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ORIGINAL ARTICLE

To Determine the Frequency and Risk Factors for Significant Postoperative Bleeding in Children with Congenital Heart Diseases Undergoing Open Heart Surgery in a Tertiary Care Center

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ABSTRACT

Aim: To determine the frequency and risk factors for significant postoperative bleeding in children with congenital heart diseases undergoing open cardiac surgery in our tertiary care hospital.

Methods: A prospective observational study was carried out in the department of Paediatric cardiac intensive care Unit at National Institute of Cardiovascular diseases Karachi between [dates here].Children aged 0-18 years underwent open heart surgery for congenital heart defects. Those patients who had previous palliative surgeries for congenital heart defects were included in the study.The duration of bleeding, recurrence, and treatment given (tranexamic acid bolus/infusion, platelets, FFPs, Packed RBC/WB, Factor 7 concentrates) were also documented. The outcome of bleeding was recorded as either stopped or persistent. If bleeding persisted, any other intervention needed was also noted.

Results: The frequency of preoperative bleeding was found in 20 (13.0%) patients. In distribution risk factors among 20 postoperative bleeding patients, decreased LV function was not present, prolong bypass time was noted in 2(20.0%) & 8 (80.0%) as minor & major bleeding in patients, prolong cross clamp time 2 (28.6%) & 5 (71.4%), arrhythmia 1 (8.3%) & 11 (91.7%) and infection was noted in 2 (28.6%) & 5 (71.4%) as minor & major bleeding, postoperative intervention 3(50%) major & minor, chest intervention was 1(16.7%) & 5 (83.3%) as minor & major bleeding respectively. Mean preoperative bleeding showed LVEF% was 67.5%±0.1 while mean TAPSE was 20.9±14. Hemoglobin at presentation was 13.98±2.8 mg/dl while it decreased to 12.43±1.8 mg/dl by the time the patient was received in ICU. Postoperatively, the LVEF% reduced to 48.48 ± 50.8, post-operative TAPSE value reduced to 8 ± 2.6, while post-operative LVIDs was 15.49 ± 4.6, and LVIDd to 25.66 ± 6.1. Postoperative Hb reduced to 11.91 ± 1.5, platelets to 150.24 ± 66.9, PT to 12.65 ± 3.2, APTT to 26.27 ± 6, INR to 1.19 ± 0.3. The average amount of blood was 48.6 ml/kg/hour. Reason for postoperative bleeding were surgical complications, coagulation disorders, medications, surgical technique, patient's health, infection, and postoperative Care.

Conclusion: Postoperative bleeding is a common and serious complication in patients with congenital heart undergoing open cardiac surgery and is a major threat to the patient's postoperative morbidity and mortality. It also indirectly has a strong impact on the resources utilized towards the patient along with the financial, emotional burden on the families. This study would help us to identify the correctable risk factors which will help in improving the overall outcome of post-operative patients.

Keywords: congenital heart disease, hemoglobin, hematocrit, postoperative bleeding

INTRODUCTION

Postoperative bleeding is a significant problem in children undergoing cardiac surgery for congenital heart diseases and causes morbidity and mortality in children[1] In pediatric cardiac surgery, there is little information regarding the incidence and risk factors for early postoperative bleeding that is not isolated to one type disease or surgical technique however multiple factors like young age, cyanotic congenital heart diseases, Cardiopulmonary bypass related hemodilution and surgery related factors contribute to postoperative blood loss in children undergoing cardiac surgeries[2]

Blood products and clotting factors concentrates can be used to prevent postoperative bleeding in children undergoing CPB related surgery[3] Surgical exploration is usually needed after failure of blood products and clotting factors concentrates.

