Assessment of postoperative complications among children with open heart surgery

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Abstract

Background: Postoperative complications assessment in pediatric cardiac surgery have been importantly to reduce mortality, hospital stay, cost, and quality of life after pediatric cardiac surgery. **Aim:** To assess postoperative complications among children with open heart surgery. **Design:** A descriptive exploratory design. **Settings:** The study carried out in cardiology unit and open heart intensive care unit at specialized Cairo-University pediatric hospital. **Subjects:** A purposive sample composed of sixty children after open heart surgery and less than 5 years of age. **Tools of data collection:** Structured questionnaire sheet and observational checklists for cardiac and extra cardiac complications assessment. **Results:** More than two fifths of the children were infants, less than two thirds of them were males, less than three quarters had consanguinity, the most common type of cyanotic and acyanotic defects were TOF and coarctation of the aorta respectively, the vast majority of children had postoperative complications either psychological or physical; more than one third of children had pain, regarding psychological complications less than one third had anxiety, regarding physical complications; near one third had sternal wound infection, less than one quarter had pneumonia, the minority of children had vomiting and diarrhea, less than one fifth of children had arrhythmia, the minority of children had developed acute renal failure, peritoneal dialysis, hyperglycemia and bleeding after operation. **Conclusion:** The most present complications was pain followed by anxiety and fear, sternal wound infection, pneumonia, vomiting and arrhythmia. The factor associated with postoperative complications were cyanotic heart defect, infant stage, underweight and lenghth of stay one month and more in hospital. **Recommendation:** Regular assessment and monitoring of children after open heart surgery to detect any complications early to be managed immediately. Special attention should be given for younger children with heart cyanotic defect, underweight, and had long stay in hospital.

Keywords: Children, complications, open heart surgery, postoperative

Introduction:

Congenital heart diseases (CHDs) are the most common cause of major congenital anomalies that are representing nearly 25% of all congenital malformations. They are the most common structural and functional abnormalities of the heart for children, having a major impact on morbidity and general mortality **(Tankeu et al., 2017)**. Congenital heart diseases prevalence was estimated at 8 to 10 per 1000 live births in the United States **(Bravo-Valenzuela et al., 2018)**. According to American heart association Approximately 35.000 newborn infant are born each year with some types of CHDs and approximately 1.01 per 1.000 children reported in Egypt among school age children **(Amel-Shahbaz et al., 2014)**.

Cardiovascular diseases are one of the leading causes of death in the world, their treatment is based on surgery; the surgery procedure controls complications of congenital heart defects and relieving symptoms and preventing complications **(Cani et al., 2019)**. The prevalence of cardiac surgeries has been increasing every year; several studies have shown that both are the

best way to treat congenital anomalies in children **(Dordetto et al., 2016)**.Postoperative complications in pediatric cardiac surgery have been inconsistently reported but have important contributions to mortality, the hospital stay, cost and quality of life after surgery **(Kansy et al., 2015)**.

Postoperative complications occurred in 43% of pediatric cardiac surgeries performed both with and without cardiopulmonary bypass (CPB); the complications were associated with longer mechanical ventilation, pediatric cardiac intensive care unit, hospital stays, and increased mortality **(Agarwal et al., 2014)**.

According to **Ball et al., (2016) and Matos et al., (2020)** the possible complications that may appear after surgery, being of cardiac origin (acute myocardial infarction, congestive heart failure and arrhythmia), pulmonary (atelectasis, pneumonia, pleural effusion, acute respiratory failure, acute respiratory distress syndrome, hypoxemia, associated pneumonia) pneumothorax, neurological (seizures), renal (acute renal failure, low renal perfusion, increased serum creatinine and decreased urinary output), digestive tract (mesenteric ischemia and digestive hemorrhage), infectious sternal incisions, radial and surgical site incisions), hematologic (thrombotic events and bleeding), hydro-electrolytic (changes in serum sodium, potassium) and the antecedents (obesity, smoking, diabetes mellitus, hypertension).

Postoperative cardiac and extra cardiac complications in pediatric cardiac surgery have been inconsistently reported but contribute importantly to mortality, hospital stay, cost, and quality of life after pediatric cardiac surgery **(Kansy et al., 2015)**. The primary outcome was the occurrence of any postoperative complication. Complications were defined as cardiac arrest, re-intubation, infection (superficial, deep, organ space, surgical site, urinary tract, or pneumonia), renal failure, neurological complication, thromboembolic complication, reoperation, prolonged hospital stay, or 30 days' mortality Secondary outcomes were the occurrences of any individual complications or overall mortality **(Faraoni et al., 2016)**.

Pulmonary complications are a leading cause of morbidity in these patients, occurring in up to one-fifth of cases **(Szelowski et al., 2015)**. Common pulmonary complications of cardiac surgery are receiving ventilation longer than 24 hours, pneumonia, pulmonary embolism, and pleural effusion requiring drainage **(Jacob et al., 2018)**.

Children with congenital heart diseases face many problems with cognitive and neuromotor function. Many issues facing patients with neurodevelopmental deficiencies after cardiac surgery are the lack of continuing support and resources as they age. Survivors of pediatrics heart surgery are more likely to need remedial services; like tutoring and special education, as well as speech, physical, and occupational therapy **(Gaynor et al., 2015)**. Because many cases of neurodevelopmental deficits after cardiac surgery are difficult to screen, patients are less likely to receive support **(Ryan et al., 2019)**.

Significance of the Study:

Most congenital heart defects are corrected by open heart surgery or interventional catheterization. With improved cardiac dynamics and disappearance of symptoms that indicate a good prognosis. After successful repair of simple lesion such as PDA, ASD or PS, children require very often specific follow-up studies and should lead active and full lives. Many types of congenital heart disease that would have been fatal now can be treated successfully **(Rao & Harris, 2018)**.

