ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

Magnitude of Early Postoperative Arrhythmias after Cardiac Surgery in Children at the Cardiac Center-Ethiopia, Ethiopia

By: Bezamariam Fesseha (MD, Pediatrics Resident)

Addis Ababa, Ethiopia

November, 2021 GC

ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

DEPARTMENT OF PEDIATRICS AND CHILD HEALTH

Magnitude of Early Postoperative Arrhythmias after Cardiac Surgery in Children at the Cardiac Center-Ethiopia, Ethiopia

By: Bezamariam Fesseha Kassa (MD, Pediatrics Resident)

Advisors: Tamirat Moges (Associate Professor of Pediatrics and Pediatric Cardiology)

A Research Paper submitted to the Department of Pediatrics and Child Health of Addis Ababa University in Partial Fulfillment of the Requirements for the Specialty Certificate in Pediatrics and Child Health

Addis Ababa, Ethiopia

Nov, 2021 GC

Acknowledgements

I would like to forward my appreciation to the Cardiac Center-Ethiopia and the department of Pediatrics and Child Health, College of Health Sciences, Addis Ababa University for providing me such a golden opportunity of undertaking a research of such kind. I am highly grateful to my supervisor, Dr. Tamirat Moges (Associate Professor of Pediatrics and Pediatric Cardiology), and all healthcare professionals working at the cardiac center. I am grateful to my colleagues who helped me through the course of my research works.

Abstract

Background*:* Early postoperative arrhythmias are a widely recognized complication of cardiothoracic surgery in the pediatric populations with CHDs. They have potentially grave consequences, particularly if they are not managed promptly. However, there remains lack of information in Ethiopian setting regarding postoperative cardiac rhythm disturbances although cardiothoracic surgeries have been performed since recently.

Objective: To assess the magnitude of early postoperative arrhythmia and its associated factors among CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020.

Methodology: A facility-based, cross-sectional study was conducted at Cardiac Center-Ethiopia, Addis Ababa. Data was collected using a structured checklist, and then entered and analyzed using SPSS version 26. Descriptive analysis along with chi square test and Student t test analyses were employed to identify factors associated with development of arrhythmia. A p-value <0.05 was considered significant. Tables and figures were used to present the results.

Results: The study evaluated medical records of 202 pediatric CHD patients who underwent cardiothoracic surgery. Their age ranged from 1 month to 14 years, and of all, females represented 54.5% (110). Arrhythmia was documented in 16 (7.9%) of the patients, and junctional ectopic tachycardia was the most common form of arrhythmia (43.8%). Statistically significant difference between the arrhythmic and non-arrhythmic group were noted in relation to cardiopulmonary bypass time (132.87 vs. 84.63mins) and aortic clamping time (89.47 vs. 51.40 mins), with p value <0.05. Chi square test showed that cyanotic CHDs and patients with TOF are at higher risk of developing post-surgery arrhythmia.

Conclusion: Early postoperative arrhythmias following surgery for congenital heart disease are not uncommon in the paediatric population. Longer ischemic time, bypass time, cyanotic heart diseases and presence of TOF were all risk factors that increased the incidence of postoperative arrhythmias.

Acronyms/Abbreviations

ASD	Atrial septal defect
AV	Atrioventricular
AVN	AV node
AVSD	Atrioventricular septal defect
CHD	Congenital heart disease
JET	Junctional ectopic tachycardia
PDA	Patent ductus arteriosus
PICU	Pediatric intensive care unit
POA	Postoperative arrhythmia
PS	Pulmonary stenosis
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	Tricuspic valve abnormalities
VSD	Ventricular septal defect
VT	Ventricular tachycardia

Table of Contents

1. Introduction

1.1 Background

Post-operative arrythmias were a major cause of mortality and morbidity after cardiac surgery for CHD. In the early post op period after cardiac surgery patients with CHD are especially vulnerable to rhythm disturbances. Arrhythmias are commonly encountered in the pediatric intensive care unit setting, most frequently in the setting of postoperative congenital heart disease(1).

Immediate postoperative arrhythmias are a widely recognized complication of cardiothoracic surgery in both the adult and pediatric populations. Although they are transient and manageable, they are considered a major cause of morbidity and mortality after cardiac surgery for congenital heart disease during the phase of postoperative hemodynamic instability(2). Review of existing literature revealed an incidence of arrhythmias ranging from 7.3% to 48%, in the early postoperative period after congenital cardiac surgery (2) (3).

There are many factors known to increase the risk of post congenital heart repair surgeries. Cardiopulmonary bypass (CPB), intraoperative injury to the conduction system and myocardium, postoperative metabolic abnormalities and electrolyte disturbances are known factors associated with increased risk of arrhythmias following surgery(4).

Despite the burden, little is known about the prevalence, treatment, and risk factors for early postoperative arrhythmias in children after cardiac operations. There is no study to show the burden of the problem in our set up and this type of studies will help us to understand the magnitude of the problem and also will also encourage further studies to be done.

1.2 Statement of the problem

Patients with CHD are especially vulnerable to rhythm disturbance. Rhythm disturbances that develop after pediatric surgery for heart disease significantly increase mortality and morbidity. Such disturbances can be of atrial or ventricular

origin. Arrhythmias are commonly encountered in the pediatric intensive care unit setting, most frequently in the setting of postoperative congenital heart disease. Arrhythmias can be life-threatening especially in the early period after pediatric heart surgery. So, knowing the prevalence and pattern of arrhythmias will help us to anticipate and initiate early management.