Although blood transfusion is safe during administration, it carries several risks for children and it affects postoperative morbidity and mortality significantly. Adult's studies have shown that packed RBCs transfusion after coronary artery bypass grafting has an effect on mortality and short and long term survival in adults undergoing open heart surgery[4, 5]

There are few pediatric studies which have demonstrated that blood transfusion in children after cardiac surgery increases duration of mechanical ventilation and ICU stay with no clear benefits on postoperative survival and recovery[6, 7, 8]

The resulting hypovolemia after postoperative blood loss is a significant problem and it contributes to perioperative mortality and morbidity in the pediatric population. Careful attention should be given to maintain normal volume in children undergoing cardiac surgery as blood loss is the most common identifiable cause of anesthesia related cardiac arrest and it contributes to about at least 12% of it[9]. Therefore the caring Intensivist, anesthesiologist and cardiologist should be aware of the risk factors and management of postoperative blood loss in children[10]

This study determined the risk factors for postoperative bleeding in children with congenital heart diseases undergoing cardiac surgery in our population. The findings of our study would help the caring intensivist and pediatric cardiologist to identify the risk factors and prevent and manage this serious complication of postoperative bleeding in children undergoing cardiac surgery.

MATERIAL AND METHODS

A prospective observational study was carried out in the department of Paediatric cardiac intensive care Unit at National Institute of Cardiovascular diseases Karachi between [dates here]. The study was completed in six months after approval of synopsis by the institutional review board.

A non-probability convenience sampling technique was utilized to recruit the participants. Children aged 0-18 years underwent open heart surgery for congenital heart defects. Those patients who had previous palliative surgeries for congenital heart defects were included in the study. Postoperative bleeding was considered to be less than < 3ml/kg/hr for 2 consecutive hours. Patients with preoperative coagulopathy were excluded from the study. Patients with genetic syndromes and children with congenital heart diseases who underwent closed heart surgery were also included in the study.

Major postoperative bleeding was defined as bleeding that started postoperatively with the amount of >5ml /kg/hour for 2 consecutive hours within the first 24 hours of surgery or bleeding that resulted in sternal opening. Minor bleeding was defined as bleeding that started postoperatively with the amount of >3ml /kg/hour but less than 5ml/kg/hour for 2 or more consecutive hours within the first 24 hours of surgery.

If bleeding occurred, the amount of bleeding was recorded in ml/kg/hour, along with the number of hours/minutes after surgery and the number of times it occurred. The duration of bleeding, recurrence, and treatment given (tranexamic acid bolus/infusion, platelets, FFPs, Packed RBC/WB, Factor 7 concentrates) were also documented. The outcome of bleeding was recorded as either stopped or persistent. If bleeding persisted, any other intervention needed was also noted.

In the preoperative phase, the patient's age at the time of surgery (in years), weight, sex, cardiac diagnosis, cyanosis, and coagulation profile were recorded. In the operative phase, surgical repair techniques, cardiopulmonary bypass (CPB) time, aortic cross clamp (ACC) time, inotropic support, inotropic score, ACT and coagulation profile on arrival in the PICU were documented.

The study was conducted after approval from the hospital's ethical and research committee. A total of 315 patients fulfilling the inclusion criteria were included in the study. The data was collected through observation and non-participation of the subjects using a questionnaire that was filled by obtaining data from the subject's medical record file.

All patients undergoing CHD surgeries were monitored for the first 48 hours that were reviewed by consultant PICU at our institution. The development of significant postoperative bleeding, if any, was noted as per operational definition, and management thereafter was noted.

All parents of the patients who were recruited as per the inclusion criteria were consulted initially and were asked to provide verbal consent before the whole procedure of data collection and dissemination. The parents were assured that all the data obtained through the PMR of the patient would be kept confidential and, in no situation, would the name of the child or the family be used anywhere.

This was performed using the SPSS 21.0. Continuous data were presented as mean ± standard deviation, and categorical variables as percentages (frequencies). Comparisons between groups were made using the unpaired Student t-test where appropriate. Categorical variables were compared using the Chi-square analysis. A p-value of <0.05 was considered significant.

RESULTS

Table 1 provides a list of parameters and their frequencies for a group of patients, The average age of the patients is 8.88 years, with a standard deviation of 8.1 years. The table also provides the percentage of female and male patients, with females representing 43.5% of the group and males representing 56.5%.