The increase in caseload in pediatric cardiac surgery was accompanied by improved management, with a lower complication related mortality rate, and improve optimal care for children with congenital heart disorders, quality management resources. According to the

study decrease in mortality rate from 4.9% to 3.2%, the rate of diaphragm paralysis decreased from 6% to 2.4%. Death due to acute renal failure in patients requiring dialysis decreased from more than 80% in the first 2 years to 36% in the last two. There was a significant improvement in pump time and duration of mechanical ventilation **(Leghrouz & Kaddourah, 2021)**.

In recent years, due to significant advances in cardiac surgery and postoperative care, the rate of mortality is reduced and age of surgery among children is decreased, High incidence of complications after congenital heart surgery makes necessary attention to complications and their treatment after surgery. It is necessary to apply the measures and careful monitoring of patients to minimize the postoperative complications **(Mirzaei et al., 2016)**.

In open heart surgery, due to cardio pulmonary bypass (CPB), which has different effects on different organs of the body, it is more likely to develop complications during or after surgery. Almost 400 thousand open heart surgery using pump cardiovascular is done in the world which approximately 6% of these are children, to better control of these complications and improve the prognosis of action, identification of mechanisms, incidence and risk factors play a major role. So should assessment outcome and identifying predictors of major complications among children undergoing and after cardiac surgery are essential to improve care **(Murni et al., 2019)**.

Children with congenital heart diseases have numerous factors affecting quality of life depending on the type and severity of the disease: for example, the delay in physical growth in terms of height and weight, change in the body image, conflict between family, lack of social acceptance, educational level of the parents, poor financial status of the family are negative impact on quality of life in both the children's and the family **(Noori et al., 2017)**. Constant evaluation of the children can help medical personnel in making decisions regarding medical procedures, in the process of informing the children or his family on possible effects of the chosen procedure, in determining the effectiveness of chosen treatment and the development of cardiac rehabilitation programs **(Murni et al., 2019)**.

Congenital heart diseases are the most frequent fetal malformations, with a prevalence of 8 in 1000 live births. Prevalence of CHDs was increasing by time from 7.93 to 17.51 in 1000 live births in Iran. Also, the mortality rate of CHDs patients has been began to fall and continuing to decrease because of advances in diagnostic, surgical and catheter interventional techniques **(Noori et al., 2017)**.

Approximately 1 in 100 children are born with CHDs. With advances in surgical techniques and practices, survival rates and life expectancy have dramatically improved. Children with CHDs, however, are at increased cardiovascular risk because traditional atherosclerotic risk factors may interact with intrinsic structural abnormalities, surgical sequelae, or disturbances in cardiac rhythm **(Voss et al., 2017)**.

Aim of the study

The aim of current study is to assess postoperative complications among children with open heart surgery.

Research questions:

What are the postoperative complications among children with open heart surgery?

Research design:

A descriptive exploratory design was utilized in the current study to answer the study question.

Research Setting:

The study carried out in cardiology unit and open heart intensive care unit (ICU) at Specialized Cairo University Pediatric Hospital (SCUPH).

Sample:

A purposive sample of 60 children with congenital heart diseases who fulfill the following criteria:

Inclusion criteria:

1. Child's age less than <5 years.
2. Children have postoperative an open-heart surgery from day of operation until discharge.
3. Children free from any other diseases.

Data collection tools:

The required data were collected through the use of the following tools after extensive reviewing of related literature, this tool was divided into two parts:-

Tool I: Structured questionnaire sheet was developed by the researchers which includes:-

A-Personal data: such as child code, age, gender, birth weight, current weight, diagnosis, type of cardiac defect, the day of operation, and length of hospital stay.

B-Medical data:- such as medical history, level of consciousness, vital signs, laboratory investigations, central venous pressure, systemic oxygen saturation, duration of nothing by mouth NPO, blood loss, required transfusions, medications, and feeding.

Tool II: Observational checklists for cardiac and extra cardiac complications;

It was adapted from **Agarwal et al., (2013)** observational checklists were containing a list of complications after surgery. Postoperative complications were divided into cardiac and extra cardiac complications, and psychological problems. Assessed most common items in cardiac complications such as (acute myocardial infarction, congestive heart failure, arrhythmia, cardiac arrest and recording other cardiac complication if child suffering from it).

Extra cardiac systems complications include neurologic complications (seizures and stroke), pulmonary (pneumonia, hemothorax, pleural effusions, pneumothorax, pulmonary oedema and acute respiratory distress), gastrointestinal (vomiting, diarrhea, necrotizing enterocolitis, GI bleeding, intestinal perforation and pancreatitis), renal (acute renal failure and peritoneal/haemodialysis), infectious (sternal wound infection and sepsis/bacteremia), endocrine (hyperglycemia and adrenal insufficiency), hematologic (bleeding and thrombosis) and psychological problems (pain, anxiety and fear).

Scoring system for tool II:

If the postoperative complications were present scored by (1), and not present scored by (0).

Pain was assessed by numeric scaling; this pain scale is most commonly used in PICU. A child rates their pain on scale of 0 to 10, zero means "no pain", from 1 to 3 "mild pain", 4 to 6 "moderate pain" and from 7 to 10 "severe pain". These pain intensity levels may be assessed upon initial treatment, or periodically after treatment **(Castarlenas et al., 2017)**. Developmental needs related to child age also assessed, if satisfied or not to judge the sense is achieved or not.

Content validity:

It was ascertained by panel of 3 experts in the field of pediatric nursing and pediatric medicine who was reviewed the content of the tools for comprehensiveness, accuracy, clarity, and relevancy.

Tools-reliability:

The reliability of data collection tool II was tested using Cronbach's alpha. The test result was 0.88 which reflect accepted internal consistency of the tools.

Pilot study:

A pilot study was conducted on 6 children those represent 10% of the total number of studied children and their accompanying parents under the study. In order to evaluate the clarity and applicability of the study tools and time needed for data collection, minor modifications were done, children involved in the pilot study included in the recruited sample.

