REVIEW ARTICLE

PREOPERATIVE INVESTIGATIONS OF OPEN HEART SURGICAL PATIENTS: OUR CURRENT INSTITUTIONAL PROTOCOL (1)

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ABSTRACT

Background: Open heart surgery is one of the complex procedures physicians undertake in modern medicine. It requires high tech equipment, special infrastructure and highly skilled manpower, especially in the areas of cardiology, cardiac surgery, anaesthesiology and cardiac perfusion. Preoperative diagnosis must be accurate and patients' safety determined in order that appropriate informed consent is given. In open heart surgery, our institution developed preoperative assessment protocol. They are clinical evaluation and preoperative investigations.

The objective of this study is to highlight our institutional preoperative investigative protocol and compare same with what is available in the literature.

Materials and Method: In our institution, the first open heart surgery was done in 1974. We performed a retrospective review of the preoperative investigation protocols from 1974 to 2016, spanning a period of 42 years noting the changes and outcome of the changes. The 42 years of cardiac surgery activity occurred in 3 phases: 1. from 1974 – 2000; 2. 2003; 3. 2013 – 2016. Data were obtained from our hospital Record Department. The types of the preoperative investigative protocol and outcome of the changes were analyzed using Microsoft excel and results expressed in arithmetic percentages and presented in tables and bar chart.

Results: These investigations are broadly divided into diagnostic and patient's fitness assessment investigations. The diagnostic investigations aid proper clinical evaluations and are used in evaluating congenital heart defects and acquired heart diseases. In addition, fitness assessment tests have two functions and they are 1. determining the risks of postoperative morbidity and mortality from patients' co-morbidities and the systemic effects of the cardiac disease(s). 2. Predicting the postoperative support that may be required in order to maximize the chances of uneventful surgery. The diagnostic and fitness investigations guide the quartet (cardiologist, cardiac surgeon, cardiac anaesthetist and cardiac perfusionist) in making appropriate management decisions especially with regard to complex congenital heart defects and complex cardiac cases in the elderly, discussed in the setting of cardiac team meetings.

Conclusion

Preoperative investigations form part of an intrinsic preoperative checklist to ensure where possible uneventful surgery. When they are holistically done and accurate diagnosis is made including patients properly worked up via-a-vis the results of the investigations, the outcome is bound to be favourable.

Key words: complex, congenital, diagnostic, preoperative, investigation

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INTRODUCTION

Our open heart surgery program started in the year 1974, firstly as a cardiac mission model and later on as a complete local affair. [1,2,3,4]. The intervention of military in governance of this country disrupted the program leading to collapse of infrastructure, brain drain and inter-professional conflict [5]. With the enthronement of democratic rule in 1999[6], Nigerians in diaspora galvanized themselves and resuscitated the center initially through a cardiac mission model and now by combination of both local team and cardiac mission [7].

During the 42 years but interrupted period of open heart surgery in our center in a developing country, ravaged by military rule, unprecedented corruption, civil strife and nepotism[8] a total of 251 cases of open heart surgeries have been performed. From the beginning, the preoperative assessment hinged mainly on clinical history and physical examination with limited diagnostic investigations [9]. This was because, the available technology like B-mode and Doppler echocardiography, cardiac catheterization, CT scan and MRI were then not available. The maximum diagnostic investigations in the armamentarium of our center at that time, used to confirm clinical diagnosis were A-mode echocardiography, chest x-ray and electrocardiogram. This therefore affected accurate preoperative diagnosis. Mortality and morbidity were relatively high. Sometimes, different diagnoses were met intra-operatively, forcing the surgeon to abandon the procedure if it could not be done. Others were made at autopsy. However, the fitness of the patients' investigations for the operation was to a reasonable degree carried out. Such tests were Complete Blood Count (CBC), Kidney function test/serum electrolyte urea and creatinine(SEUC), Antistreptococcal Antigen(ASO) titre, coagulation profile(Partial Thromboplastin Time,PTT; Prothrombin Time, PT and International Normalized Ratio,INR), urinalysis, liver function test and Hepatitis-B surface Antigen(HBs-Ag) as well as Hepatitis-C Antigen(HC-Ag test). Others include the genotype of the patients and Fasting Blood Sugar (FBS). These scenarios were used in the late 1970s and throughout 1980s.

In the early 1990s, there was the availability of B mode and Doppler echocardiography in the center, made personally available by a Nigerian in diaspora, who then returned from Texas Heart Institute, Houston, USA, to join the local team [1]. Indeed, the combination of echocardiography, electrocardiogram and chest x-ray improved the accuracy of the preoperative diagnostic investigations, which in turn impacted positively on the outcome.

With the combined effort of the Federal Government of Nigeria, Tertiary Education Trust Fund(TETFUND), from University of Nigeria/Federal Ministry of Education and Nigerians in diaspora, the center now has both 2D- and 3D-echocardiography, Cardiac catherisation instruments, static and mobile chest x-ray machines, ABG analyzer, 4 *i*-stat machines among other state-of-the-art equipment to make accurate preoperative diagnosis [5]. While efforts were being made in providing the desired equipment, training and retraining of staff are also ongoing. With the equipment and local staff available at our center, preoperative investigative protocol was formulated and this guarded the successful management of both adult cardiac and pediatric cardiac diseases, including complex ones [7].

