

ADDIS ABABA UNIVERSITY



COLLEGE OF HEALTH SCIENCES DEPARTMENT OF CARDIOLOGY

**Assessment of Prevalence and Associated Factors of Postoperative
Arrhythmia and it's Outcome Among Patients Who Underwent Open Heart
Surgery at Tikur Anbessa Specialized Hospital and Cardiac Center-
Ethiopia,2025**

BY: Segni Eliyas

Addis Ababa, Ethiopia

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**A Research Paper Submitted to the Department of Cardiology of Addis
Ababa University in Partial Fulfillment of the Requirements for the MSc in
cardiovascular perfusion**

Addis Ababa, Ethiopia

June, 2025

Declaration

I the undersigned, here by certify that the research titled “Assessment of Prevalence and Associated Factors of Postoperative Arrhythmia and its outcome Among Patients Who Underwent Open Heart Surgery at Tikur Anbessa Specialized Hospital and Cardiac Center- Ethiopia,2025” is my original work, submitted in partial fulfillment of the requirement for the Masters of Science degree in Cardiovascular Perfusion. I acknowledge that plagiarism is unacceptable, and all directly cited contents has been properly referenced.

Investigator

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Approval of the board of examiners

Advisor

1. Name _____ Signature _____ Date _____

Internal Examiner

2. Name _____ Signature _____ Date _____

External Examiner

3. Name _____ Signature _____ Date _____

Acknowledgements

I would like to thank Addis Ababa University College of health sciences for funding and facilitating my study. I would also want to thank my advisors, Dr Abebe Bezbih (Assistant Professor of Cardiothoracic Surgery), for his support and feedback, which considerably improved this thesis work.

I am also extremely grateful to the school of medicine department of Cardiology for offering this opportunity and assisting me to acquire the skill of conducting research, which in turn can help me undertake numerous breakthrough researches in my future career. Last but not least, many thanks to the data collectors, and all staff of the of both TASH and CCE for their unreserved cooperation and full support throughout the process.

Abstract

Background: Arrhythmia is a prevalent and significant complication following open heart surgery, affecting a significant number of patients and leading to increased morbidity, mortality, and healthcare costs. There is limited data on the prevalence of postoperative arrhythmia following cardiac surgery in Ethiopia. This is because advanced cardiac surgery had been introduced in recent years. This study will benefit the cardiac team in identifying the prevalence, patterns and factors associated with postoperative arrhythmia after open heart surgery.

Objectives: To assess the prevalence and associated factors of postoperative arrhythmia and its outcome in patients who underwent open heart Surgery at TASH and Cardiac Center-Ethiopia, Ethiopia.

Methods: A Multi facility-based, cross-sectional study was conducted at TASH and Cardiac Center- Ethiopia, Addis Ababa. Data was collected using a structured checklist, and then it was entered and analyzed using SPSS version 27. Descriptive analysis along with chi square test and Student t test analyses was employed to identify factors associated with development of arrhythmia. A p-value <0.05 will be considered significant. Tables and figures were used to present the results.

Results: This study included data from 215 patients who underwent open heart surgery with age range from 1 to 73 years. Out of 215 participants, 52 individuals (24.2%) were from TASH. The remaining 163 individuals (75.8%) were from CCE. Among the study participants, more than half (128; 59.5%) were females and the remaining 87 (40.5%) were males. Overall, 29 patients (13.5%) developed arrhythmia during the postoperative period following open heart surgery, and the most frequently observed postoperative arrhythmia was supraventricular tachycardia (24%). Statistically significant difference between the arrhythmic and non-arrhythmic group were noted in relation to cardiopulmonary bypass time (153 Vs 108.7 mins) and aortic clamping time (98.4 Vs 66.07 mins), with p value <0.05. Moreover, this study identified a significant association between postoperative hypokalemia and the occurrence of cardiac rhythm disturbances yielding a p-value of 0.008.

Conclusion: Cardiac arrhythmias in the early postoperative phase are prevalent in patients who underwent open heart surgery, although a substantial proportion of the conduction abnormalities exhibit favorable recovery. The most commonly detected postoperative arrhythmia was supraventricular tachycardia, succeeded by Atrial fibrillation and Junctional ectopic tachycardia. ICU stay was longer in arrhythmic groups when compared to non-arrhythmic group. Prolonged ischemia duration, extended cardiopulmonary bypass duration, and postoperative hypokalemia were factors that elevated the incidence of arrhythmias in the postoperative phase following open heart surgery.

Keywords:

- ✓ Postoperative arrhythmia
- ✓ Patient outcome
- ✓ Open heart Surgery

Acronyms/Abbreviations

AF	Atrial fibrillation
ASD	Atrial septal defect
AV	Atrioventricular
AVN	AV node
AVSD	Atrioventricular septal defect
AXC	Aortic Cross-clamp
BPM	Beats per minute
CABG	Coronary artery bypass graft
CPB	Cardiopulmonary Bypass
CHD	Congenital heart disease
JET	Junctional ectopic tachycardia
PACU	Post-Anaesthesia Care Units
PDA	Patent ductus arteriosus
POA	postoperative arrhythmia
PS	Pulmonary stenosis
PVC	Premature ventricular complexes
SAM	Subaortic membrane
SPSS	Statistical Package for Social sciences
SVT	Supraventricular tachycardia
TASH	Tikur anbessa specialized hospital
TGA	Transposition of great arteries
TOF	Tetralogy of Fallot
TVA	Tricuspid valve abnormalities
VSD	Ventricular septal defect
VT	Ventricular tachycardia

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1.Introduction

1.1 Background

17.5 million deaths worldwide are attributed to cardiovascular disease, and it is the leading cause of death worldwide. Arrhythmias are a common complication after heart surgery and can result in high medical costs, prolonged hospitalization, and mortality (1).

Arrhythmia is an irregular heartbeat, and normal sinus rhythm is the only physiologically normal cardiac rhythm. The atrioventricular (AV) node slows an impulse from the sinoatrial (SA) node as it passes through it. It moves into the Purkinje fibers through the left and right bundle branches and the bundle of His. Any interference in this pathway of conduction results in arrhythmia. There are several parameters on which arrhythmias can be categorized. Based on the rate of conduction, they are most frequently divided into two categories: bradyarrhythmia, if the heart rate is less than 60 beats per minute (bpm), and tachyarrhythmia, if the heart rate is more than 100 bpm. They are further divided based on the origin, mechanism of transmission, and syndromes involved (2).

Cardiac arrhythmia, that is abnormal heart rhythms happening due to interruption in the generation or conduction of electrical impulses within the heart. It is among the most frequent complications following cardiac surgery in both pediatric and adult patients. Despite the fact that most arrhythmias are temporary and can be easily treated, they have a great potential for morbidity and mortality in pediatric patients with congenital heart disease who undergo open heart surgery (3).

Cardiac arrhythmia has been widely known to be a complication following heart surgery. Recent studies revealed that cardiac arrhythmia incidence in coronary artery bypass grafting patients ranges from 10% to 40%, while in heart valve surgery, the incidence is 40% to 70%. Furthermore, arrhythmias will happen between the second and fourth day after surgery. Patients who develop cardiac arrhythmia post-heart surgery carry a higher mortality compared to patients who don't develop arrhythmia post-surgery (4).