Field work:

Data was collected after obtaining an official permission from the directors of SCUPH and the head of open heart ICU and cardiology unit. The actual field work started from the beginning of December 2020 to the end of May 2021. Data collection was done during different shifts, the accompanying parents were met individually in cardiology unit, to collect personal data and medical history about their children, the researcher introduce himself to the parents, explained the aim of the study, and expected outcomes, the components of the tools and also assured that data collected would be confidential and would be only used to achieve the purpose of the study.

The data of the child was collected by using child sheet, observations, laboratory investigations, medical rounds and nursing staff notes.

Ethical considerations:

An official permission to conduct the proposed study would be obtained from the ethical committee in the Faculty of Nursing, Helwan University. Also an official permission was obtained from the directors of SCUPH and the head of ICU and cardiology unit at SCUPH. Written consent was obtained from children' parents to participate in the current study after explanation of the aim of the study and their freedom to withdraw from the study at any time without any effect of the care provided to their children. Confidentiality of the information collected and anonymity is guaranteed.

Statistical design:

The collected data was statistically analyzed using statistical package of social science (SPSS) version 25. Frequency distribution was used to describe the qualitative data; mean and standard deviation were used to describe the quantitative data. A comparison between variables carried out by using Chi square. Pearson's correlation test was used to assess the relationship between quantitative data. P value was considered statistically insignificant at >0.05.

Results

Table (1): Frequency distribution of children's personal data and medical history (n=60)

Items	No.	%
Age		
<1 year	26	43.3
1-<3 years	24	40
3-5 years	10	16.7
X́±SD= 1.44± 1.35		
Gender		
Male	38	63.3
Female	22	36.7
Consanguinity		
Yes	43	71.7
No	17	28.3
Birth weight		
Normal	60	100
Underweight	0	0
X́±SD= 3.2± 0.34		
Current weight		

Normal	33	55
Underweight	27	45
X̄±SD= 9.03± 4.46		
Family history of CHDs		
Yes	8	13.3
No	52	86.7
The member having CHDs (8)		
Father	3	5.0
Mother	2	3.3
Brothers	2	3.3
Grand Mother	1	1.7
Residence		
Rural	40	66.7
Urban	20	33.3

Table (1) revealed that more than two fifths (43.3%) of the children were infants, less than two thirds (63.3%) of them were males, less than three quarters (71.7%) had consanguinity, all children with CHDs had normal birth weight, while near half (45%) of them were underweight currently, only 13.3% had family history of congenital heart disease, the most affected family members were fathers and mothers 5% and 3.3% respectively, slightly more than two thirds (66.7%) of children were living in rural areas.

Table (2): Frequency distribution of children's cardiac defect types (n=60)

Items	No.	%
Type of cardiac defect		
Cyanotic	35	58.3
Acyanotic	19	31.7
Mixed	6	10
Cyanotic Specific defect [@]		
Tetralogy of Fallot	21	35
Tricuspid Atresia	9	15
Pulmonary Atresia	8	13.3
Hypoplastic left heart syndrome	6	10
Transposition of the Great Arteries	6	10
Others	1	1.7
Acyanotic Specific defect[@]		
Coarctation of the aorta	10	16.7
Patent ductus arteriosus	5	8.3
Pulmonary stenosis	3	5
Ventricular septal defect	3	5

@ Not mutually exclusive

Table (2) revealed that near three fifths (58.3%) of children had cyanotic type while only less than one third (31.7) had acyanotic cardiac defects, the most common type of cyanotic and acyanotic defects were TOF and coarctation of the aorta (35% and 16.7%) respectively.

Table (3): Frequency distribution of children's postoperative complications (n=60)

Items	No.	%
Presence of complications		
yes	55	91.7
No	5	8.3
Pain	22	36.7
Psychological problems		
Anxiety	19	31.7
Fear	16	26.7
Sepsis complications		
Sternal wound infection	19	31.7
Sepsis/ bacteremia	5	8.3
Pulmonary complications		
Pneumonia	10	16.7
Pneumothorax	6	10
Acute respiratory distress	5	8.3
Pleural effusions	3	5
Hemothorax	1	1.7
Gastrointestinal complications		
Vomiting	9	15
Diarrhea	6	10
Cardiovascular complications		
Arrhythmia	9	15
Acute myocardial infarction	4	6.7
Congestive heart failure	3	5
Cardiac arrest	2	3.3
Endocrine complications Hyperglycemia	6	10
Renal complications		
Acute renal failure	4	6.7
Peritoneal dialysis	4	6.7
Hematologic complications		
Bleeding	3	5
Thrombosis	1	1.7
Neurologic complications		
Seizures	3	5

Table (3) revealed that the vast majority (91.7%) had postoperative complications either psychological or physical; 36.7% of children had pain, regarding psychological complications 31.7% and 26.7% respectively had anxiety and fear, while regarding to physical complication 31.7% had sternal wound infection, 16.7% had pneumonia followed by 10% had pneumothorax respectively, 15% had vomiting and 10% had diarrhea respectively, 15% of children had arrhythmia, 6.7% had developed acute renal failure and peritoneal dialysis,10% of children had hyperglycemia and 5% of them had bleeding after operation.