Prevalence and of arrhythmia in post-cardiac surgery patients in pediatric age group has not been studied in our country. And also, there is limited data in Africa so this study will help as a base line for further studies.

1.3 Significance of this study

This study is expected to contribute to the body of knowledge regarding the magnitude of early postoperative arrhythmias after cardiac surgery in children at the Cardiac Center-Ethiopia, Ethiopia. Furthermore, it will shed some light to the health professional about the updated evidences concerning the magnitude of early postoperative arrhythmias after cardiac surgery. By extension, this may contribute to the overall quality of care partly by emphasizing on the ways to prevent postoperative arrhythmia, which will reduce the burden of the problem and its potential consequences.

Moreover, this study is hoped to help health care policy strategists to design programs that are targeted to train health care providers so that they can attain adequate theoretical and technical preparation to prevent and diagnose early postoperative arrhythmias in children undergoing cardiac surgery. Finally, it also will serve as a baseline literature for further research undertakings related to postoperative cardiac arrhythmia.

2. Literature review

2.1 Overview of cardiac arrhythmia

Rhythm disturbances that develop after pediatric surgery for heart disease significantly increase mortality and morbidity. Such disturbances can be of atrial or ventricular origin (5).

Arrhythmias represent a major cause of morbidity, increased length of hospital stay, and economic costs. However, little is known about incidence, risk factors, and treatment of early postoperative arrhythmias. Both tachyarrhythmias and bradyarrhythmia's can present in the postoperative period(6).

The prevalence of postoperative arrhythmias varies between 15 and 48% following surgical repair of congenital heart disease (CHD). Risk factors include lower age, prolonged cardiopulmonary bypass, long aortic cross-clamp time, deep hypothermia and circulatory arrest (7), (4), (8).

Complications due to arrhythmias are due to inadequate cardiac output either due to loss of atrio-ventricular synchrony or a rapid ventricular response. Most postoperative arrhythmias are associated with surgery around the sinus or the atrioventricular (AV) node or related to atriotomy or ventriculostomy incisions or perioperative ischemia (9).

There was a study done in Pediatric Department, Faculty of Medicine, Ain Ainshams University, Cairo, Egypt; in 2017 a cross-sectional study was carried out between March 2013 and March 2014. All patients had preoperative sinus rhythm and normal preoperative magnesium and other electrolytes levels and arrhythmias were found in 15 out of 30 patients who represented an overall incidence of 50%. Those were grouped as follow: 5 patients (33.33%) with Junctional ectopic tachycardia (JET), 4 patients (26.67%) with Junctional rhythm (JR), 2 patients (13.33%) with complete heart block (CHB), 2 patients (13.33%) with premature ventricular contractions (PVCs), 1patient (6.67%) got attack of ventricular tachycardia (VT) and another one (6.67%) got supraventricular tachycardia(SVT) (2).

There was a prospective observational study conducted in the cardiothoracic and vascular surgery intensive care unit (CTVS ICU) of a tertiary care hospital new delhi,india ,Of 412 pediatric patients who underwent cardiac surgeries from November 2015 to December 2016, 12 did not consent to the study A total of 369 consented patients up to age 18 years who fulfilled the inclusion criteria were included in this prospective study. Of these patients, 259 children were males and 110 were females. There were 187 (50.6%) patients with cyanotic

congenital heart disease and 182 (49.6%) were a cyanotic. A total of 25 (6.7%) patients developed arrhythmias. Junctional ectopic tachycardia (JET) was the most common arrhythmia occurring in 15 (60%) patients, followed by supraventricular tachycardia in 3 (12%), ventricular premature contractions in 3 (12%), hemodynamically unstable ventricular tachycardia and fibrillation in 3 (12%), and atrial fibrillation in 1 (4%) patient. Different grades of heart block were noted in 13 patients (5).

JET is a tachyarrhythmia associated mostly with surgery for CHD. It is usually a self-limiting condition but can cause serious hemodynamic condition in the immediate post op phase. A study done in the department of anesthesia and intensive care, HELLSINKI university hospital Finland in 2010. During the study period a total of 1026 patients underwent heart surgery with cardiopulmonary bypass. The median age was 6.7montth and of all 103 patients (10%) were diagnosed with peri-or post-operative tachyarrhythmia's. From this 51 patients were diagnosed with JET(10).

Arrhythmias are common in the early postoperative period after cardiac surgery for congenital heart disease. A STUDY done at Department of Pediatric Cardiology, Aachen University Hospital, Aachen, Germany, a total of 494 consecutive patients, including 96 neonates, were studied with serial 24-hour Holterelectrocardiograms before as well as uninterruptedly during the first 72 hours after surgery and prior to discharge: Within 24 hours of surgery 59% of the neonates and 79% of the older children developed arrhythmias. Junctional ectopic tachycardia occurred in 9% of neonates and 5% of non-neonates and ventricular tachycardia in 3% and 15%, respectively.

For neonates, male sex and longer cross-clamping time independently increased the risk for arrhythmias (odds ratios 2.83 and 1.96/minute, respectively). Ventricular septal defect repair was a strong risk factor for junctional ectopic tachycardia in neonates and in older children (odds ratios 18.8 and 3.69, respectively). For infants and children, older age (odds ratio 1.01/month) and closure of atrial septal defects (odds ratio 2.68) predisposed to arrhythmias (4).