A variety of risk factors have been reported to increase the risk of developing arrhythmia, including younger age and lower body weight; Certain procedures, increased cardiopulmonary

bypass (CPB) duration and aortic cross-clamp (AXC) duration; electrolytes imbalance, and hemodynamic instability (5).

The incidence, management, and risk factors for postoperative arrhythmias in open-heart surgery patients are not clearly understood, despite the burden. Only one study on postoperative arrhythmia has been done in children at Cardiac Center-Ethiopia to demonstrate the extent of the problem in Ethiopia. These kinds of studies help us know the extent of the problem and also initiate other studies to be carried out.

1.2 Statement of the problem

Cardiac surgery plays a vital role in treating various cardiovascular disorders, such as coronary artery disease, valvular disease, and congenital heart disease, and arrhythmias are mentioned to be critical postoperative complication

The prevalence of arrhythmias is estimated be 1.5% to 5% in the general population and most often atrial fibrillation. Arrhythmias can be asymptomatic or paroxysmal and hence impossible to determine their actual prevalence. The presence of arrhythmia in general is a predictor of increased mortality and morbidity(2).

Arrhythmia is the commonest postoperative complication of open heart surgery, affecting a high percentage of patients and leading to additional morbidity, mortality, and healthcare costs(1). Arrhythmias may be associated with hemodynamic instability, prolonged hospitalization, an increased risk of stroke and heart failure and high mortality(6). With regards to advancing surgical skill and perioperative care, the pathophysiology of postoperative arrhythmias is still unclear and prevention strategies have varied(7).

In Ethiopia, cardiac surgery is not part of routine clinical practice and as such studies related to the subject are scarce. Limited data exist on the prevalence of postoperative arrhythmia in Ethiopia. This is because advanced cardiac surgery had been introduced in recent years.

The research tries to fill these gaps by examining the prevalence, arrhythmia pattern and arrhythmia-related factors following open heart surgery to improve patient outcomes and reduce the associated healthcare burden. Thus, the knowledge of the pattern and prevalence of arrhythmias will allow us to anticipate and initiate early management.

1.3 Significance of this study

This study will benefit the cardiac team in identifying the prevalence of and factors associated with postoperative arrhythmia after open heart surgery. The finding from the study will help in promoting prevention and early control mechanisms, conscious the policy makers and national programs about the need of diagnostic and treatment facilities and will play a fundamental role in reducing morbidity and mortality from arrhythmia. Therefore, result of this study may contribute important evidence that can be used by the policy makers, program planners and educators to design appropriate strategy to address the problem. Further, the result of the study can be used as a baseline data for future studies in the topic area.

2.Literature review

2.1 Overview of cardiac arrhythmia

After heart surgery, arrhythmias are common and a major cause of morbidity and mortality. While the majority of these arrhythmias are transient and have a benign course, they can prolong hospital stays and intensive care, and in rare cases, they can cause mortality. Postoperative arrhythmias (POAs) include atrial tachyarrhythmias (ATs) and, to a lesser extent, ventricular arrhythmias (VAs) and bradyarrhythmias(8).

Arrhythmias can occur in any area of the heart, including the atria, the ventricles, or in the specialized cells that regulate cardiac rhythm. Adequate blood flow depends on the heart producing enough cardiac output to distribute blood to body tissues. Because abnormal heart rhythms change the stroke volume and rate, they directly lower cardiac output, which may be potentially dangerous to the patient(9).

In both the adult and pediatric populations Arrhythmias are a widely recognized complication after cardiac surgery. Early postoperative tachyarrhythmias typically occur hour to days after cardiac surgery with a reported incidence ranging between 8 and 47%(10).

Among children with congenital cardiac conditions A significant amount of arrhythmias are linked to certain operations, most frequently the surgical repair of tetralogy of Fallot (TOF), atrial septal defect (ASD), and ventricular septal defect (VSD). Younger age and lower body weight, longer cardiopulmonary bypass (CPB) and aortic cross-clamp (AXC) durations, and elevated lactic acid levels are among the risk variables that have been shown to enhance the likelihood of developing arrhythmia(5).

There was a cross- sectional study conducted on the prevalence and risk factors for early postoperative arrhythmias after cardiac surgery for patients with pediatric congenital heart defects at a single center in Bali, Indonesia between January 2020 and December 2022. Among 120 pediatric patients with CHD who underwent cardiac surgery, 92 patients met inclusion criteria in the study. Among 92 patients, 14 (15.2%) developed postoperative arrhythmias. Complete heart block (CHB) the most common arrhythmia, observed in five patients (35.7%), followed by supraventricular tachycardia three patients (21.4%). There were statistically

significant differences between arrhythmia and no arrhythmia groups for cardiopulmonary bypass (CPB) duration (171.23 vs. 108.01 min), aortic cross-clamp duration (115.58 vs. 73.59 min), ischemia duration (106.33 vs. 65.43 min), and potassium level (3.33 vs. 3.88 mmol/L) with $p < .05$. Based on multivariate linear regression analysis, CPB time and potassium level were found to be independent risk factor(3).

After heart surgery, arrhythmias are common complications that can have a major impact on the prognosis of patients. A Single Center retrospective observational study conducted in bahrain from (November 15, 2020 till November 30, 2021) where all adult patients (18 years or older) who were booked for cardiac surgery were reviewed. Patients with pre-existing documented arrhythmias were excluded from the study. A total of 161 patients were enrolled in the study with a mean age of 56.75 ± 1.68 years. Among the total enrolled population, 68.32% were male and 31.68% were female. Premature ventricular complexes (PVC), atrial fibrillation (AF), junctional rhythm, heart block, and atrial flutter were reported in 30.43%, 29.19%, 11.18%, 9.31%, and 8.07% of patient populations respectively(1).

Congenital Heart Disease in adults can be associated with several complications, one of the most important of these complications are cardiac arrhythmias. In this descriptive-analytic cross-sectional study done at Shahid Rajaee Hospital Iran, 800 cases of patients referred for the diagnosis of CHD were investigated. Among them, 110 (13.75%) patients with CHD were complicated with arrhythmia. The mean age of patients in the study was 33.73 ± 13.15 years. 55 (50%) patients were <30 years old, and 55 (50%) were over 30 years old. Among patients, 59 (53.6%) were male, and 51 (46.4%) were female. The most common type of arrhythmias was atrial flutter (AFL) in 35.5%, followed by (AF) in 28.2% , CHB in 19.1%, VT in 5.5 % , AVB in 4.5%, AT 2.7 % (11).

Potassium imbalance post-cardiopulmonary bypass is major factor that may lead to increased risk of postoperative arrhythmias. There was a prospective observational study that was conducted at cardiac surgery department of Punjab Institute of Cardiology Lahore from 2nd November 2018 to 10th January 2020. 100 patients who fulfilled the inclusion criteria was included in the study. Overall potassium imbalance was noted in 39 patients, 33 were hypokalemic and 6 were hyperkalemic and the mean potassium with S.D was 3.95 ± 0.83 and 37

had postoperative arrhythmias out of which 18 (54.5%) were hypokalemic and 2 (33.3%) were hyperkalemic(12).