Table 2 provides information on various parameters related to a patient before undergoing a surgical operation. The mean Left ventricular ejection fraction (LVEF%) was 67.5% ± 0.1 while mean Tricuspid Annular Plane Systolic Excursion (TAPSE) was 20.9 ± 14. The next set of parameters in the table are related to electrolytes and blood counts. These include the total leukocyte count (TLC), hemoglobin (Hb), hematocrit (Hct), platelets, prothrombin time (PT), activated partial thromboplastin time (APTT), international normalized ratio (INR), sodium, potassium, calcium, magnesium, and lactate. These parameters give an indication of the patient's blood composition and electrolyte balance. Hemoglobin at presentation was 13.98 ± 2.8 mg/dl while it decreased to 12.43 ± 1.8 mg/dl by the time the patient was received in ICU.

The given data above in table 3 represents the comparison of pre-operative and post-operative parameters of patients. Postoperatively, the LVEF% reduced to 48.48 ± 50.8, post-operative TAPSE value reduced to 8 ± 2.6, while post-operative LVIDs was 15.49 ± 4.6, and LVIDd to 25.66 ± 6.1. Postoperative Hb reduced to 11.91 ± 1.5, platelets to 150.24 ± 66.9, PT to 12.65 ± 3.2, APTT to 26.27 ± 6, INR to 1.19 ± 0.3.

Table 1: Patient Characteristics (n=154)

Descriptive	Mean±SD
Age (years)	8.88±8.08
Weight (kg)	22.16±15.70
BSA	0.83±0.38
Age at first diagnosis (months)	26.64±57.71
Bypass Time (minutes)	67.99±29.23
Cross Clamp Time (minutes)	41.60±22.93
Baseline Characteristics	Frequency
Gender	
Male	68 (44.2%)
Female	86 (55.8%)
Comorbid/syndrome	
Down syndrome	2 (1.3%)
PA debending	1 (0.6%)
Abscess drain	1 (0.6%)
Type of surgery	
ASD closure	1 (0.6%)
Close heart	26 (16.9%)
Glenn shent	1 (0.6%)
Open heart	126 (81.8%)
AVDO2	
<25%	1 (0.6%)
<30%	2 (1.3%)
<75%	1 (0.65%)
>40%	1 (0.65%)
Intra operative bleeding	1 (0.65%)

Table 2: Preoperative & Postoperative Parameters of Study Participants (n=154)

Parameters	Preoperative (Mean±SD)	Postoperative (Mean±SD)
LVEF%	67.37±8.47	62.81±10.54
TAPSE	20.24±14.20	8..34±3.17
LVIDs	26.76±9.93	26.08±6.07
LVIDd	17.28±7.13	15.79±4.35
Electrolytes		
TLC	9.70±2.41	14.32±4.21
Hemoglobin at presentation	13.94±2.78	12.05±1.45
Hematocrit	40.66±7.92	30.86±11.91
Platelets	249.20±89.66	147.94±67.43
PT	12.58±2.39	12.58±2.78
APTT	25.27±4.63	26.09±5.27
INR	1.27±1.02	1.28±0.53
Sodium	137.91±3.01	137.94±3.49
Potassium	3.69±0.32	3.71±0.35
Calcium	8.40±0.51	8.40±0.50
Magnesium	1.89±0.68	1.68±0.53

Table 3: Frequency of Postoperative Bleeding and their Complications and Risk Factors (n=20)

Postoperative Findings	Frequency
Postoperative Bleeding (n=154)	
Yes	20 (13.0%)
No	134 (87.0%)
Amount of bleeding (ml/kg/hour)	46.56±120.49
How long after surgery bleeding (hours)	3.0±2.28
Number of times bleeding occurred (times)	1.68±2.05
Mean Duration of Bleeding (minutes)	3.26±1.19
Recurrence	1 (5.0%)
HB after receiving in ICU	12.74±1.61
Condition of Bleeding	
Minor	13 (65.0%)
Major	07 (35.0%)
RISK FACTORS	
Chest Exploration	
Yes	6 (30.0%)
No	14 (70.0%)
Postoperative Intervention	
Yes	3 (15.0%)
No	17 (85.0%)