Table (4): Relationship between the children's postoperative complications and type of cardiac defect (n=60)

Items	Defect type						Chi square test	
	Acyanotic		Mixed		Cyanotic			
	No.	%	No.	%	No.	%	χ2	P
Cardiovascular complications@								
Acute myocardial infarction	0	0	2	50.0	2	50.0	29.5	0.001*
congestive Heart failure	0	0	0	0	3	100.0	1.58	0.45
Arrhythmia	0	0	0	0	9	100.0	5.29	0.07
Cardiac arrest	0	0	0	0	2	100.0	1.03	0.60
Neurologic complications@								
Seizures	0	0	0	0	3	100.0	1.58	0.45
Pulmonary complications@								
Pneumonia	0	0	2	20	8	80.0	13.92	0.001*
Hemothorax	0	0	0	0	1	100.0	.51	0.78
pleural effusions	0	0	0	0	3	100.0	1.58	0.45
Pneumothorax	0	0	0	0	6	100.0	3.33	0.19
Acute respiratory distress	2	40.0	0	0	3	60.0	.40	0.82
Gastrointestinal complications@								
Vomiting	4	44.4	2	22.2	3	33.3	13.83	.001*
Diarrhea	3	50.0	0	0	3	50.0	1.39	.50
Renal complications@								
Acute renal failure	0	0	0	0	4	100.0	2.14	0.34
Peritoneal dialysis	0	0	0	0	4	100.0	2.14	0.34
Sepsis complications@								
Sternal wound infection	4	21.1	0	0	15	78.9	2.30	0.32
Sepsis/ bacteremia	0	0	0	0	5	100.0	2.73	0.26
Endocrine complications@								
Hyperglycemia	0	0	0	0	6	100.0	3.33	0.19
Hematologic complications@								
Bleeding	1	33.3	0	0	2	66.7	.12	0.94
Thrombosis	0	0	0	0	1	100.0	.51	0.78
Psychological problems@								
Anxiety	3	15.8	2	10.5	14	73.7	12.68	0.01*
Fear	3	18.8	2	12.5	11	68.8	13.19	0.01*
Pain@	6	27.3	2	9.1	14	63.6	3.59	0.17

@ Not mutually exclusive **(*) Statistically significant at p <0.05**

Table (4) concluded that acute myocardial infarction as cardiovascular complication were detected among children with mixed and cyanotic heart defects 50% for each, while not detected among acyanotic heart defects children, 80% of children had pneumonia had cyanotic heart defect, the rest of children with pneumonia (20%) had mixed heart defects, 44.4 % and 33.3% of children with vomiting had acyanotic and cyanotic heart defects respectively, less than three

quarters 73.7% of children with anxiety had cyanotic heart defect while 10.5% was among mixed type of defects, more than two thirds (68.8%) of children with fear had cyanotic heart defects compared to 12.5% among mixed type of defects children. All these differences were statistically significant.

Table (5): Relationship between the children's postoperative complications and their age (n=60)

Items	Age						Chi square test	
	<1year		1-<3years		3-<5years			
	No.	%	No.	%	No.	%	$\chi 2$	P
Cardiovascular complications[@]								
Acute myocardial infarction	2	7.7	2	8.3	0	0	.87	0.65
congestive Heart failure	1	3.8	2	8.3	0	0	1.16	0.56
Arrhythmia	7	26.9	2	8.3	0	0	2.36	0.31
Cardiac arrest	1	3.8	1	4.2	0	0	.42	0.82
Neurologic complications[@]								
Seizures	2	7.7	0	0	1	10	2.19	0.33
Pulmonary complications								
Pneumonia	7	26.9	1	4.2	2	20	4.75	0.09
hemothorax	1	3.8	0	0	0	0	1.33	0.51
pleural effusions	2	7.7	1	4.2	0	0	.96	0.62
Pneumothorax	4	15.4	1	4.2	1	10	1.75	0.42
Acute respiratory distress	3	11.5	2	8.3	0	0	1.26	0.53
Gastrointestinal complications[@]								
Vomiting	5	19.2	4	16.7	0	0	2.18	0.34
Diarrhea	3	11.5	3	12.5	0	0	1.35	0.51
Renal complications[@]								
Acute renal failure	2	7.7	2	8.3	0	0	.87	0.65
Peritoneal dialysis	2	7.7	2	8.3	0	0	.87	0.65
Sepsis complications[@]								
Sternal wound infection	10	38.5	7	29.2	2	20	1.25	0.53
Sepsis/ bacteremia	4	15.4	1	4.2	0	0	3.15	0.21
Endocrine complications[@]								
Hyperglycemia	3	11.5	3	12.5	0	0	1.35	0.51
Hematologic complications[@]								
Bleeding	1	3.8	2	8.3	0	0	1.16	0.56
Thrombosis	1	3.8	0	0	0	0	1.33	0.51
Psychological problems[@]								
Anxiety	11	42.3	6	25	2	20	2.53	0.28
Fear	12	46.2	3	12.5	1	10	6.03	0.20
Pain[@]	10	38.5	7	26.9	5	19.2	5.09	0.28

@ Not mutually exclusive (*) Statistically significant at p <0.05

Table (5) showed that infant children more affected than other ages in relation to fear and anxiety respectively with 46.2% and 42.3%, also 38.5% of infants had pain and sternal

wound infection respectively than other ages. No statistically significant differences were detected between postoperative complications and age of children.

Table (6): Relationship between the children's postoperative complications and their current weight (n=60)

Items	Current weight				Chi square test	
	Underweight		Normal			
	No.	%	No.	%	$\chi 2$	P
Cardiovascular complications@						
Acute myocardial infarction	2	7.4	2	6.1	.04	0.84
congestive Heart failure	1	3.7	2	6.1	.17	0.68
Arrhythmia	6	22.2	3	9.1	2.01	0.16
Cardiac arrest	1	3.7	1	3	.02	0.89
Neurologic complications @						
Seizures	2	4.7	1	3	.60	0.44
Pulmonary complications						
Pneumonia	7	25.9	3	9.1	3.03	0.08
Hemothorax	1	3.7	0	0	1.24	0.27
pleural effusions	2	7.4	1	3	.60	0.44
Pneumothorax	4	14.8	2	6.1	1.26	0.26
Acute respiratory distress	3	11.1	2	6.1	.50	0.48
Gastrointestinal complications@						
Vomiting	5	18.5	4	12.1	.48	0.49
Diarrhea	3	11.1	3	9.1	.07	0.76
Renal complications@						
Acute renal failure	2	7.4	2	6.1	.04	0.84
Peritoneal dialysis	2	7.4	2	6.1	.04	0.84
Sepsis complications@						
Sternal wound infection	10	37	9	27.3	.65	0.42
Sepsis/ bacteremia@	4	14.8	1	3	2.7	0.10
Endocrine complications@						
Hyperglycemia	3	11.1	3	9.1	.07	0.80
Hematologic complications@						
Bleeding	1	3.7	2	6.1	.17	0.68
Thrombosis	1	3.7	0	0	1.24	0.27
Psychological problems@						
Anxiety	11	40.7	8	24.2	.35	0.55
Fear	12	44.4	4	12.1	3.72	0.16
Pain@	10	37	12	44.4	2.74	0.26

(*) Statistically significant at p <0.05

@ Not mutually exclusive

Table (6) showed that no statistically significant differences were detected between postoperative complications and current weight.