A retrospective observational study done on Risk factors for prolonged intensive care unit stays in patients after cardiac surgery with cardiopulmonary bypass at a tertiary hospital in Guangzhou from June 2015 to June 2017 shows that Several variables were found associated with prolonged ICU Length of stay: duration of CPB, prolonged mechanical ventilation and non-invasive assisted ventilation use, PaO₂/FiO₂ ratios within 6 h after surgery, type of surgery, red blood cell infusion during surgery, postoperative atrial arrhythmia, postoperative ventricular arrhythmia (all $P < 0.05$)(13).

There was a retrospective and analytic study conducted in children operated at the Cardiac Center Shisong (Cameroon) between January 2010 and December 2013. A total of 150 children were included. Among the 150 patients, at least one episode of arrhythmia was found in 47 patients (31.3%). Of the 150 the 133 patients underwent open heart surgery while 17 patients with closed heart surgery, from those 47 who underwent open heart surgery 46 (34.6%) had arrhythmias while only 01 (5.9%) of the 17 patients with closed heart surgery had an arrhythmia. The most common arrhythmias were supra-ventricular tachycardia 18 (35.3%), sinus bradycardia 10 (19.6%) and junctional ectopic tachycardia 8 (15.7%), sinus tachycardia 3 (5.9%), ventricular tachycardia 3 (5.9%), atrial fibrillation 2 (3.9%), ventricular fibrillation 1 (2%), ventricular extrasystoles 1 (2%). Arrhythmias appeared mainly in the first 24 hours postoperative (57.4%)(14).

There was a study conducted on Magnitude of Early Postoperative Arrhythmias after Cardiac Surgery in Children at the Cardiac Center-Ethiopia, Ethiopia. This study included data derived from 202 pediatric congenital heart disease patients who underwent cardiac surgery, after excluding 14 patients who didn't fulfill the inclusion criteria. Arrhythmia were observed in 16 (7.9%) patients in the postoperative period. In particular, ectopic junctional tachycardia accounted for most of the early postoperative arrhythmia (POA) as they were noted in 7 (43.8%) of the patients with post-surgery arrhythmia. This was followed by bundle branch block which was observed in one-fourth (4;25%) of them, while premature ventricular contractions (PVCs) represented 18.75% of the arrhythmias as they were observed in 3 of the patients(15).

Etiology of arrhythmias in post cardiac surgery patients:

(i) Structural Heart Disease- Those patients with structural disease of the heart carry the highest risk of developing arrhythmias postoperatively. Atrial enlargement or high atrial pressure are common among patients undergoing cardiac surgery. These changes promote development of atrial tachyarrhythmias. Increased atrial diameter that can house multiple circuits, can favor reentry during atrial fibrillation (AFib). Analogously, cardiomegaly patients may have unrecognized structural heart disease providing the substrate for ventricular arrhythmias. Other important predisposing factors are: a history of severe stenosis of the right coronary artery, disease of the artery of the sinus node or of the atrio ventricular node, mitral valvular disease, especially rheumatic mitral stenosis, past history of cardiac surgeries and POAs, and arrhythmias particularly if AFib.

(ii) Trauma and Inflammation- Patients are prone to atrial and ventricular arrhythmias due to the injury sustained during heart surgery. The delayed incidence of POAF between postoperative days 2 and 3 has led to the hypothesis of inflammatory pathways behind POAF development. Inflammation is often the precipitating event for either silent or clinically overt pericarditis. In one series, 63% of patients with pericardial effusion and 11% of those without effusion presented with supraventricular arrhythmias.

(iii) Hemodynamic Stress- Risk factors for postoperative atrial arrhythmias include various potential atrial insults that occur acutely during the operative procedure including acute atrial dilation, localized ischemia, acute hypertension, and physical trauma associated with cannulation. Other reported risk factors include postoperative pleural effusion requiring thoracotomy and postoperative pulmonary edema. Focal arrhythmias may also be induced by hemodynamic changes. Atrial strain, hypertension, pressure and volume shifts, and catecholamine excess can all genuinely provoke ectopic foci from the pulmonary veins in AF.

(iv) Ischemic Injury- Atrial and ventricular ischemia and/or infarction may play a role as a trigger for POAs. Myocardial focal ischemia is majorly caused due to hypoxemia, hypercarbia, endogenous or exogenous catecholamines, acid- base derangements, drug effects, and is also mechanical, as in the case of instrumentation. This could then result in a POA. CPB and cross-

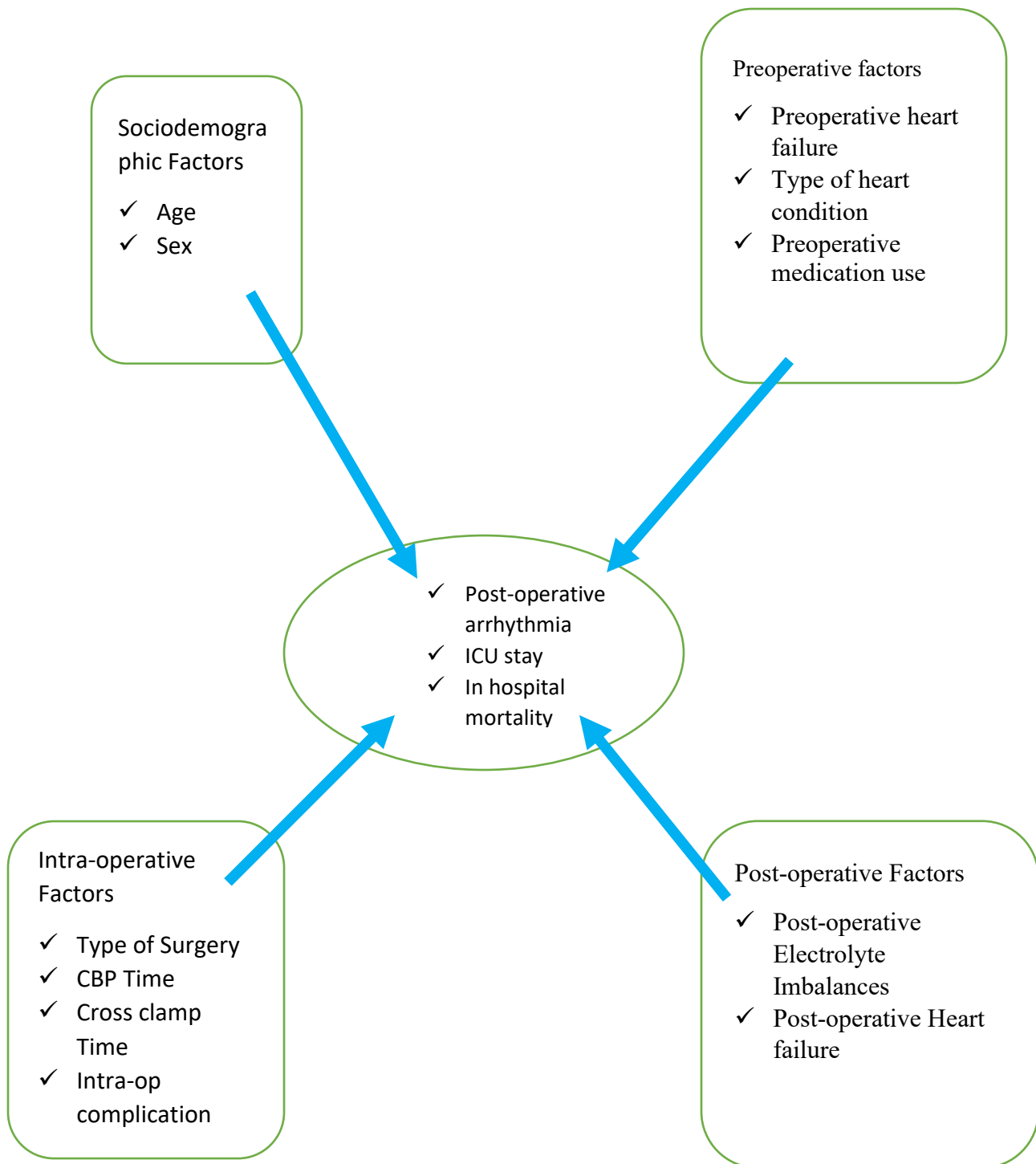
clamp times, type of cardioplegia, and CABG surgical technique are also of importance in the ischemic injury that occurs. The development of AFib is less common following off-pump CABG than traditional CABG. In addition, off-pump CABG is linked to a lower inflammatory response.

