 1 suggests a strong decrease in the likelihood of not being transfused as CPB time is increased. Such findings are supported by previous research into the influence of CPB time on recovery following open heart surgery, a study that is being conducted in Jordan in 2024(1), where those undergoing longer CPB times had a 75% greater risk of requiring blood transfusions compared to those undergoing shorter CPB times. Such agreement of findings adds strength to the conclusion that increased CPB time does have a strong impact on transfusion requirement. Clinical significance of these findings relates to clinical practice. It suggests that reduction in CPB time can be warranted in an effort to reduce intraoperative requirement for transfusion, which can result in better patient outcomes and reducing risk

associated with them. Optimisation of CPB time is a field for future research, and so are the mechanisms involved in increased transfusion need in patients having cardiac surgery.

This study, involving 219 patients, evidences a close relationship between intraoperative hemofiltration and CPB time, as quantified by an adjusted odds ratio (AOR) value of 0.40 (CI: 0.21-0.78). This finding indicates a significant 60% reduction in the need for hemofiltration for CPB times of less than 120 minutes. However, it stresses the fact that increased CPB times of more than 120 minutes are strongly associated with a 60% increase in hemofiltration need. The results are consistent with the current literature investigating the impact of CPB time on the outcome of patients. A study conducted in Jordan in 2024 indicates that 33-50% of patients in whom extended CPB times are indicated need hemofiltration(1). This correlation suggests that not only does the prolonged duration of CPB complicate surgery recovery but also increase the risk of requiring additional treatment such as hemofiltration. The clinical practice implications of the results are significant, requiring the reduction of CPB time whenever possible in an attempt to enhance patient outcomes and reduce the need for hemofiltration.

The result of ICU stay durations reveals a significant correlation between prolonged cardiopulmonary bypass (CPB) times and extended ICU stays. Specifically, only 9.47% of patients who spent less than 48 hours in the ICU experienced CPB durations exceeding 120 minutes. In contrast, a substantial 69.09% of patients with ICU stays longer than 72 hours had CPB times greater than 120 minutes (p=0.000). This result directly aligns with the primary data reported by research done on impact of CPB duration on recovery after open heart surgery in Jordan (2024)(1). Their analysis demonstrated that a CPB duration less than 120 min had a 5 a day's stay in ICU compared to 12 days stay for those who had a CPB duration greater than 120 minutes which shows clear, stepwise increase in average ICU LOS as CPB duration lengthened. Additionally, research done on the risk factors for delayed recovery in patients with cardiopulmonary bypass in China (2020)(4) shows that a CPB duration >120 as the strongest independent risk factor for longer ICU stay with AOR=1.204, CI[1.061-1.367] with (p=0.004). The mechanisms linking prolonged cpb to extended ICU exists because of hemodynamic instability, coagulopathy, or systemic inflammation.

In this study, we analysed that a vast majority of patients (88.58%) were extubated within 12 hours post-surgery. However, the patients who required ventilation for a prolonged period of time, i.e., > 12 hours, were highly correlated with greater cardiopulmonary bypass (CPB) time, with 76% (CPB times > 120 minutes) compared with only 33.5% (CPB times < 120 minutes) p=0.000. This observation considers CPB duration to be a significant predictor of the need for prolonged ventilation. Conversely, extubation during very early times (within 12 hours) was determined in most to be for those with short CPB durations, with 66.5% being operated on within less than 120 minutes. This result is in agreement with the study that was done on the impact of cardiopulmonary bypass time on the duration of mechanical ventilation in Dubai (2019) with the result of CPBT was the strongest independent variable linked to higher MV (correlation coefficient: 0.88, *p* = 0.001).(13) This means that minimizing CPB time may be a significant aspect in having faster extubation and, most importantly, potentially improved total patient outcome.