Table (7): Relationship between the children's postoperative complications and length of stay at hospital (n=60)

Items	Length of stay						Chi square test	
	< 7 days		7-< 30 day		≥ 30 day			
	No.	%	No.	%	No.	%	χ2	P
Cardiovascular complications@								
Acute myocardial infarction	2	16.7	0	0	2	18.2	6.92	.03*
Congestive Heart failure	0	0	1	2.7	2	18.2	5.07	.08
Arrhythmia	1	8.3	5	13.5	3	27.3	1.78	.41
Cardiac arrest	0	0	0	0	2	18.2	9.22	.01*
Neurologic complications@ Seizures	0	0	0	0	3	27.3	14.07	.00*
Pulmonary complications@								
Pneumonia	2	16.7	5	13.5	3	27.3	1.16	.56
Hemothorax	0	0	1	2.7	0	0	.63	.73
Pleural effusions	0	0	2	5.4	1	9.1	1.03	.60
Pneumothorax	0	0	4	10.8	2	18.2	2.18	.34
Acute respiratory distress	0	0	1	2.7	4	36.4	13.94	.00*
Gastrointestinal complications@								
Vomiting	2	16.7	5	13.5	2	18.2	.18	.92
Diarrhea	0	0	2	5.4	4	36.4	10.70	.01*
Renal complications@								
Acute renal failure	0	0	2	5.4	2	18.2	3.30	.19
Peritoneal dialysis	0	0	2	5.4	2	18.2	3.30	.19
Sepsis complications@								
Sternal wound infection	0	0	13	35.1	6	54.5	8.43	.02*
Sepsis/ bacteremia	0	0	2	5.4	3	27.3	6.67	.04*
Endocrine complications@								
Hyperglycemia	0	0	2	5.4	4	36.4	10.70	.005*
Hematologic complications@								
Bleeding	1	8.3	0	0	2	18.2	6.25	.04
Thrombosis	0	0	1	2.7	0	0	.63	.73
Psychological problems@								
Anxiety	2	16.7	17	45.9	0	0	3.86	.15
Fear	5	41.7	11	29.7	0	0	20.36	.00*
Pain@	4	33.3	13	35.1	5	13.5	14.16	.01*

(*) Statistically significant at p <0.05 @ Not mutually exclusive

Table (7) showed that children stay 30 days and more had postoperative complications than another period of stay concerning to acute myocardial infarction and cardiac arrest with 18.2% respectively, also 27.3% for seizures, 36.4% for acute respiratory distress and diarrhea, 54.5% for sternal wound infection, 27.3% for suspected sepsis/ bacteremia, 36.4% for hyperglycemia, 18.2% for bleeding. Children stay less than 7 days had more fear and pain 41.7% and 33.3% respectively than other period of hospital stay. These differences were statistically significant.

Table (8): Relationship between the children's postoperative complications and stage of first identification (n=60)

Items	stage of first identification						Chi square test	
	Infant		Toddler		Preschool			
	No.	%	No.	%	No.	%	$\chi 2$	P
Cardiovascular complications@								
Acute myocardial infarction	2	10	1	3.7	1	7.7	.76	0.68
Congestive Heart failure	1	5	2	7.4	0	0	1.01	0.60
Arrhythmia	5	25	3	11.1	1	7.7	2.43	0.30
Cardiac arrest	1	5	1	3.7	0	0	.63	0.73
Neurologic complications@								
Seizures	1	5	1	3.7	1	7.7	.29	0.86
Pulmonary complications@								
Pneumonia	5	25	2	7.4	3	23.1	3.05	0.22
Hemothorax	1	5	0	0	0	0	2.03	0.36
Pleural effusions	2	10	1	3.7	0	0	1.83	0.40
Pneumothorax	3	15	2	7.4	1	7.7	.83	0.66
Acute respiratory distress	3	15	0	0	2	15.4	4.46	0.11
Gastrointestinal complications@								
Vomiting	5	25	2	4.7	2	15.4	2.79	0.25
Diarrhea	3	15	2	4.7	1	7.7	.83	0.57
Renal complications@								
Acute renal failure	2	10	2	7.4	0	0	1.31	0.52
Peritoneal dialysis	2	10	2	7.4	0	0	1.31	0.52
Sepsis complications@								
Sternal wound infection	8	40	7	25.9	4	30.8	1.06	0.59
Sepsis/ bacteremia	4	20	0	0	1	7.7	6.03	0.05
Endocrine complications@								
Hyperglycemia	3	15	2	7.4	1	7.7	.83	0.66
Hematologic complications@								
Bleeding	1	5	2	7.4	0	0	1.01	0.60
Thrombosis	1	5	0	0	0	0	2.03	0.36
Psychological problems@								
Anxiety	8	40	7	25.9	4	30.7	3.09	0.21
Fear	11	55	5	18.5	0	0	8.34	0.08
Pain@	8	40	7	25.9	7	53.8	3.91	0.42

(*) Statistically significant at p <0.05 **@ Not mutually exclusive**

Table (8) showed that no statistically significant differences were detected between postoperative complications and stages of first identification those children having cardiac anomalies.