(v) Perioperative Drugs- Inotropic agents are known to increase sinoatrial node automaticity and decrease AV nodal conduction time. The occurrence of dobutamine- induced ventricular ectopy varies between 3% and 15% of patients. In addition, intravenous administration of other phosphodiesterase inhibitors such as amrinone and milrinone can lead to VPB and short bursts of VT in 17% of patients when administered IV for short periods of time.

(vi) Electrolytes Disorders- The electrophysiologic characteristics of cardiac myocytes, such as increased phase 3 depolarization, increased automaticity, and decreased conduction velocity, are known to be altered by hypokalemia, which causes postoperative arrhythmias. Given that variations in the inward-rectifier potassium current are already believed to act as profibrillatory substrates in the atria, this could be particularly apparent in that chamber. Ventricular tachyarrhythmias, on the contrary, are more commonly associated with hypokalemia(16).

2.2 Conceptual framework

Figure 1: Conceptual framework for Postoperative arrhythmia



3. Objective of study

3.1 General objective

- ✓ To assess the prevalence and associated factors of postoperative arrhythmia and its outcome in patients who underwent open heart Surgery at TASH and Cardiac Center-Ethiopia, Ethiopia

3.2 Specific objectives

- ✓ To determine the prevalence of postoperative arrhythmia in patients who underwent open heart surgery at Cardiac Center-Ethiopia, Ethiopia
- ✓ To analyze the pattern and types of postoperative arrhythmia in patients who underwent open heart surgery at TASH and Cardiac Center-Ethiopia, Ethiopia
- ✓ To identify factors associated with the development of postoperative arrhythmia in patients who underwent open heart surgery at TASH and Cardiac Center-Ethiopia, Ethiopia
- ✓ To examine the association between postoperative arrhythmia and postoperative outcomes in patients who underwent open heart surgery at TASH and Cardiac Center-Ethiopia, Ethiopia

4. Methods and Materials

4.1 Study area

Addis Ababa, the capital city of Ethiopia, had over 52 hospitals, including 12 state-run and more than 40 private facilities. Among these, Tikur Anbessa Specialized Hospital (TASH), the Children's Heart Fund Ethiopia, and Surgical Centre are notable for their specialization in open-heart surgery and related cardiac procedures, serving the community's needs.

Tikur Anbessa Hospital is a prominent specialized facility located in Addis Ababa, Ethiopia. Established in 1964, it functions as a major teaching hospital affiliated with the School of Medicine at Addis Ababa University. The hospital offers a broad range of specialized clinical services and serves as a key training center for medical students and health professionals from Ethiopia and other African countries. It is well-known for its comprehensive medical training programs and research initiatives. With various departments, including a cardiothoracic unit, Tikur Anbessa provides specialized services not available in other public or private institutions within the country. Annually, the hospital treats over 500,000 outpatients and accommodates more than 21,000 inpatients, making it the largest referral hospital in Ethiopia. It features over 15 major operating theatres and 2 Post-Anesthesia Care Units (PACUs).

The Children's Heart Fund Foundation (CHFE) was established in 1989 by Dr. Belay Abegaz to address the pressing need for specialized cardiac treatment in Ethiopia. In 2009, CHFE inaugurated the first dedicated cardiac center in Addis Ababa, marking a significant milestone in the quest for sustainable cardiac care solutions in the country. Since the Centre's establishment, CHFE has provided expert care to over 4,000 young patients locally. Additionally, the organization focuses on the future by training Ethiopian cardiologists and nurses, thereby empowering local talent. The center has three dedicated OPDs, two operating rooms, 15 beds and one Post-Anesthesia Care Unit (PACU). The service is delivered by four cardiothoracic surgeons, three interventional cardiologists and twelve especially-trained nurses.

4.2 Study design

A retrospective facility-based, cross-sectional study was employed.

4.3 Study period

The study was conducted from Dec 1, 2025 to June 10, 2025.

4.4 Population

4.4.1 Source population

All patients who underwent open heart surgery at TASH and Cardiac Center of Ethiopia.

4.4.2 Study population

Patients who underwent Open heart surgery at TASH and Cardiac Center within the study period and fulfilled the inclusion criteria.

4.5 Eligibility criteria

4.5.1 Inclusion criteria

- ✓ All patients who had preoperative sinus rhythm
- ✓ Patients with normal preoperative electrolytes levels

4.5.2 Exclusion criteria

- ✓ Patients with documented preoperative arrhythmias
- ✓ Patients whose medical records are incomplete or irretrievable
- ✓ Patients with deranged preoperative electrolytes levels

4.6 Sample size and sampling technique

Since there are no studies that indicates the prevalence of postoperative arrhythmia after open cardiac surgery study that accommodates both pediatric and adult population our country and countries which have the same set up with our country.so I took the estimated proportion of the population that exhibits the characteristics of interest as 0.5, as it maximizes sample size.

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

n = the required sample size

p = The estimated proportion of the population that exhibits the characteristics of interest (if unknown –50 %, as it maximizes sample size.)

$Z_{\alpha/2}$ = the critical value at 95% confidence level = 1.96

e = precision (margin of error) = 5%

Accordingly,

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

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

$$n = 384.16 \approx 385$$

The total number of patients who underwent open heart surgery between jan 2021- Dec 2024 is 420.

Since the study population is less than 10,000, sample size reduction is used.