There was a study done at cardiology and cardiac center of Philadelphia and university of Pennsylvania from December 1 1997- to Nov 30 1998 The incidence of a particular arrythmia was based on total of 789 admission of these 229 (29%) had 1 or more arrhythmias (11).

A study done in the Department of Pediatrics, University Children's Hospital Zurich, and Division of Cardiovascular Anesthesia, Institute of Anesthesiology, University Hospital Zurich, Zurich, Switzerland in 2002 and Sixty-four arrhythmias were observed in 48 patients during a median observation time in the ICU of 7 days (range, 2 to 395 days). The time of arrhythmia occurrence ranged from the same day of operation to 15 days after operation, with a median time of 1 day. Thirteen patients experienced two different types of arrhythmias, and four different arrhythmias were observed in 1 patient. Hemodynamic impairment was observed in 48 of 64 arrhythmias (75%). However, arrhythmias never represented life-threatening events, nor were they the cause of death in any patient(12).

Etiology of arrythmias in post cardiac surgery patients (British Columbia)

Anatomical and surgical factors- In children with CHD, preoperative and intraoperative factors contribute to the development of postoperative rhythm disturbances. The underlying anatomy is an important predictor of postoperative arrhythmias. Chronic volume or pressure loading leads to chamber hypertrophy and fibrosis. This and previous palliative or corrective surgery may result in anatomic barriers to conduction and scarring. During the conduct of surgery itself, bypass cannulation is near the sinus node, which may impair sinus node automaticity. Sinus node dysfunction can b, arterial switch). Normal AVN conduction may be affected by e seen acutely and chronically following open heart surgery. Many procedures for the correction of CHD involve the manipulation of tissues in the vicinity of the AVN (e.g. ventricular septal defects, AV septal defects tissue trauma related edema or by direct injury from suture lines. Junctional ectopic tachycardia (JET) – the most common tachycardia in the postoperative CHD patient – occurs when surgery in the vicinity of the AVN results in local changes that appear to enhance automaticity

Electrolytes and metabolic state- Disturbances of electrolytes are common following open-heart surgery and can affect rate, rhythm and automaticity. The most common abnormalities affect potassium, magnesium and acid-base balance. Frequent monitoring of electrolytes and blood gases is imperative. Preoperative diuresis can predispose to sodium, potassium and magnesium depletion. Postoperative renal impairment, bleeding, blood transfusion and diuretic requirements can aggravate these electrolyte imbalances. Potassium is important for maintaining a stable cell membrane potential.

Medications and fever- Fever is common in the postoperative period and reflects the inflammatory state induced by cardiopulmonary bypass. Fever increases the endogenous catecholamine's and can accelerate automatic tachycardia.

Medications-The spectrum of medications that can predispose patients to postoperative arrhythmias is extensive. The most frequent medications prescribed in children with heart disease are diuretics. Diuretics commonly cause both acute extracellular and chronic intracellular electrolyte abnormalities and set the stage for arrhythmias. Drug interactions with antiarrhythmic agents in combination with electrolyte disorders are of particular importance (4).

3. Objective of study

3.1 General objective

- To assess the magnitude and pattern of early postoperative arrhythmia and associated factors in pediatric patients who went through cardiac surgery for congenital heart disease at Cardiac Center-Ethiopia, Ethiopia

3.2 Specific objectives

- To determine the prevalence of early postoperative arrhythmia in post-cardiac surgery pediatric patients at Cardiac Center-Ethiopia, Ethiopia
- To assess the pattern of early postoperative arrhythmia in post-cardiac surgery pediatric patients at Cardiac Center-Ethiopia, Ethiopia
- To identify the risk factors associated with the development of early postoperative cardiac arrhythmia at Cardiac Center-Ethiopia, Ethiopia

4. Methods and Materials

4.1 Study area

4.1 Study area

The current study was conducted at the Cardiac Center-Ethiopia, which is the only government institution in the country where a well-functioning cardiac surgical service is available. The center was established inside Zewditu Memorial Hospital in 1992 GC and later was translocated to Tikur Anbessa Specialized Hospital in 2009 GC. Each year, the center delivers various cardiac surgical services to more than 500 patients with different cardiac pathologies coming from different corners of the country. The center has three dedicated OPDs, one major operation theatre and has 15 beds. The service is delivered by three 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 period was from July 1st to August 31st, 2021.

4.4 Population

4.4.1 Source population

All pediatric patients with CHD who underwent cardiac surgery at the cardiac center

4.4.2 Study population

All pediatric patients with CHD who underwent cardiac surgery at the cardiac center within the study period and fulfilled the inclusion criteria

4.5 Inclusion and exclusion criteria

4.5.1 Inclusion criteria

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

4.5.2 Exclusion criteria

- Pediatric 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

Taking the population proportion of CHD patients undergoing cardiac surgery reported to develop early postoperative cardiac arrhythmia to be 8.8% taken from the previous study done in Turkish pediatric population (5),

$$n = \frac{z^2 p(1-p)}{e^2}$$

n = the required sample size

p = proportion of CHD patients reported to have early postoperative arrhythmia – 8.8%

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

e = precision (margin of error) = 5%

Accordingly,

$$n = \frac{(1.96)^2 * 0.1(1-0.088)}{0.05^2}$$

$$n = \frac{(1.96)^2 * 0.1(0.912)}{0.05^2}$$

$$n = 123$$

Hence, adding 10% of the calculated sample size for contingency that might happen due lost charts or incomplete reports, the final sample size became 135. Therefore, as the total number of CHD patients who underwent cardiothoracic surgery during the study period is estimated to be close to the minimum calculated sample size, the researcher decided to include all medical records of CHD patients who underwent cardiothoracic surgery during the specified study period. Accordingly, all medical records of 214 patients who underwent cardiac surgery for CHD from January 1st, 2018 to December 31st, 2020 were reviewed. Of these, only 200 patients were eligible for the study as they fulfilled the inclusion criteria.