Table (9): Correlation between children weight, health history and their age (n=60)

	Pearson Correlation	Age	Birth weight	Current weight	Times of hospitalization	Length of stay at hospital
Birth weight	R	.243				
	P	.061				
Current weight	R	.817**	.343**			
	P	.000*	.007			
Times of hospitalization	R	.503**	-.041	.491**		
	P	.000*	.756	.000*		
Length of stay at hospital	R	-.017	-.304*	-.203	.095	
	P	.895	.018	.120	.469	
Length of stay in pediatric ICU	R	-.013	.058	-.170	.180	.629**
	P	.924	.659	.195	.169	.0001*

(*) Statistically significant at p <0.05

Table (9) demonstrated that high positive correlation was detected between current weight and age; also there are positive correlation between times of hospitalization and child age, times of hospitalization and current weight, length of stay in pediatric ICU and length of stay at hospital. These correlations were statistically significant.

Table (10): Frequency distribution of developmental needs satisfaction among children postoperatively (n=60)

Developmental needs	Satisfied		Not satisfied	
	No.	%	No.	%
Infant@ (n=26)				
Love and security	17	28.3	9	15
Feeding	19	31.6	7	11.7
Warmth and comfort	23	38.3	3	5
Sucking pleasure	15	25	11	18.3
Sensory stimuli	21	36	5	8.3
Toddler@ (n=24)				
Love and security	15	25	9	15
Graded independency	13	21.6	11	18.3
Toilet training	13	21.6	11	18.3
Preschool@ (n=10)				
Love and security	6	10	4	6.7
Religious information	5	8.3	5	8.3
Learning language	9	15	1	1.7

@ Not mutually exclusive

Table (10) revealed that regarding infants developmental needs 18.3% and 11.7% of children had not satisfied sucking pleasure and feeding need respectively, and 8.3% and 5% respectively for sensory stimuli and, warmth and comfort. Less than two fifths (18.3%) of children in toddler age had not satisfied graded independency and toilet training.

Discussion

Congenital heart disease (CHD) is the most common major congenital anomaly, representing a major global health problem that require immediate surgical intervention, postoperative complications in pediatric cardiac surgery have been inconsistently reported but have important contributions to mortality, the hospital stay, cost and quality of life after surgery, postoperative complications can involve several organs such as cardiac complications, renal complications, respiratory complications and sepsis, prevention of complication or even early prediction of postoperative complications is the most critical first step in management and good prognosis **(Kumar et al., 2019)**.

As regarding to children age the results of the present study illustrated that more than two fifths of children were infants and less than two thirds of children were males, these results are congruent with **Meng et al., (2020)** in a study entitled "Effect of retrograde autologous priming based on miniaturized cardiopulmonary bypass in children undergoing open heart surgery" who reported that age of children was ranged from 3.7–18.1 months. Also these findings in accordance with **Zeng et al., (2020)** in a study entitled "Prediction of complications after pediatric cardiac surgery" who revealed that more than half of the children were males.

Conversely the study results are in congruent with a study done by **Nafiu et al., (2020)** entitled "Race, postoperative complications, and death in apparently healthy children" who revealed that more than half of the children aged over two years old. From the researcher point of view this might be related to that congenital heart disease manifestations occur very early after birth and require immediate intervention to overcome the manifestations and to avoid possible complications.

Regarding consanguinity relationship, the results of the current study illustrated that less than three quarters of children had a consanguinity relationship; the study results are supported by **Fazeriandy et al (2018)** in a study titled "Consanguinity and congenital heart disease in offspring" who revealed that more than nearly two thirds of their studied sample had Consanguinity relationship. The study results also disagreed with **Shah et al., (2020)** in a study entitled "The relationship of consanguinity with congenital heart disease in children" who concluded that more than one third of children had a consanguinity relationship. From the researcher point of view this might be related to that consanguineous marriage is common in rural areas in Egypt.

The result of this study illustrated that all children had a normal birth weight whenever, nearly half of the children were currently underweight, these results supported by **Abassi et al., (2020)** in a study entitled "Health-related quality of life in children with congenital heart disease: a multicenter controlled cross-sectional study" who revealed that more than one third of the study sample were underweight at the time of the study whenever, the majority of the children had normal birth weight at the time of delivery. From the researcher point of view this might be related to that children had normal body weight as they were supplied by all needed nutrients from their mothers through the placenta during pregnancy, But, after delivery the children with CHD not able to suck well therefore after period of time their weight may be affected due to their disease and poor feeding.

Regarding the place of residence, the result of the current study illustrated that slightly more than two thirds of children were from rural areas, the study results are in the same line with **Ladak et al., (2019)** in a study titled "Health-related quality of life in congenital heart disease surgery in children and young adults" who reported

that more than half of the children were from rural areas. From the researcher point of view this might be related to the pediatric specialized hospital serve all cases all over Egypt especially rural areas.

As regarding to the type of children's cardiac defects, the findings of the current study revealed that; near three fifths of the children were diagnosed as having cyanotic cardiac defects and more than one third of them had a tetralogy of Fallot, these findings approved in a study done by **Smith et al., (2019)** titled "Long-term outcomes of tetralogy of fallot a study from the pediatric cardiac care consortium" who revealed that cyanotic disease is the most common congenital anomaly and also that tetralogy of Fallot the most frequent type of CHD.

Also the study are supported by **Sertçelik et al., (2018)** in a study entitled "Life quality of children with congenital heart diseases" who illustrated that half of the children had a cyanotic disease and nearly one third of the children had a tetralogy of Fallot defect**.** Conversely with **Kafian Atary et al. (2019)** in a study entitled "Epidemiologic study of congenital heart diseases and its related factors in children referred to the pediatric cardiac clinic of Birjand University of medical sciences", who revealed that more nearly one third of their children had ventricular septal defect as a congenital anomaly.