We classified the patients in our research based on the length of stay in hospital, and we found important information regarding how recovery time is associated with cardiopulmonary bypass (CPB) time. The Short Stay Group of 0-4 days had the lowest percentage of increased CPB time at a mere 16.07%. This indicates that those who recovered quickly enough to be discharged earlier had shorter CPB time compared to others. On the other hand, the Moderate Stay (5-9 days) Group with the highest percentage had considerably higher proportions of prolonged CPB time at 44.75% (p=0.000). This implies that longer CPB times were more prevalent in the patients with the normal recovery time, indicating a potential relationship between recovery time and the length of bypass time. Lastly, the Extended Stay (>10 days) Group had the highest proportion of increased CPB time, at 55.00%. Further, greater than a half of these patients had CPB times of more than 120 minutes, which indicates strong association between increased CPB time and significantly prolonged recovery times. This result is in line with a study that was done on risk factors and outcomes of prolonged cardiopulmonary bypass duration during surgery in Pakistan (2021)(9) with a conclusion that explains patients with CPB >120 min having a mean hospital stay of 10.19 days against 7.01 days in the case of patients with CPB < 120 min (*p* < 0.04). These findings suggest that more extended CPB times are potentially an important determinant of extended hospital stays and warrant closer study of methods designed to abbreviate CPB times in order to enhance patient outcomes on recovery.

CHAPTER SEVEN: CONCLUSION

A retrospective cross-sectional study conducted at TASH and CCE hospitals in Addis Ababa, Ethiopia, found there to be a strong association between a lengthy cardiopulmonary bypass (CPB) time, i.e., CPB times greater than 120 minutes, and unfavorable postoperative outcomes.

The study found that 38.36% of the patients underwent prolonged CPB times, which were significantly correlated with extended ICU stays; interestingly, 69.09% of patients who had extended ICU stays of more than 72 hours had prolonged CPB. In addition, 76% of patients who needed mechanical ventilation greater than 12 hrs. also had longer CPB runs, and 55% of those hospitalized for 10 or more days faced similar issues.

In a critical observation, patients with decreased left ventricular ejection fraction (LVEF < 40%) had a 60% increased risk of prolonged CPB (AOR = 0.40; 95% CI: 0.23–0.71). Intraoperative hemofiltration and blood transfusion contributed to increased risks of prolonged CPB by 30% and 60%, respectively.

These findings acknowledge prolonged CPB as a valid modifiable risk factor that impacts recovery for patients undergoing open-heart surgery, particularly in low-resource settings. Preoperative intervention to optimize cardiac function, minimize transfusions, and optimize hemofiltration procedures may reduce CPB times. The availability of protocols for managing such variables may enhance postoperative outcomes, reduce length of stay, and reduce the total workload on the Ethiopian health system. We need further prospective studies to confirm the effectiveness of interventions to limit CPB time.

CHAPTER EIGHT: STRENGTH AND LIMITATION OF STUDY

The study has several limitations that should be acknowledged. It utilized a retrospective design based on medical records, which may introduce biases due to missing or incomplete data. Additionally, unmeasured confounding factors, such as surgeon experience and anaesthesia protocols were not analysed, despite their known influence on recovery.

On the other hand, the study possesses significant strengths and high quality. It employs a well-calibrated and fitted model to assess the prevalence and factors associated with postoperative outcomes. While the statistical analysis accounts for known confounders, the combination of univariate and multivariate analyses allows for a comprehensive exploration of the relationships between CPB duration and various outcomes. Additionally, the use of direct chart reviews enables detailed collection of demographics, clinical, and postoperative data, thereby enhancing the quality of the findings.

CHAPTER NINE: RECOMMENDATION

Based on the comprehensive findings of this thesis on prolonged cardiopulmonary bypass (CPB) duration and its impact on postoperative outcomes in open-heart surgery, the following evidence-based recommendations are provided.

For future researchers' it's better to do a prospective intervention studies which focus on investigating targeted strategies to reduce cardiopulmonary bypass (CPB) duration, such as optimizing surgical workflows, enhancing preoperative left ventricular ejection fraction (LVEF) protocols, and standardizing practices. Additionally, exploring the causal mechanisms linking low LVEF to prolonged CPB is essential. Furthermore, examining socioeconomic factors, such as access to preoperative care, can provide insights into their influence on CPB outcomes.

Clinicians should prioritize preoperative optimization by focusing on cardiac rehabilitation for patients with a left ventricular ejection fraction (LVEF) of less than 40%, as this can enhance ventricular function and reduce cardiopulmonary bypass (CPB) time.

Hospitals should focus on protocol standardization by integrating CPB duration reduction measures into surgical safety checklists.