4.7 Data collection tools and procedures

Data was collected from patients' medical records using structured, pre-tested data collection checklist. The data collection format included questions divided into three parts (background information, preoperative clinical variables, intraoperative clinical variables and postoperative clinical variables). The latter was adapted from previous literatures such as [12]. Electrocardiography records, vital sign sheet records, and preoperative and

postoperative physician evaluation notes were reviewed. Two professional healthcare workers were recruited and trained on data collection procedures.

4.8 Study variables

4.8.1 Dependent variable

- Early postoperative cardiac arrhythmia

4.8.2 Independent variables

- Age
- Sex of the patient
- Type of CHD
- Preoperative medication use
- Cardiopulmonary bypass time
- Aortic cross-clamping time
- Intraoperative complication

4.9 Operational definitions

- **Arrhythmia**: any irregular cardiac rhythm as documented in the patients' medical record
- **Early postoperative period:** arrhythmia that occurs within the first 7 postoperative days

4.10 Data processing and analysis

Data entering, coding, and clearing was performed using Epi-info version 7.0 and statistical analysis was done using SPSS (Statistical Package for Social science) version 26. Frequency and cross tabulation was used to check for missed values and variables. The demographic and clinical characteristics of patients were computed using descriptive statistics such as mean, standard deviation, frequencies, and percentage. Chi square test was used to identify categorical variables associated with the dependent variables while Student t test was run to determine associations between continuous variables and the dependent variable. A p value of <0.05 and 95% confidence level was used as a difference of statistical significance. Finally, the study findings were presented using diagrams, tables and figures.

4.11 Data quality assurance

To assure the quality of the collected data, data collection tool was prepared after thorough review of relevant literatures and similar studies conducted previously. 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 was 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

In order to make the study ethically sound and protect human subjects, certain important ethical considerations were taken into account. A support letter was taken from the Ethical Review Committee of the Department of Pediatrics and Child Health, and it was submitted to the onsite director. After this, introduction & familiarization of the data collectors with team unit was secured. Moreover, effort was exerted to maintain the anonymity and confidentiality of the collected data.

4.13 Dissemination of the study findings

The findings of this study will be submitted to the Department of Pediatrics and Child Health of College of Health Sciences, Addis Ababa University as a partial fulfillment of specialty certificate in Pediatrics and Child Health. The outcome of this study will be presented to the 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 derived from 202 pediatric congenital heart disease patients who underwent cardiac surgery, after excluding 14 patients who didn't fulfill the inclusion criteria. Among the study participants, a little more than half (110; 54.5%) were females and the remaining 92 (45.5%) were males. And participants' age ranged from 1 month to 14 years with a median of 4.0 years and interquartile range of 2 to 7. Of all the study participants, majority (82; 40.6%) aged 1 to 5 years by the time of cardiac surgery while more than two-fifths of the patients (90;44.2%) belonged to the age range that span from 5 to 14 years. Moreover, according to the documented address of the studied patients, most (179; 88.6%) were described as urban dwellers while the remaining 23 (11.4%) were rural residents (Table 1).

Table 1: Distribution by socio-demographic characteristics of CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020

Variable	Frequency	Percent (%)
Sex		
Female	110	54.5
Male	92	45.5
Age group		
1 to 12 months	30	14.9
1.1 year to 5 years	82	40.6
>5 years	90	44.2
Residence		
Urban	179	88.6
Rural	23	11.4

5.2 Clinical characteristics

With regard to, the type of congenital heart disease, majority (171;84.7%) of the patients were diagnosed to have acyanotic variant of the disease whereas only 31 (15.3%) had cyanotic form of CHD. Likewise, in relation to the type of cardiac anomaly identified, PDA was the most frequently mentioned cardiac pathology as it was mentioned in two-fifths (82)

of the patients, followed by VSD, ASD and SAM which were diagnosed in 60 (29.7%), 44 (21.8%) and 14 (6.9%) of the studied patients, respectively. Similarly, the cyanotic forms of CHDs such as TOF, TGA, TVA appeared in 19 (9.4%), 6 (3.0%), and 4 (2.0%) of the patients, respectively (Table 2).

Table 2: Clinical characteristics of CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020

Variable	Frequency	Percent (%)
Type of CHD		
Cyanotic	31	15.3
Acyanotic	171	84.7
Cardiac lesion		
PDA	82	40.6
VSD	60	29.7
ASD	44	21.8
SAM	14	6.9
AVSD	7	3.5
PS	7	3.5
TOF	19	9.4
TGA	6	3.0
TVA	4	2.0
Others	15	7.4

ASD: Atrial septal defect; VSD :Ventricular septal defect AVSD : atrioventricular septal defect; PS: Pulmonary stenosis; PDA: patent ductus arteriosus; SAM: Subaortic membrane; TOF: Tetralogy of Fallot; TGA: Transposition of great arteries; TVA: Tricuspic valve abnormalities

5.3 Perioperative characteristics of patients

With regard to the early preoperative conditions of the studied patients, only 2 (1%) had been diagnosed to have overt heart failure while only a single (0.5%) patient had infection of certain focus preoperatively. Before undergoing cardiac surgery, two-fifths (41;20.3%) of all patients were taking loop diuretics as monotherapy while 3 (1.5%) patients were taking diuretics and β-blockers and only 1 (0.5%) patient was on diuretics and ACEIs (Angiotensin

converting enzyme inhibitors), respectively. Of all patients, 3 (1.5%) had been noted to have some sort of intraoperative complication such as hypotension and hypoxia (Table 3).