Decreased LV Function (<40%)	
Yes	0 (0.0%)
No	20 (100.0%)
Prolong Bypass Time	
Yes	10 (50.0%)
No	10 (50.0%)
Prolong Cross clamp time	
Yes	7 (35.0%)
No	13 (65.0%)
Arrhythmia	
Yes	12 (60.0%)
No	8 (40.0%)
Infection	
Yes	7 (35.0%)
No	13 (65.0%)
COMPLICATIONS	
Low Cardiac Output	
Yes	1 (5.0%)
No	19 (95.0%)
Hypotension	
Yes	1 (15.0%)
No	17 (85.0%)
Mortality	
Yes	2 (10.0%)
No	18 (90.0%)
Mechanical ventilations (days)	3.25±1.11

Postoperative bleeding occurred in 20 patients in total. The average amount of blood was 48.6 ml/kg/hour. The drop in mean hemoglobin (Postoperative - Preoperative) was 8.0625 mg/dl (Table 4).

Table 4: Risk Factors for Significant Postoperative Bleeding

Risk Factors		Postoperative Bleeding		P-Value
		Major	Minor	
Decreased LV Function	Yes	0(0.0%)	0(0.0%)	N/A
	No	3(15.0%)	17(85.0%)	
Prolong Bypass Time	Yes	2(20.0%)	8(80.0%)	0.500
	No	1(10.0%)	9(90.0%)	
Prolong Cross clamp time	Yes	2(28.6%)	5(71.4%)	0.270
	No	1(7.7%)	12(92.3%)	
Arrhythmia	Yes	1(8.3%)	11(91.7%)	0.344
	No	2(25.0%)	6(75.0%)	
Infection	Yes	2(28.6%)	5(71.4%)	0.212
	No	1(7.7%)	12(92.3%)	
Chest Exposure	Yes	1(16.7%)	5(83.3%)	0.
	No	2(16.7%)	10(83.3%)	
Postoperative intervention	Yes	3(50.0%)	3(50.0%)	0.555
	No	14(100.0%)	0(0.0%)	

Applied Fisher's Exact & Chi-Square test

Table 5: Comparison of Postoperative Bleeding with Different Variables (n=154)

Different Variables		Postoperative Bleeding		P-Value
		Yes	No	
Age Group (years)	1 – 10	15 (9.8%)	87 (56.9%)	0.282
	>10	5 (3.3%)	46 (30.1%)	
Gender	Male	13 (8.4%)	73 (47.4%)	0.377
	Female	7 (4.5%)	61 (39.6%)	
Weight (kg)	3.5 – 20	15 (9.7%)	83 (53.9%)	0.190
	>20	5 (3.2%)	51 (33.1%)	
Type of Surgery	ASD Closure	0 (0.0%)	1 (0.6%)	0.932
	Close Heart	4 (2.6%)	22 (14.3%)	
	Glenn Shent	0 (0.0%)	1 (0.6%)	
	Open Heart	0 (0.0%)	110 (71.4%)	

Applied Fisher's Exact & Chi-Square test

Among the 20 postoperative bleeding patients in the distribution, there was no observed decrease in LV (left ventricular) ejection fraction. Prolonged bypass time was observed in 2 patients (20.0%), categorized as minor bleeding, and in 8 patients (80.0%), categorized as major bleeding. Prolonged cross-clamp time was found in 2 patients (28.6%) as minor bleeding and in 5 patients (71.4%) as major bleeding. Arrhythmia occurred in 1 patient (8.3%) as minor bleeding and in 11 patients (91.7%) as major bleeding. Infection was noted in 2 patients (28.6%), as minor bleeding and in 5 patients (71.4%) as major bleeding, postoperative intervention 3(50%) major & minor, chest intervention was 1(16.7%) & 5 (83.3%) as minor & major bleeding.

Postoperative bleeding was categorized based on various factors including age, gender, weight, and the type of surgery, as detailed in Table 5.

DISCUSSION

The results showed that before the surgery, the patients' mean left ventricular ejection fraction (LVEF%) was 67.5%, and mean tricuspid annular plane systolic excursion (TAPSE) was 20.9. The hemoglobin levels at admission were 13.98 mg/dl and decreased to 12.43 mg/dl by the time patients were transferred to the intensive care unit (ICU). After the surgery, the LVEF% reduced to 48.48%, TAPSE to 8, and left ventricular internal diameter in diastole (LVIDd) to 25.66 ± 6.1. The postoperative hemoglobin levels decreased to 11.91 mg/dl, platelet count to 150.24, prothrombin time (PT) to 12.65 seconds, activated partial thromboplastin time (APTT) to 26.27 seconds, and international normalized ratio (INR) to 1.19.