Regarding to the type of children's cardiac defects, the findings of the current study revealed that; less than three fifths of the children were diagnosed as having acyanotic cardiac defects and more than one fifth of them had coarctation of the aorta, these results are supported by **da Rosa Pereira et al., (2015)** in a study entitled "Evaluation of swallowing in infants with congenital heart defect" who revealed that less than three fifths of the children had acyanotic heart disease and less than one fifth of the children had coarctation of the aorta**.**

Concerning postoperative complications, the results of the current study illustrated that the most of children had post-operative complications, the study results are supported with **Murni et al., (2019)** in a study entitled "Outcome of pediatric cardiac surgery and predictors of major complication in a developing country" who concluded that the majority of patients had post-operative complications. Conversely the study results incongruent with **Gamal et al., (2020)** in a study entitled "Postoperative complications in pediatric cardiac surgery patients had done in a tertiary hospital" who illustrated that nearly a quarter of the patients who undergo congenital heart surgery experience postoperative complications. From the researcher point of view, the high postoperative complication rate could be related to long time of waiting to be in a list of operation which makes children risky for health problems before surgery.

The results of the current study also revealed that more than one third of children had a pain sensation which assessed by numeric rating scale which assessing pain of children postoperative such as face manifestation, crying and breathing pattern, this results are congruent with **Pollak et al., (2019)** in a study entitled "Postoperative pain management in pediatric patients undergoing cardiac surgery: where are we heading" who revealed that more than half of pediatric children show pain manifestations post cardiac surgery such as crying, catching the surgical site, and verbalizing pain in toddler children.

Pertaining to psychological problem, the result of the current study illustrated that less than one third of children had anxiety and more than one quarter had fear, these results are in accordance with **Tully et al., (2015)** in a study entitled "Depression, anxiety and major adverse cardiovascular and cerebrovascular events in patients following coronary artery bypass graft surgery: a five year longitudinal cohort study" who concluded

that minority of children had generalized anxiety disorder post coronary artery bypass graft, also the study result was congruent with **Alexander et al., (2019)** in a study entitled "Posttraumatic stress disorder in children after cardiac surgery", who concluded that most of these subjects showed overt anxiety, fearful sensation, and restlessness, toward procedures performed in the ICU. From the researcher point of view this could be related to the effect of separation anxiety from their mothers and insecure ICU environment.

Regarding sepsis complications, the results of the current study concluded that less than one third of children had sternal wound infection; the study results are supported by **Murni et al., (2019)** who illustrated that the minority of the children had wound site infection and surgical sepsis. Conversely, also the study results are congruent with **Kumar et al., (2019)** in a study entitled "Cardiac surgery procedures in a rural tertiary care teaching hospital" who concluded that the minority of studied children had superficial wound and surgical site infection. From the researcher point of view, this could be related to the effect of compromised child health condition, underweight or low immunity that results in poor wound healing.

Regarding pulmonary complications post open heart surgery, the results of the current study revealed that less than one fifth of children had pneumonia post open heart surgery. The study results are congruent with **Kalogianni et al., (2016)** in a study entitled "Can nurse-led preoperative education reduce anxiety and postoperative complications of patients undergoing cardiac surgery" who reported that the minority of children had postoperative respiratory infection, atelectasis or pneumonia post open heart surgery, the study results also, are supported with **Murni et al., (2019)** in a study illustrated that about one fifth of pediatric patients had postoperative pneumonia. From the researcher point of view may be related to embolization, ventilator days and related procedures.

Concerning post-operative gastrointestinal complications, the results of the current study showed that less than one fifth of children had postoperative vomiting, the study results were congruent with **Stoicea et al., (2015)** in a study entitled "Alternative therapies for the prevention of postoperative nausea and vomiting", who concluded that postoperative nausea and vomiting are a complication affecting between twenty and forty percent of all surgery children, from the researcher point of view this could be related to the effect of anesthesia, certain medications especially intravenous antibiotic and postoperative opioid use which be one of the most likely independent predictors of nausea and vomiting.

Regarding cardiovascular complications post open heart surgery, the results of the current study showed that less than one fifth of children developed arrhythmia, the results were congruent with **Sahu et al., (2018)** in a study entitled "Arrhythmias in children in early postoperative period after cardiac surgery", who concluded that the minority of children had postoperative arrhythmia. The study results also, are supported with **Murni et al., (2019)** in a study illustrated that about one fifth of pediatric patients had postoperative arrhythmia.

Regarding endocrinal complications , the result of the current study revealed that the minority of children had hyperglycemia post operatively, the study results are consistent with **Sonkusale et al., (2016)** in a study entitled "Blood glucose monitoring in pediatric patients on cardio-pulmonary bypass", who revealed that the mean blood glucose level post cardiopulmonary bypass surgery in pediatric ICU was about 166.7±27.52 which considered a high blood glucose level, from the researcher point of view this could be related to metabolic response to surgical trauma.

Regarding renal complications post open heart surgery, the result of the current study showed that the minority of children had post-operative acute renal failure and peritoneal dialysis, the study results were supported by **Aoun et al., (2021)** in a study entitled "Acute kidney injury post-cardiac surgery in infants and children: a single-center experience in a developing country", who concluded the minority of patients developed acute kidney injury (AKI), patients with cyanotic heart disease were more prone to develop AKI compared to those with non-cyanotic heart disease and also, children with AKI had a higher length of stay in PICU.

Regarding haematological complications, the results of the current study illustrated that the minority of children had bleeding , the study results are in accordance with **Shaykh et al., (2021)** in a study entitled " Epidemiology of bleeding in critically ill children following cardiopulmonary bypass, pediatric critical care medicine", who concluded that the minority of the children had bleeding post open heart surgery, from the researcher point of view this could be related to the complexity of the surgery or pre-operative long period use of anticoagulant.

Pertaining to neurological complications, the result of the current study showed that the minority of children had seizures the study result was congruent with **Kuraim et al., (2018)**, in a study entitled "Predictors and outcomes of early post-operative veno-arterial extracorporeal membrane oxygenation following infant cardiac surgery", who concluded that minority of the children had seizures. From the researcher point of view this could be related to temporary impairment of hemodynamic stability and brain oxygenation post-open-heart surgery.