Table 3: Perioperative characteristics of CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020 (n=202)

Variable	Frequency	Percent (%)
Preoperative heart failure	2	1.0
Preoperative infection	1	0.5
Preoperative renal failure	0	0
Preoperative medications		
Diuretics monotherapy	41	20.3
Diuretics + β-blockers	3	1.5
Diuretics + ACEIs	1	0.5
Intraoperative complication	3	1.5
Postoperative heart failure	0	0
Postoperative hypokalemia	19	9.4
Postoperative renal failure	1	0.5
Postoperative medications		
Diuretics monotherapy	95	47.0
Diuretics + ACEIs	72	35.6
Diuretics + β-blockers	2	1.0
β-blockers monotherapy	2	1.0
ACEIs monotherapy	2	1.0

ACEIs: Angiotensin converting enzyme inhibitors

By the same token, none of the patients was on cardiac failure in the early postoperative period. But, nineteen (9.4%) patients who had normal baseline electrolyte study developed hypokalemia in the first seven postoperative days. Considering the postoperative medications, almost half (95;47.0%) of the patients were on loop diuretics alone whereas a little more than a third (72;35.6%) of the patients were prescribed both diuretics and ACEIs in the early postoperative period. Further, 4 (2%) of the studied patients were on either β-blockers or ACEIs monotherapy, as detailed in Table 3.

5.4 Arrhythmia-related characteristics

In relation to the occurrence of arrhythmia following cardiac surgery, 16 (7.9%) patients were observed to have arrhythmia in the early postoperative period. On the other hand, 186 (92.1%) were reported not to have any form rhythm disturbance in their early postoperative period (Figure 1).

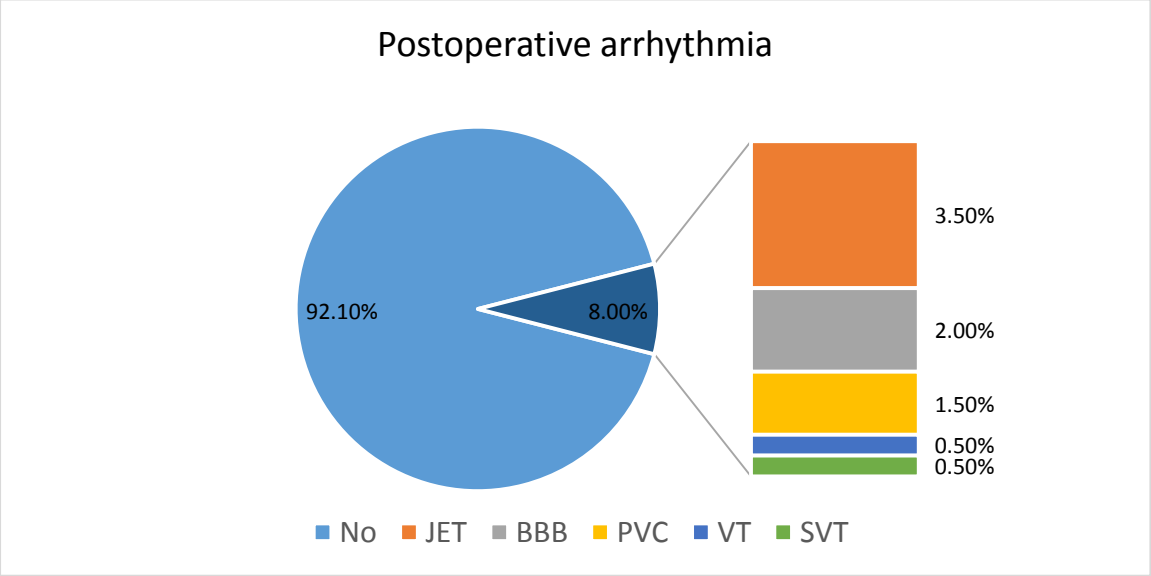

Figure 1. Prevalence of arrhythmia among CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020 (n=202)

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 (Figure 1).

Table 4: Arrhythmia-related characteristics of CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020

Variable	Frequency	Percent (%)
Onset of arrhythmia		
< 24 hours	6	37.5
24 to 72 hours	6	37.5
>72 hours	4	25.0

Type of treatment given (n=16)		
None	5	31.25
Medication	4	25.0
Medication + Manoeuvres	2	12.5
Medication + Electric cardioversion	1	6.25
Cardiac pacemaker	3	18.75
Medication + Pacemaker	1	6.25
Outcome of arrhythmia (n=16)		
Spontaneous resolution	5	31.25
Cure	10	62.5
Death	1	6.25

Majority (12;75%) of the rhythm disturbances had an onset within the first 72 hours of postoperative state while the remaining one-fourth were detected after 72 postoperative hours had elapsed. With regard to the type of treatment given, 5 (31.25%) of the patients with arrhythmias received no treatment while one-fourth (4;25%) of the patients received antiarrhythmic medications. And cardiac pacemaker was administered to 3 (18.75%) of the postoperative patients who developed arrhythmia. Moreover, regarding the time course of the arrhythmias, nearly one-third (5;31.25%) were transient as they resolved spontaneously, without any use of intervention. The remaining 10 (62.5%) arrhythmias were controlled successfully with the use of some sort of antiarrhythmic therapy (Table 4).