$N_f = n_i / (1 + n_i / N)$; Where: -

$$n_{adjusted} = \frac{n_i}{1 + \frac{n_i - 1}{N}}$$

n_{adjusted}= final Sample Size

n_i= initial Sample Size

N= total population

$$n_{adjusted} = 385 / (1 + (385 - 1 / 420))$$

$$n_{adjusted} = 385 / 1.91$$

$$n_{adjusted} = 201.1 \approx 201$$

$$n_{adjusted} = 201$$

$$n_{adjusted} = 201 + (201 \times 0.10) = 221.1 \text{ participants}$$

$$n_{adjusted} \approx 221 \text{ participants.}$$

After adding 10% for missing data and data quality issues the final sample size becomes **221**.

The proportional value will be calculated using the formula

Total sample * total population of specific area

Total population

➤ TASH

$$\frac{221 \times 107}{420} = 56.3 \approx 56$$

➤ CC

$$\frac{221 \times 313}{420} = 164.6 \approx 165$$

Selection of participants was carried out by using Systemic random sampling technique from the log book.

4.7 Data collection tools and procedures

An organized, pre-tested data collection checklist was used to collect information from patients' medical records. Background information, preoperative clinical variables, intraoperative clinical variables, and postoperative clinical variables were the three categories of questions that made up the data collecting format. The check list was modified from previous pieces of literature (15).

Preoperative and postoperative physician evaluation notes, vital sign sheet records, and electrocardiogram records will all be examined. Two qualified healthcare professionals were hired and given training on how to collect data.

4.8 Study variables

4.81 Dependent variable

- ✓ Postoperative cardiac arrhythmia
- ✓ Postoperative ICU stays
- ✓ Postoperative in hospital mortality

4.82 Independent variables

Background variables

- ✓ Age
- ✓ Sex of the patient

Explanatory variables

- ✓ Type of Cardiac lesion
- ✓ Postoperative electrolyte imbalance
- ✓ Preoperative medication use
- ✓ Preoperative heart failure
- ✓ Post-operative Heart failure
- ✓ Cardiopulmonary bypass time
- ✓ Aortic cross-clamping time
- ✓ Intraoperative complication

4.9 Operational definitions

- ✚ **Arrhythmia:** Arrhythmia is defined as any deviation from normal sinus rhythm, identified by electrocardiographic evidence, characterized by abnormal rate, rhythm, or conduction of electrical impulses in the heart as documented in the patients' medical record.
- ✚ **Postoperative period:** arrhythmia that occurs within the first 7 postoperative days.
- ✚ **Postoperative Outcomes:** refer to the results or effects of post-operative Arrhythmia on patients' ICU stay and mortality during in hospital stay.

4.10 Data processing and analysis

Epi-Data 4.7 was used for data entry, coding, and cleaning, and SPSS (Statistical Package for Social Science) version 27 was used for statistical analysis. To look for missing variables and values, frequency and cross tabulation were employed. Using descriptive statistics like mean, standard deviation, frequency, and percentage, the clinical and demographic features of the patients were calculated. The student t-test was used to ascertain relationships between continuous variables and the dependent variable, while the chi square test was utilized to find categorical variables related to the dependent variables. A 95% confidence level and a p value of less than 0.05 were used to determine a statistically significant difference. Lastly, tables, figures, and diagrams were used to present the study's findings.

4.11 Data quality assurance

The researcher used standard tools which were adopted from other study and amended after detailed review of relevant literatures and similar studies conducted earlier. This ensures the quality of the collected data. Hence, a pretested, English version checklist was used to collect data. Brief training for the data collectors (two health professionals) about the process of data collection were given before the data collection phase. Close supervision was maintained during the data collection process, and filled checklists were double-checked daily for consistency and completeness by data collectors and principal investigator before proceeding to the analysis phase.

4.12 Ethical considerations

After carefully reviewing pertinent literature and previous investigations of a similar nature, the researcher modified the usual tools that were used from prior studies. This guarantees the quality of the information gathered. Therefore, data was gathered using a pretested checklist in English. Prior to the data collecting phase, two health professionals who were the data collectors received brief training on the data collection process. Before moving on to the analysis stage, data collectors and the principal investigator double-checked completed checklists every day for consistency and completeness under strict supervision.

4.13 Dissemination of the study findings

The findings of this study will be submitted to the Department of Cardiology of College of Health Sciences, Addis Ababa University as a partial fulfillment of MSc in Cardiovascular Perfusion. The outcome of this study will be presented to the Academic director of TASH and medical director of the cardiac center and other interested stakeholders such as annual conferences. Finally, the manuscript will be submitted to a reputable scientific journal for possible publication.

5. Results

5.1 Sociodemographic characteristics of patients

This study included data from 215 patients who underwent open heart surgery, after excluding 6 patients due to missing data from the medical record. Out of 215 participants, 52 individuals (24.2%) were from TASH. The remaining 163 individuals (75.8%) were from CCE. Among the study participants, more than half (128; 59.5%) were females and the remaining 87 (40.5%) were males. Participants' age ranged from 1 year to 73 years with a mean of 15.34 years and interquartile range of 5 to 16. The study population comprised predominantly younger individuals. Specifically, (152,70.7%) of the participants were under 18 years of age, indicating a majority pediatric population. Additionally, (52,24.2%) were between 19 and 45 years old, and only (11,5.1%) were older than 46 years.

Table 1: Distribution by socio-demographic characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Frequency	Percent (%)
Hospital		
CCE	163	75.8%
TASH	52	24.2%
Sex		
Female	128	59.5%
Male	87	40.5%
Age group		
1– 18 years	152	70.7%
19 – 45 years	52	24.2%
>45	11	5.1%

5.2 Clinical characteristics

The study showed that majority 201 (93.5%) of the patients were diagnosed to have acyanotic variant of the disease whereas only 14 (6.5%) had cyanotic form of heart disease. With regard to, the type of cardiac lesion identified, VSD was the most frequently mentioned cardiac pathology as it was mentioned in one-fourth (56,26%) of the patients, followed by ASD, double valve abnormalities DVA which were diagnosed in 49 (22.7%), 29 (13.5%) of the studied patients, respectively. Similarly, the cyanotic forms of CHDs such as TOF, TAPVR, AVSD + TOF appeared in 9 (4%), 1 (0.46%), and 1 (0.46%) of the patients, respectively.