Finally, training multidisciplinary teams—including surgeons, anaesthesiologists, and perfusionists—in CPB efficiency techniques and partnering with global cardiac centers for skill-transfer programs will enhance overall surgical performance and patient care.

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ANNEX I: INFORMATION SHEET

Title of the Research Project: Assessment of Perioperative Factors and Postoperative Outcomes Associated with Prolonged Cardiopulmonary Bypass Duration in Open Heart Surgery: A Retrospective Cross-Sectional Study at TASH AND CCE Hospitals in Addis Ababa, Ethiopia (2025).

Name of Principal Investigator: Yared Jenberu

Name of the Organization: Addis Ababa University, College of Medicine and health science Department of Cardiology.

Introduction: Greetings! My name is Yared Jenberu. I am a student at Addis Ababa University College of medicine and health science Département of Cardiology MSc in clinical cardiovascular perfusion. As part of this degree, I am undertaking a research project." Assessment of Perioperative Factors and Postoperative Outcomes Associated with Prolonged Cardiopulmonary Bypass Duration in Open Heart Surgery: A Retrospective Cross-Sectional Study at TASH AND CCE Hospitals in Addis Ababa, Ethiopia (2025).

Purpose of the Research Project: To evaluate the relationship between perioperative factors and prolonged cardiopulmonary bypass duration, and its association with postoperative outcomes in patients undergoing open-heart surgery at TASH and CCE hospitals in Addis Ababa, Ethiopia, from 2021 to 2024.

Procedure: The data collection will be conducted in Tikur Anbesa Specialized Hospital (TASH) and the Children's Heart Fund Ethiopia. Standard questioner is prepared to collect necessary information from patient chart.

Risk and /or Discomfort: The data will be taken from patient medical records and documentation devices like computers, so it will not impose any harm on patients.

Confidentiality: During data collection the patients name will not be taken, instead they will be identified by their card number in the chart. All questionaries collected will be kept confidential and destroyed two years after the end of the project. The information collected will be used only for research purpose. The thesis will be submitted for marking to Addis

Ababa University, Department of cardiology, College of Medicine and Health Sciences and displayed in the University Library and website. This study is also intended to be submitted for publication in scholarly journals.

Right to Refusal or Withdraw: Approval of the manager of the hospital and participant will be required to start data collection.

Person to contact: If you have any further questions or would like to receive further information about the project, please contact:

1. Yared Jenberu (Principal investigator): +251916508955
2. Dr Ashanfi Negash (Advisor): +251939654535

Thank you for reading the Information Sheet, and asking any questions that you might have had.

ANNEX II

Questionnaire

1.For each of the questionaries, please Encircle the number of alternative(s) that fit the response and fill the blank space provided or provide appropriate response accordingly.

Section 1: Socio-Demographic Data and physical characteristics of the patient filled preoperatively.

Sr.no	Questions	Response	Code
101	Age	A. Under 18 B. 19-45 C. 45 and above	
102	Sex	A. Male B. Female	
103	BMI	A. < 18.5 B. 18.5-24.9 C. > 25	
104	LVEF	A. <40% B. 40-50% C. >50%	
105	Hypertension	A. YES B. NO	
106	DM	A. YES B. NO	
107	CKD	A. YES B. NO	

Section 2: SURGICAL DETAILS

Sr.no	Question	Response	Code
201	Type of Surgery Performed	A. CHD (ASD, VSD, TOF, AVSD and others) B. Valve Replacement C. CABG on pump D. Other: _____	
202	CPB duration	A. <120 minutes B. >120 minutes	

203	Intraoperative blood transfusion	A. YES B. NO	
204	Intraoperative hemofiltration	A. YES B. NO	

SECTION 3: POSTOPERATIVE RECOVERY

Sr.no	**Questions**	**Response**	**Code**
301	How long did you stay in the Intensive Care Unit after surgery?	A. < 48 hrs. B. 48-72 hrs. C. > 72 hrs.	
302	How many hours were you on mechanical ventilation postoperatively?	A. < 12 hours B. > 12 hours	
303	What was the total duration of your hospitalization from the day of surgery until discharge?	A. 0-4 days B. 5-9 days C. > 9 days	
304	In hospital mortality	A. YES B. NO	