5.5 Factors associated with postoperative arrhythmia

To analyze factors statistically associated with development of arrhythmias, both chi square test and Student t test were run. Accordingly, among all the analyzed preoperative characteristics, cardiopulmonary bypass time was found to be significantly associated with development of cardiac arrhythmia as the cardiopulmonary bypass time of patients who developed post-surgery arrhythmia was higher than that of those with sinus cardiac rhythm (mean ± standard deviation: 132.89 ± 41.65 versus 86.13 ± 39.77 minutes) with p value of 0.001. Similarly, aortic cross-clamping time was statistically associated with development of early postoperative arrhythmia in patients since the aortic cross-clamping time of patients who developed post-surgery arrhythmia was higher than that of those on whom cardiac rhythm was recorded (mean ± standard deviation: 89.47 ± 46.13 versus 52.27 ± 33.22

minutes) with p value of 0.007. However, patients' age was not statistically related to the development of postoperative arrhythmia, as shown in Table 5.

Furthermore, in this study, cyanotic CHDs were noted to be associated with early postoperative cardiac rhythm disturbances as higher percentage of cyanotic patients had arrhythmia in comparison to their acyanotic counterparts (19.4% versus 5.8%) with p value of 0.01 (Table 5).

Table 5: Factors associated with arrhythmia among CHD patients who underwent cardiac surgery at the Cardiac Center-Ethiopia, Addis Ababa, Ethiopia from January 1st, 2018 to December 31st, 2020

Variable	Arrhythmic (n=16)	Nonarrhythmic (n=186)	P value
Age (year)[a]	4.66 ± 3.30	5.11 ± 3.58	0.61
Cardiopulmonary bypass time (min)[a]	132.89 ± 41.65	86.13 ± 39.77	0.001
Aortic cross-clamping time (min)[a]	89.47 ± 46.13	52.27 ± 33.22	0.008
Sex[b]			0.88
Male	7 (7.6%)	85 (92.4%)	
Female	9 (8.2%)	101 (91.8%)	
Type of CHD[b]			0.01
Cyanotic	6 (19.4%)	25 (80.6%)	
Acyanotic	10 (5.8%)	161 (94.2%)	

[a]Student t test ; [b]Chi-square test
*Only factors with significant associations are dsiplayed

6. Discussion

The overall frequency of occurrence of postoperative arrhythmias after cardiac surgery in the present study was 7.9%. A very close figure was observed by Yildirim et al who recorded a prevalence of 8.8% in Turkish population (5). However, this rate was lower than the rate (50%%) observed by Abdel Gawad et al. in Egyptian population (13), and probably due to the fact that in the present study, only sustained arrhythmias (≥30 seconds duration, recurrent and/or affecting the hemodynamic status) were considered.

Moreover, in contrast to the present study, Grosse-Wortmann et al (14) documented a much higher rate of 79.1% rhythm disturbances following open heart surgery. This prominent result was attributed to the use of the Holter electrocardiogram, a more sensitive apparatus in the detection of certain arrhythmias such as extrasystoles when compared with the conventional (overhead) bedside monitor. Moreover, in the present study, the evolution of the patients was observed through the first seven days following surgery while in others to an extended period. As such, this could reduce the actual incidence of early postoperative arrhythmias. More importantly, the inclusion of PDA patients (for whom both cardiopulmonary bypass and aortic cross-clamping are not required during ligation) might have resulted in a relatively low prevalence of POA in the present study.

The current study documented that junctional ectopic arrhythmias were the most common variants in patients who developed POA, followed by bradyarrhythmia including bundle branch block. A similar pattern was reflected by the previous Egytian study (13) which recorded junctional ectopic tachycardia in 33.33%, junctional rhythm in 26.67%, and complete heart block in 13.33% of the pediatric patients. It is also in line with Yıldırım and colleagues' finding that documented supraventricular tachycardia (41.1%), junctional ectopic tachycardia (23.5%), and complete atrioventricular block (19.6%) were commonest post-surgery arrhythmias (5). This was also supported by another Turkish study where JET was the most common arrhythmia in patients undergoing congenital heart surgery (15).

The frequent observation of JET as a postoperative arrhythmia in the current study and others can be the result of a surgical injury to the conduction system, as has been pointed by others (14). In fact, although the precise aetiology of JET remains to be explored, authors assumed it to be the result of enhanced automaticity in the bundle of His, either in its right atrial or right ventricular portion, promoted by haemorrhage into the conduction tissues. It is postulated that disruption of conduction tissue, either by direct trauma or penetrating blood and interstitial

inflammatory cells, may result in an irritable focus leading to JET (14). Similarly, bradyarrhythmias are particularly common after valve surgery and are a consequence of direct surgical injury and local edema as explained by Peretto and colleagues (6**)**.