Table 2. Clinical characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Frequency	Percent (%)
Type of Cardiac defect		
Acyanotic	201	93.5
Cyanotic	14	6.5

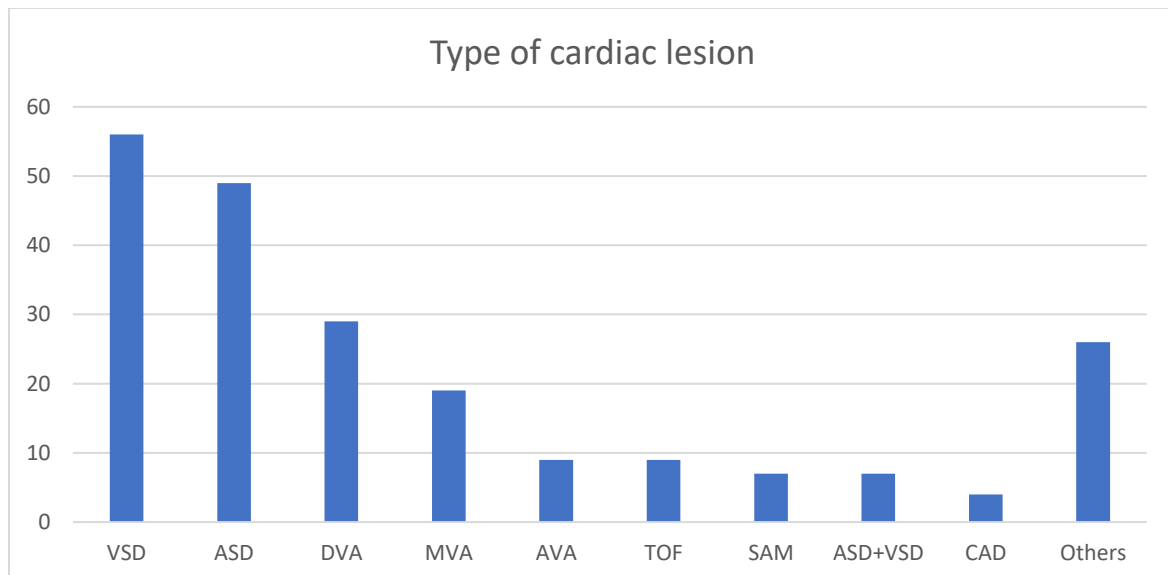


Fig 2. Clinical characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

ASD: Atrial septal defect; VSD: Ventricular septal defect; SAM: Subaortic membrane; TOF: Tetralogy of Fallot; TGA: Transposition of great arteries; MVA: Mitral valve abnormalities; AVA: Aortic valve abnormalities; CAD: Coronary Artery Disease; Double Valve abnormalities

5.3 Preoperative characteristics of patients

In relation to the preoperative conditions of the studied patients, 4 (1.9%) had been diagnosed to have overt heart failure while 2 (0.9%) patients had infection of certain focus preoperatively. Only two patients were found to have acute kidney injury (AKI) during the preoperative assessment. Before undergoing cardiac surgery, one-third (68;31%) of all patients were taking loop diuretics as monotherapy while 15 (6.97%) patients were taking diuretics and β -blockers and 22 (10.2%) patient was on diuretics and ACEIs (Angiotensin converting enzyme inhibitors).

Table 3: Preoperative characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Frequency	Percent (%)
Preoperative heart failure	4	1.9%
Preoperative infection	2	0.9%
Preoperative medications		
Diuretics monotherapy	68	31%
β -blockers monotherapy	10	4.65
ACEIs monotherapy	17	7.9
Diuretics + β -blockers	15	6.97%
Diuretics + ACEIs	22	10.2%

ACEIs: Angiotensin converting enzyme inhibitors

5.4 Postoperative characteristics of patients

In the postoperative period, 3 patients (1.39%) developed cardiac failure. However, hypokalemia was observed in 26 patients (12%) who had normal baseline electrolyte levels prior to surgery, occurring within the first seven days postoperatively. Regarding pharmacologic management, 48.8% (n=105) of patients were administered loop diuretics alone, while 30% (n=66) received a combination of diuretics and angiotensin-converting enzyme inhibitors (ACEIs) during the early

postoperative phase. Additionally, 15 patients (6.97%) and 11 patients (5.1%) were treated with ACEIs as monotherapy and β -blockers respectively as summarized in Table 4.

Table 4: Postoperative characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Frequency	Percent (%)
Postoperative heart failure	3	1.39%
Postoperative infection	8	3.7%
Postoperative electrolyte imbalance	32	14.8
Postoperative hypokalemia	26	12%
Postoperative medications		
Diuretics monotherapy	105	48.8%
Diuretics + ACEIs	66	30%
Diuretics + β -blockers	24	9.3%
β -blockers monotherapy	11	5.1%
ACEIs monotherapy	15	6.97%

5.5 Arrhythmia-related characteristics

A total of 29 patients (13.5%) developed arrhythmia during the postoperative period following open heart surgery. However, 186 patients (86.5%) did not experience any form of rhythm disturbance during their postoperative period as shown Figure 3 below.

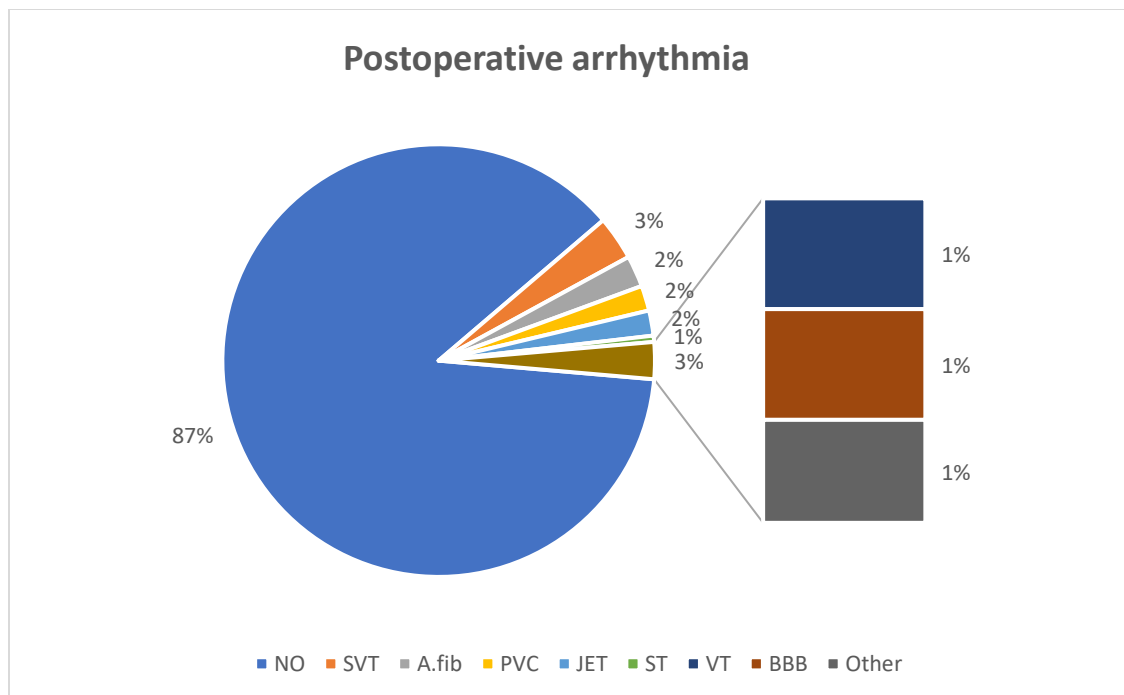


Figure 3. Prevalence of arrhythmia among patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

The most frequently observed postoperative arrhythmia was supraventricular tachycardia (SVT) as it was noted in 7 patients, which represents 24% of those who experienced arrhythmias after surgery, followed by (AF) in 5 patients (17%). Junctional ectopic tachycardia (JET) and Premature ventricular contractions (PVCs) were each identified in 4 patients (14%), while Bundle branch block (BBB) and Ventricular tachycardia (VT) were each observed in 2 patients (7%). Notably, 4 patients experienced more than one type of postoperative arrhythmia in different episode. (Figure 2).