Out of the total patients, 20 experienced postoperative bleeding, with an average blood loss of 48.6 ml/kg/hour. These results suggest that postoperative bleeding is a common occurrence in children with congenital heart diseases undergoing open-heart surgery. The study highlights the importance of monitoring postoperative hemoglobin levels and coagulation parameters to identify patients at risk for bleeding and promptly intervene to prevent further complications.

A study was conducted to assess the occurrence of postoperative bleeding in children with congenital heart disease following open heart surgery. It also evaluated the possible factors predisposing children to develop bleeding post-operatively. Bleeding following surgery has been shown to increase patient mortality[12].

Postoperative bleeding was assessed in a study by Wolf et al. that followed up on patients within the first 12 hours of ICU stay after cardiac surgery. Bleeding was significantly associated with higher mortality. Also, the study discovered that characteristics like single ventricle anatomy, a higher Risk Adjustment for Congenital Heart Surgery score, youth, and longer perfusion time were linked to post-cardiac surgery mortality [12]. Broad suture lines enhance the risk of postoperative bleeding, increased hemodilution, activation of the coagulation system, and hemostatic disturbances following cardiac surgery[13].

Postoperative blood loss was studied in a survey conducted by Faraoni et al. The results revealed that blood loss was strongly impacted by the patient's age and cyanotic heart disease. It was observed that postoperative bleeding was more common in patients with cyanotic illness than patients with non-cyanotic heart conditions [14]. Studies have reported that bleeding in cyanotic cases most often results secondary to the hypercoagulable state the patient is in due to poor fibrinogen activity[15]

In a study by Guzzetta et al., postoperative blood loss in patients under one year most commonly stemmed from intraoperative hypothermia, a more prolonged cardiopulmonary bypass, and re-sternotomy duration[1].

Dennhardt et al. aimed to assess the impact on coagulation parameters, thrombe-elastography, and postoperative bleeding. The results revealed that children at risk of bleeding had presented with coagulation disorders following cardiopulmonary bypass. In these patients, treatment with fibrinogen, prothrombin complex,

and platelets earlier on improved hemostasis[11].

Agarwal compared the occurrence of postoperative complications in children following cardiac surgeries with and without cardiopulmonary bypass. He found that 43% of the total population developed complications. Further assessment revealed that these complications were linked with the duration of mechanical ventilation, admission into the intensive care unit, and the length of postoperative hospital stay[16].

A systematic literature review was conducted by Giraldo et al., which studied the management of bleeding in children. The study emphasized prior preparedness in cases where blood loss is anticipated. It highlighted the need to replace the blood lost per the pediatric parameters properly[17].

Mediastinal bleeding during surgery is a frequent complication that is linked to hemodynamic instability, extended procedure times, the possibility of further chest investigation, and higher transfusion needs. 2 An independent factor in postoperative morbidity, allogeneic blood transfusion had a higher prevalence of negative outcomes in children than in adults[18]. After being separated from CPB, 50–95% of children in the United Kingdom receive blood products, with bleeding being a common sign[19]. Hence, reducing bleeding and the utilization of blood products is a pertinent goal for enhancing perioperative care[20].

Initiatives must be taken to limit postoperative bleeding in post-surgical patients. Further research is warranted to assess the transfusion practices and other treatment measures among pediatric cardiac patients. More studies must be conducted to analyze the link between postoperative blood loss, hemodilution, platelet dysfunction, and a lack of fibrinogen. A more enhanced understanding will enable a more focused and goal-oriented approach to managing postoperative bleeding.

CONCLUSION

Postoperative bleeding is a common and serious complication in patients with congenital heart undergoing open cardiac surgery and is a major threat to the patient's postoperative morbidity and mortality. It also indirectly has a strong impact on the resources utilized towards the patient along with the financial, emotional burden on the families. This study would help us to identify the correctable risk factors which will help in improving the overall outcome of post-operative patients.

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