Regarding the relationship between the children's postoperative complications and type of cardiac defect, the result of the current study revealed that myocardial infarction as cardiovascular complication were detected among children with mixed and cyanotic heart defects 50% for each and not detected among acyanotic heart defect, the study results is agreed with **Murni et al., (2019)** who illustrated that predictors for developing major complications were cyanotic congenital heart disease. The presence of cyanotic congenital heart disease is an intrinsic factor that cannot be controlled in increasing the risk of developing major complications after cardiac surgery, but it can raise awareness to mitigate harmful outcomes.

Conversely these results were incongruent with **Asija et al., (2016)** whose study entitled "Postoperative respiratory failure in children with tetralogy of fallot, pulmonary atresia, and major aortopulmonary collaterals" and revealed that Children with tetralogy of Fallot, pulmonary atresia, and major aortopulmonary collaterals (TOF/PA), who undergo unifocalization surgery are at risk for prolonged postoperative respiratory failure.

The majority of children had pneumonia post open-heart surgery with cyanotic heart defect and only one fifth of the children had pneumonia with mixed heart defects whenever no one had a pneumonia with acyanotic heart defect, the study results are established with **N'guyen et al., (2017)** in a study entitled "Risk factors for child pneumonia - focus on the western pacific region, pediatric respiratory reviews" who showed that pneumonia is commonly complication post open heart surgery among children especially in cyanotic and mixed congenital heart defect compared with acyanotic defect.

Regarding psychological problems among various types of heart defects post-operatively, the result of the current study illustrated that less than three quarters of children with cyanotic defects and the minority of children with mixed type of defects had anxiety while, more than two

thirds of children with cyanotic defect and less than one fifth of children with acyanotic defects had fear, the study results are congruent with **Kumer et al., (2019)** who concluded that most pediatric children with cyanotic defect undergoing open-heart surgery had anxiety and fear compared with minority of children with mixed or acyanotic defect.

Regarding the relationship between the children's postoperative complications and their age, there were no statistically significant differences were detected between postoperative complications and age of children, whenever the result of the current study showed that infant children more affected than other ages in relation to fear and anxiety, the study results were in accordance with **Zeng et al., (2020)** who revealed that more than one third of infant children had fear and anxiety compared to other age groups. From the researcher point of view this could be related to strange ICU environment, separation from the mother and unfamiliar personnel which affect the child coping abilities which lead to sense of mistrust.

Regarding to relationships between the children age and postoperative complications, less than one quarters of infants had arrhythmia and underweight, the study results were congruent with **Gawad et al., (2017)** in a study entitled "The prevalence and risk factors of early arrhythmias following pediatric open-heart surgery in Egyptian children", who revealed that lower age and lower body weight were associated with postoperative complications like arrhythmia and tachycardia. These results might be related to the younger age and underweight children might be prone to more postoperative complications than others.

Also more than one third of infants had pain than other ages; The study results are consistent with **Ladak et al., (2017)** in a study entitled "Health-related quality of life in congenital heart disease surgery in children and young adults" who showed that infant had most pain sensation post open-heart surgery.

Concerning the relationship between the children's postoperative complications and length of stay at hospital, the results of the current study showed that the children stay equal or more than 30 days and more had postoperative complications than another period of stay; more than half had sternal wound infection; more than one third had acute respiratory distress and diarrhea, and more than one quarter had arrhythmia, seizures and anxiety, these results were congruent with **Blinder et al., (2017)** in a study entitled "Acute kidney injury after pediatric cardiac surgery: a secondary analysis of the safe pediatric euglycemia after cardiac surgery trial", who concluded that the length of stay after cardiac surgery was associated with worse outcomes.

Concerning the relationship between the children's postoperative complications and time of first identification, the results of the current study illustrated that no statistically significant differences were detected between postoperative complications and time of first identification, the study results are incongruent with **Nayeri et al., (2021)** who revealed that there were statistically significant difference between postoperative complications and time of first disease identification as early identification, diagnosis and treatment of congenital heart anomaly is associated with decreased incidence of complications. From the researcher point of view the early identification of CHDs in younger children protect them from major complications after surgery.

Regarding correlation between children weight, health history and their age, the results of the current study illustrated that a highly statistically positive correlation were detected between current weight and children' age; the study results are supported with **Huisenga et al., (2021)** in a study entitled " Developmental

outcomes after early surgery for complex congenital heart disease: A systematic review and meta-analysis" who revealed that there were statistically significant positive correlation between children age and their weight. This could be explained that the child weight significantly increased with child age due to normal growth and development.

The study results also showed that there were a positive statistically correlation between the times of hospitalization and child age, the current study results are in accordance with **Abassi et al., (2020)** in a study entitled "Health-related quality of life in children with congenital heart disease: a multicenter controlled cross-sectional study" who illustrated that there were statistically significant correlation between times of hospitalization and child age and also times of hospitalization.

Regarding children's developmental needs, the results of the current study concluded that only less than one third of infant satisfied with love and security and less than one fifth of the infant were dissatisfied regarding suckling pleasure, the study results are congruent with **Huisenga et al., (2021)** in a study entitled who concluded that the minority of children were satisfied with affiliated feeling such as love and feeling secure post open heart surgery. From the researcher point of view this could be related to hospitalization and might be related to pediatric ICU admission that results in feeling of being separated from their mother and feeling of lack of security.

Conclusion

The most present complications were pain followed by anxiety and fear, sternal wound infection, pneumonia, vomiting and arrhythmia. The factor associated with postoperative complications was cyanotic heart defect infant stage, underweight and length of stay one month and more in hospital. The study recommended that regular assessment and monitoring for children after open heart surgery is essential to detect any complications early to be managed immediately. Also special attention should be given for younger children with heart cyanotic defect, underweight, and had long stay in hospital.

Recommendations

1- Regular assessment and monitoring for children after open heart surgery to detect any complications early to be managed immediately.
2- Special attention should be given for younger children with heart cyanotic defect, age, underweighted, and had long stay in hospital.

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