Table 5: Arrhythmia-related characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Frequency	Percent (%)
Onset of arrhythmia		
< 24 hours	14	48%

24 to 72 hours	9	31%
72 hours	6	20%
Type of treatment given (n=29)		
None	11	38%
Medication	8	27%
Medication + Pacemaker	4	13%
Medication + Electric cardioversion	2	7%
Cardiac pacemaker	2	7%
Medication + Manoeuvres	2	7%
Outcome of arrhythmia (n=29)		
Spontaneous resolution	11	38%
Cure	18	62%
Death	0	0%

As confirmed in the above table, almost half of the Rhythm disturbances were observed within the first 24 hours post-surgery in 14 patients (48%). More 9 patients (31%) developed arrhythmias between 24 and 48 hours after the operation, while 6 (20%) patients experienced rhythm disturbances beyond 48 hours postoperatively. With regard to arrhythmia management, 11 patients (38%) did not require any treatment, whereas 8 patients (27%) were administered antiarrhythmic medications. Additionally, 2 patients (7%) received cardiac pacemaker support. Regarding the progression of arrhythmias, more than one-third (11 patients, 38%) resolved spontaneously without intervention, while the remaining 18 cases (62%) were effectively managed using various forms of antiarrhythmic therapy.

5.6 Postoperative outcome of patients

Concerning post operative ICU stay of patients 17 (8%) patients stayed in the ICU for less than 24 hours, 156(72.5%) had ICU stays between 24 and 72 hours, 42 (19.5%) remained in the ICU for more than 72 hours. Despite the varied durations of ICU stays, no in-hospital mortalities recorded. All patients survived to discharge.

Table 6: Clinical characteristics of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Frequency	Percent (%)
Post op ICU stay		
<24 Hrs.	17	8%
24-72Hrs	156	72.5%
>72 Hrs.	42	19.5%
Mortality during hospital stay		
NO	215	100%
YES	0	0%

5.7 Factors associated with postoperative arrhythmia

To identify factors statistically associated with the development of postoperative arrhythmias, both the Chi-square test and Student's t-test were employed. Among the variables analyzed, cardiopulmonary bypass (CPB) time demonstrated a significant association with postoperative arrhythmia. Patients who developed arrhythmias had a longer mean CPB time (mean $\pm$ standard deviation): (153 ± 59.29 minutes) compared to those who maintained sinus rhythm (108.7 ± 43.9 minutes), with a statistically significant p-value of 0.009. Similarly, aortic cross-clamp time was also significantly related to arrhythmia occurrence, with affected patients showing a longer mean cross-clamp time (mean $\pm$ standard deviation) (98.41 ± 41.7 minutes) than those without arrhythmias (66.07 ± 31.43 minutes), yielding a p-value of 0.022. Moreover, this study identified a significant association between postoperative hypokalemia and the occurrence of cardiac rhythm disturbances, with a higher incidence of arrhythmias observed in patients with hypokalemia compared to those with normal potassium levels (34.6% vs. 11.0%), yielding a p-value of 0.008.

In contrast, in patients age, sex, type of surgery, preoperative medication use, Preoperative heart failure, intra-op complication and Post-operative Heart failure, does not exhibit a statistically significant association with the development of postoperative arrhythmias.

Table 7: Factors associated with postoperative arrhythmia of patients who underwent open heart surgery at TASH and CCE, Addis Ababa, Ethiopia from January 1st, 2021 to December 31st, 2024 (n=215)

Variable	Arrhythmic (n=29)	Nonrhythmic (n=186)	P value
Age (year)	19 ± 17.64	14.6 ± 13.76	0.288
Cardiopulmonary Bypass time(min)	153 ± 59.29	108.7 ± 43.9	0.009
Aortic cross-clamping time (min)	98.41 ± 41.72	66.07 ± 31.43	0.022
Sex			0.375
Male	13(15%)	74(85%)	
Female	16(12.5%)	112(87.5%)	
Hypokalemia			
Yes	9(31%)	17(9.1%)	0.008
No	20(68.9%)	169(90.9)	

6. Discussion

The current study was conducted to assess the Prevalence and associated factors of postoperative arrhythmia and its outcome among 215 patients who underwent open-heart surgery at TASH and CCE between January 1, 2021, and December 31, 2024. Among the study participants, 112(59.5 %) were females with a 1.5 to 1 female-to-male ratio. This contrasts with findings from another study, which reported a male-to-female ratio of 1.5:1 (12).

The overall frequency of occurrence of postoperative arrhythmias after cardiac surgery in the present study was 13.5%. A very close figure was observed in Indonesia who recorded a prevalence of 15.2% (3). However, the rate of the current study was higher than the rate (7.9%) observed in CCE(15).

Moreover, in contrast to the present study, study done in Cameroon reported a significantly higher incidence of rhythm disturbances (34.6%) following open-heart surgery (14). The variation in the prevalence of postoperative arrhythmia between our results and prior studies could be explained by a difference in the study age demography. A study done in Turkish population shows there was a trend toward higher incidence of arrhythmia (rate, 43.1%) in the 0-6 months age group (17).

In this study, the most frequently observed postoperative arrhythmia was supraventricular tachycardia (24%), followed by atrial fibrillation (17%), premature ventricular contractions, (14%) and junctional ectopic tachycardia (14%). In line with, a study conducted in Switzerland reported supraventricular tachycardia (30.1%) as the most frequently observed arrhythmia followed by atrial fibrillation (27.4%)(18). According to a study in Thailand, patients with septal defects were more likely to experience AF and AFL, whereas patients who had post-TOF repair showed a wider variety of tachyarrhythmia's, such as AF, AFL, and both monomorphic and polymorphic VTs. Patients are more vulnerable to supraventricular arrhythmias due to the structural and electrical remodeling of the atrium caused by chronic volume overload and increased atrial strain caused by septal abnormalities. Myocardial fibrosis and surgical scars further increase the incidence of ventricular and supraventricular arrhythmias by contributing to arrhythmogenic substrates (19).

The present study revealed a statistically significant difference between the arrhythmic and non-arrhythmic group in relation to cardiopulmonary bypass time (153 vs. 108.7 mins) and aortic clamping time (98.4 vs. 66.07 mins), with p value <0.05. This aligns with a study which reported a statistically significant difference between the mean values for the arrhythmic and non-arrhythmic groups about CBP time (171.23 vs. 108.01 min) and ischemic time (106.33 vs. 65.43 min) (3). Another study reflected a similar picture of mean values in cardiopulmonary bypass time (132.89 vs. 86.13 min), ischemic time (89.47 vs. 52.27 min) (15). This could be related to the complexity of heart surgery, inflammation caused by the long CPB duration, and the use of cardioplegia, which leads to electromechanical arrest and potentially causes arrhythmia (3).