The present study revealed a statistically significant difference between the arrhythmic and non-arrhythmic group in relation to cardiopulmonary bypass time (132.87 vs. 84.63mins) and aortic clamping time (89.47 vs. 51.40 mins), with p value <0.05. This is in agreement with Delaney et al. who showed a statistically significant difference between the mean values for the arrhythmic and non-arrhythmic groups about ischemic time (105 vs 44 min) and cardiopulmonary bypass time (189 vs 109 min) (16). Another study by Abdel and colleagues reflected a similar picture of mean values in ischemic time (74.5 vs. 54 min), cardiopulmonary bypass time (125.5 vs. 93.5 min) (13).

Furthermore, Pfammatter et al. reported that the incidence of early postoperative arrhythmia after cardiac operation in children was 11% of children with bypass time of < 50 minutes. This proportion rose to 33% for bypass time between 50 and 100 minutes, and to 50% for bypass time more than 100 minutes. The authors stated that the association between higher occurrence rate of arrhythmias and longer cardiopulmonary time might just reflect increasing complexity of the surgical procedure (17).

Finally, chi square test showed that patients with cyanotic CHDs and TOF are at higher risk of developing post-surgery arrhythmia. This can be attributed in part to the complexity of the surgical procedure undertaken, including the intraoperative variables such as cardiopulmonary bypass time and aortic cross-clamp time. However, it should be also noted that in the current study, surgical procedures were not carried out by the same team, introducing bias on the variables linked to the surgery.

7. Strength and Limitation

7.1 Strength

- This assessment of arrhythmia among cardiac patients undergoing cardiac surgery is the first study to be conducted in the study setting, to the best knowledge of the student researcher.
- The study was conducted in one of the biggest cardiac centers in the country with a big catchment area.
- The fact that the study was a retrospective chart review in its nature and no patient was contacted physically, there was no concern of COVID-19 transmission during the process of data collection.

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.
- The study included of PDA patients (for whom both cardiopulmonary bypass and aortic cross-clamping are not required during ligation) might have underestimated the actual prevalence of early postoperative arrhythmia in such a resource-poor seeting.
- 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.
- The study is a single-centered study; therefore, it might not be generalizable to the general population where differing participants' characteristics, disease distribution, and healthcare infrastructure may exist.

8. Conclusion and Recommendation

8.1 Conclusion

Cardiac arrhythmias in the early postoperative period are not uncommon in pediatric CHD patients undergoing cardiac surgery although a significant portion of the conduction disturbances had good recovery. The most frequently observed postoperative arrhythmia was junctional ectopic tachycardia, followed by bradyarrhythmias such as BBB. Longer ischemic time, prolonged cardiopulmonary bypass time, and presence of cyanotic heart diseases such as TOF as cardiac pathology were the risk factors that increased the incidence of arrhythmias in the early postoperative period following cardiac surgery.

8.2 Recommendation

Based on the findings of the study, the following recommendations are forwarded.

To health professionals

- More effort needs to be exercised to detect postoperative arrhythmia as early as possible in order to prevent morbidities and mortalities associated with arrhythmia. And particular attention (including consideration of prophylaxis administration) should be directed to patients to those with increased risks such as longer ischemic time, longer bypass time, presence of cyanotic heart diseases and TOF as cardiac pathology.

To local health policy makers

- Customized guidelines should be designed, and sensitization and training programs should be instituted.

To researchers

- Future studies should be comprehensive enough to include potential factors such as Aristotle Basic Score, inotropic drugs use, residual anatomical defect and oxygen saturation.

References

1. Rekawek J, Kansy A, Miszczak-Knecht M, Manowska M, Bieganowska K, Brzezinska-Paszke M, et al. Risk factors for cardiac arrhythmias in children with congenital heart disease after surgical intervention in the early postoperative period. J Thorac Cardiovasc Surg. 2007 Apr;133(4):900–4.
2. Gawad TAA, Elguindy WM, Youssef OI, Abosalem TA. The Prevalence and Risk Factors of Early Arrhythmias Following Pediatric Open Heart Surgery in Egyptian Children. Open access Maced J Med Sci. 2017 Dec;5(7):940–4.
3. Sahu MK, Das A, Siddharth B, Talwar S, Singh SP, Abraham A, et al. Arrhythmias in Children in Early Postoperative Period After Cardiac Surgery. World J Pediatr Congenit Hear Surg [Internet]. 2018 Jan 1;9(1):38–46. Available from: https://doi.org/10.1177/2150135117737687
4. Lan Y-T, Lee JCR, Wetzel G. Postoperative arrhythmia. Curr Opin Cardiol. 2003 Mar;18(2):73–8.
5. Yildirim SV, Tokel K, Saygili B, Varan B. The incidence and risk factors of arrhythmias in the early period after cardiac surgery in pediatric patients. Turk J Pediatr. 2008;50(6):549–53.
6. Peretto G, Durante A, Limite LR, Cianflone D. Postoperative arrhythmias after cardiac surgery: incidence, risk factors, and therapeutic management. Cardiol Res Pract. 2014;2014:615987.
7. Skippen PW, Sanatani S, Gow RM, Froese N. Diagnosis of postoperative arrhythmias following paediatric cardiac surgery. Anaesth Intensive Care. 2009 Sep;37(5):705–19.
8. Pfammatter J-P, Wagner B, Berdat P, Bachmann DCG, Pavlovic M, Pfenninger J, et al. Procedural factors associated with early postoperative arrhythmias after repair of congenital heart defects. J Thorac Cardiovasc Surg. 2002 Feb;123(2):258–62.
9. Nelson JS, Vanja S, Maul TM, Whitham JK, Ferns SJ. Early arrhythmia burden in pediatric cardiac surgery fast-track candidates: Analysis of incidence and risk factors. Prog Pediatr Cardiol [Internet]. 2019;52:8–12. Available from: https://www.sciencedirect.com/science/article/pii/S1058981318300067
10. Mildh L, Hiippala A, Rautiainen P, Pettilä V, Sairanen H, Happonen J-M. Junctional ectopic tachycardia after surgery for congenital heart disease: incidence, risk factors and outcome. Eur J cardio-thoracic Surg Off J Eur Assoc Cardio-thoracic Surg. 2011 Jan;39(1):75–80.