In addition, the current study showed a statistically significant difference between the arrhythmic and non-arrhythmic group in relation to hypokalemia with a higher incidence of arrhythmias observed in patients with hypokalemia compared to those with normal potassium levels (34.6% vs. 11.0%), yielding a p-value of 0.008, aligning with study done in Lahore teaching hospital (12) and Indonesia (3). Hypokalemia causes hyperpolarization and prolongs the action potential duration, increasing susceptibility to early afterdepolarization and delayed afterdepolarizations. Hypokalemia enhances automaticity and triggered activity by increasing the excitability of Purkinje fibers and ventricular myocytes, promoting ectopic beats. Which finally results in arrhythmia (20).

Patients who developed postoperative arrhythmia were about four times more likely to have an ICU stay exceeding 72 hours compared to those without arrhythmia, highlighting the association between rhythm disturbances and prolonged intensive care recovery. This extended ICU stay may be attributed to the need for continuous cardiac monitoring, administration of antiarrhythmic drugs, management of hemodynamic instability, and the potential for arrhythmia-related complications.

Moreover, among patients with cardiopulmonary bypass (CPB) time greater than 120 minutes, 53.3% experienced an ICU stay longer than 72 hours. In contrast, among those with CPB time less than 120 minutes, only 36.5% had prolonged ICU stays. This suggests that longer CPB duration has an impact in increasing likelihood of extended ICU admission.

7. Strength and Limitation

7.1 Strength

- The study is multi center study, it reduces risk of site-specific bias.
- The study was conducted in two of the largest cardiac centers in the country, each serving a wide catchment area.

7.2 Limitations

- The study design was a cross-sectional, and hence it is challenging to make causal inferences and alternative explanations for the findings.
- This study assessed only the early postoperative arrhythmia and short-term outcome of the patients without considering the longer-term post arrhythmia complications.
- The study relied on documentation to assess the risk factors, and because of poor documentation, some of the possible risk factors such as Aristotle Basic Score, and preoperative oxygen saturation that would have affected the incidence of postoperative arrhythmia were not studied.

8. Conclusion and Recommendation

8.1 Conclusion

Cardiac arrhythmias in the postoperative phase are prevalent in patients who underwent open-heart surgery, although a substantial proportion of the conduction abnormalities exhibit favorable recovery. The most commonly detected postoperative arrhythmia was supraventricular tachycardia, succeeded by atrial fibrillation and Junctional ectopic tachycardia. ICU stay was longer in arrhythmic groups when compared to non-arrhythmic group. Prolonged ischemia duration, extended cardiopulmonary bypass duration, and postoperative hypokalemia were factors that elevated the incidence of arrhythmias in the postoperative phase following open-heart surgery.

8.2 Recommendation

To health professionals

To reduce the morbidities linked to arrhythmia, more work must be done to identify postoperative arrhythmia as soon as possible. Additionally, patients with higher risks such as those with longer ischemia or bypass times, postoperative hypokalemia should get special attention, including consideration of prophylactic medication.

To local health policy makers

Guidelines need to be developed, along with the implementation of awareness and training programs.

To researchers

To have a full insight, future investigations should include variables such as oxygen saturation, any remaining anatomical defects, the administration of inotropic medications, and the Aristotle Basic Score.

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Annex

Annex I: Information sheet to the director of TASH and Cardiac Center- Ethiopia

Addis Ababa University : bDepartment of Cardiology

This sheet was readied for the director of TASH and Cardiac Center-Ethiopia before collecting any information from the registries.

Greetings. My name is Segni Eliyas and I am a postgraduate student in Cardiovascular perfusion at AAU.

These two centers are selected to conduct the proposed study “**Assessment of Prevalence and Associated Factors of postoperative Arrhythmia and it’s outcome in patients underwent open heart surgery at TASH and Cardiac Center, Ethiopia**” as both institutions are leading centers in the country dedicated to cardiac care with a wide range of cardiac services.

I am humbly requesting your esteemed office to give me permission to conduct the stated study in these hospitals. Please read the following information for further understanding:

What the study is about: The purpose of this study is to Assess the Prevalence of postoperative Arrhythmia and Associated Factors in patients underwent open heart surgery at TASH and Cardiac Center, Ethiopia.

What I will ask you to do: If you agree to facilitate the undertaking of this study; I will be using a pretested checklist that will include questions about background data and clinical characteristics. I would very much appreciate your cooperation in this study.

Risks and benefits: The result of the study is believed to help responsible body to advance the body of knowledge in the assessment of Prevalence and Associated Factors of Postoperative Arrhythmia and patient outcome in Patients who Underwent Open Heart Surgery at TASH and Cardiac Center, Ethiopia., which can be helpful to improve the overall cardiac care.

Confidentiality: All information gathered from the participants will be kept confidential. Any of respondents’ personal information will not be registered. The records of this study will be kept

private. In any sort of public report, any information that will be making it possible to identify the participant will not be included. Research records will be kept in a locked file; only the researcher will have access to the records.

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Annex II: English Version Questionnaire

Addis Ababa University

Department of Cardiology

Sociodemographic data	
1. Institution	TASH ☐ CCE ☐
2. Age	Years
3. Sex	Male ☐ Female ☐
4. Specific diagnosis	A. ASD ☐ B. VSD ☐ C. AVSD ☐ D. TGA ☐ E. TOF ☐ F. PS ☐ G. TVA ☐ H. AR ☐ I. AS ☐ J. MR ☐ K. MS ☐ L. CAD ☐ M. Other, please specify _____
Characteristics related to preoperative and postoperative condition of the patient	
1. Type of heart condition	Cyanotic ☐ Acyanotic ☐
2. Preoperative heart failure	No ☐ Yes ☐
3. Preoperative infection	No ☐ Yes ☐
4. Preoperative AKI/CKD	No ☐ Yes ☐
5. Post-operative Electrolyte imbalance	No ☐ Yes ☐
6. If yes is the answer to Q 5, what kind? How much?	Na ☐ K ☐ Cl ☐ Ca ☐ Other, please specify _____ Amount
7. Post-operative Heart failure	No ☐ Yes ☐

8. Post-operative infection	No ☐ Yes ☐
9. History of previous cardiac surgery	No ☐ Yes ☐
10. What medication is he /she on preoperatively?	A. Diuretics ☐ B. ACE inhibitors ☐ C. B-Blockers ☐ Other, please specify _____
11. What medication is he /she on postoperatively?	A. Diuretics ☐ B. ACE inhibitors ☐ C. B-Blockers ☐ Other, please specify _____
12. Intra OP condition	
I. Intra op complication	No ☐ Yes ☐
If yes, what kind	_____
13. Cardiopulmonary bypass time	_____ min
14. cross clamp time	_____ min
Clinical features related to the surgery and arrhythmia	
15. Type of surgery done	_____
16. Was there arrhythmia	No ☐ Yes ☐
17. Type of arrhythmia	JET ☐ VT ☐ VF ☐ AF ☐ Other,specify _____
18. The time of onset of arrhythmia	_____
19. For which treatment did they respond?	A. Medical ☐ B. Maneuver's ☐ C. Cardioversion ☐ Other,specify _____
20. Post-operative icu stay	_____
21. Outcome of the patient	A.Spontaneously resolved ☐ B.Treated and cured ☐ C. Still on chronic treatment ☐ D. Died ☐ Unknown/other _____