11. Hoffman TM, Wernovsky G, Wieand TS, Cohen MI, Jennings AC, Vetter VL, et al. The incidence of arrhythmias in a pediatric cardiac intensive care unit. Pediatr Cardiol. 2002;23(6):598–604.
12. Valsangiacomo E, Schmid ER, Schüpbach RW, Schmidlin D, Molinari L, Waldvogel K, et al. Early postoperative arrhythmias after cardiac operation in children. Ann Thorac Surg. 2002 Sep;74(3):792–6.
13. Abdel Gawad TA, Elguindy WM, Youssef OI, Abosalem TA. The Prevalence and Risk Factors of Early Arrhythmias Following Pediatric Open Heart Surgery in Egyptian Children. Open Access Maced J Med Sci. 2017 Dec 15; 5(7):940-944.
14. Grosse-Wortmann L, Kreitz S, Grabitz R, Vazquez-Jimenez J, Messmer B, von Bernuth G, et al. Prevalence of and risk factors for perioperative arrhythmias in neonates and children after cardiopulmonary bypass: continuous holter monitoring before and for three days after surgery. Journal of Cardiothoracic Surgery. 2010;5(1):85.
15. Alp H, Baysal T and Karaarslan S. Supraventricular tachycardia due to blunt chest trauma in an adolescent. Ulusal travma ve acil cerrahi dergisi Turkish journal of trauma & emergency surgery: TJTES. 2014;20(3):211-3.
16. Delaney JW, Moltedo JM, Dziura JD, Kopf GS and Snyder CS. Early postoperative arrhythmias after pediatric cardiac surgery. The Journal of thoracic and cardiovascular surgery. 2006;131(6):1296-300. https://doi.org/10.1016/j.jtcvs.2006.02.010 PMid:16733160
17. Pfammatter J, Wagner B, Berdat P, Bachmann D, Pavlovic M, Pfenninger J, et al. Procedural factors associated with early postoperative arrhythmias after repair of congenital heart defects. The Journal of thoracic and cardiovascular surgery. 2002;123:258-

Annex

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

Department of Pediatrics and Child Health, Addis Ababa University

This sheet will be read for the director of the Cardiac Center-Ethiopia before collecting any information from the registries.

Greetings. My name is Dr. Bezamariam Fesseha and I am a postgraduate student in Pediatrics and Child Health at AAU.

This center was selected to conduct the proposed study "**Magnitude of Early Postoperative Arrhythmias after Cardiac Surgery in Children at the Cardiac Center-Ethiopia, Ethiopia**" as it is leading center 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 this hospital. Please read the following information for further understanding:

What the study is about: The purpose of this study to magnitude of early postoperative arrhythmias after cardiac surgery in children at the Cardiac Center-Ethiopia, 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 assess the magnitude of early postoperative arrhythmias after cardiac surgery in children at the Cardiac Center-Ethiopia, 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.

Contact address of the principal investigator

Name: Bezamariam Fesseha

Mobile Phone**:** +251946490059

Email address: bezamariamfesseha @gmail.com

Annex II: English Version Questionnaire

Addis Ababa University

Department of Pediatrics and Child Health

Data collection checklist from chart review for pediatric patients with CHD who underwent open cardiac surgery (this checklist is prepared from the results of literature I have used in the literature review).

Code: ……. Date: ……

Sociodemographic data

1. Age …….
2. Sex
    - Male
    - Female
3. Residence
    - Urban
    - Rural

4. Specific diagnosis (underlying cardiac pathology)

    1.ASD

    2.VSD

    3.PDA

    4.AVSD

    5.TGA

    6.TOF

    7.PS

    8. Coarctation of aorta

    9. TVA

    10. TGA

    11. OTHERS

Characteristics related to preoperative and postoperative condition of the patient

1. Type of CHD

- 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?

- ✓ Na
- ✓ K
- ✓ Cl
- ✓ Ca
- ✓ Others (specify…….)

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?

1. Diuretics
2. ACE inhibitors

3. B-Blockers

4.Other please specify

11. What medication is he /she on postoperatively?

1.Diuretics

2.ACE inhibitors

3.B –Blockers

4.Other please specify

12. Intra OP condition

I. Intra op complication

1. No

2. Yes

II. Estimated blood loss

13. Cardiopulmonary bypass time……mins
14. Clinical features related to the surgery and arrhythmia
15. Type of surgery done ……

16. Was there arrhythmia

1.yes

2.No

17. Type of arrhythmia

1. JET

2. VT

3. VF

4. SVT

5. Others…. Please specify

18. The time of onset of arrhythmia

19. For which treatment did they respond?

1. Medical

2. Maneuver's

3. Cardioversion

4. Others specify……

20. Outcome of the patient

1. Spontaneously resolved

2.Treated and cured

3. Still on chronic treatment

4. Died

5. Unknown/other