MATERIALS AND METHOD

National Cardiothoracic Center of Excellence, UNTH, Enugu, Nigeria, was born in 1984, following the unification and designation of the combined units of cardiology (adult and paediatric) and cardiothoracic surgery as the National Cardiothoracic Center of Excellence. The center performed about 251 cases of open heart surgeries between 1974 and 2016(42years). A retrospective study of the preoperative investigations done for these patients and the outcome of these tests on patients' morbidity and mortality was done. These investigations were divided into diagnostic and patients' fitness assessment. The diagnostic types were subdivided into radiologic and non-radiologic. Also, the fitness assessment investigations were also divided into co-morbidities assessment and complications emanating from cardiac diseases. Inclusion criteria were those that had open heart surgery within the specified period and those investigations done before the operation. Exclusion criteria were those that had extra-cardiac operations and the postoperative investigations. The protocol was modified over time as equipment and expertise became available.

Data were analyzed using SPSS version 16(Chicago). Rates and proportions were calculated with 95% confidence interval (CI). The proportions were compared using student's *t*- tests. Level of significance was set at $P < 0.05$.

RESULTS

The cardiac operations included congenital heart defects and acquired heart diseases. The types of diagnostic investigations are listed according to the number of patients that benefited and the period of the surgery.

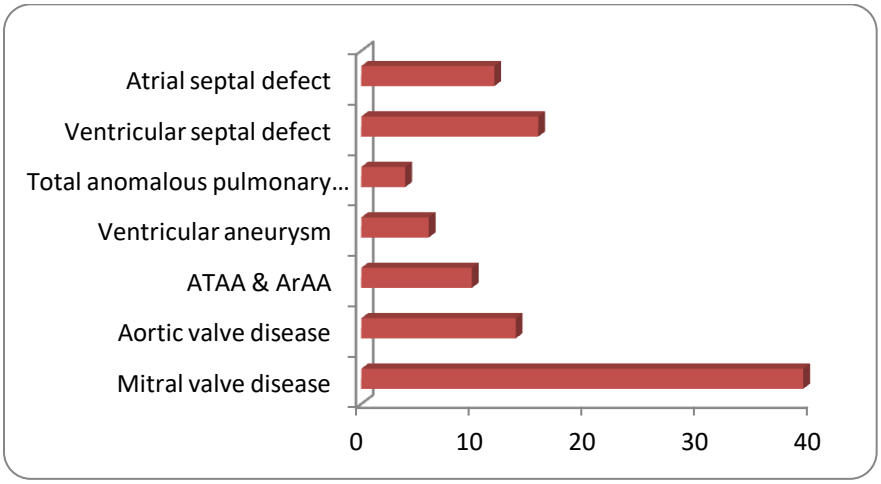

Figure 1: Open heart operations done between 1974 -2000

Table 1: showing age range distribution of the patients

SNO	Age range(years)	Female	Male	Total	Percentage (%)
1	0-10	20	25	45	37.82
2	11-20	5	9	14	11.77
3	21-30	4	1	7	5.88
4	31-40	8	7	15	12.61
5	41-50	7	10	17	14.29
6	51-60	4	7	11	9.24
7	61-70	2	3	5	4.20
				114	100%

In 2003, ICF/KHF did 11 cases of Open Heart surgeries, comprising 6 paediatric and 3 adults

Table 2: **showing the distribution of number of cases managed during the period of 2013-2016**

SNO	Types of Cases managed	Number	Percentage(%)
1	Aortic valve disease	20	11.90
2	Mitral valve disease	44	26.67
3	Tricuspid valve disease	13	7.74
4	Tetraology of Fallot	14	8.50
5	Ventricular septal defect	19	11.31
6	Atrial septal defect	11	6.55
7	Atrial myxoma	6	3.57
8	Ruptured aneurysm of Sinus of Vasalva	2	1.19
9	Double outlet ventricle	4	2.38
	Atrial + Ventral Septal Defects(ASD + VSD)	2	1.19
10	Subaortic membrane	4	2.38
11	Coronary artery disease	5	2.98
12	Cotriatrium	2	1.19
13	Truncus arteriosus, type 1	2	1.19
14	Mitral atresia	1	0.60
15	Complete Atrioventricular defect/endocardial cushion	2	1.19
	Partial Atrioventricular Canal Defect	3	1.79
16	Pulmonary atresia with MAPCAS	1	0.60
17	Modified Bental procedure	2	1.19
18	Congenital absence of anterior and posterior leaflets of tricuspid valve	1	0.60
19	Patent Ductus Arteriosus	10	5.95
Total		**168**	**100**

Table 3: showing mortality rate of patients in relation to period of Open Heart Surgery.

Period	No of patients	Mortatlity	Mortality rate(%)
1974-2000	102	50	49
2003	9	6	66
2013-2016	140	15	11
	251	**71**	28.3

Table 4: showing the Institutional Protocol for preoperative investigations of Open Heart Surgery patients.

SNO	DIAGNOSTIC TESTS	FUNCTIONAL CAPACITY TESTS	FITNESS OF PATIENTS' TESTS
1	Chest x-ray	Lung function test	APTT, PT, INR
2	Electrocardiogram	Liver function test Serum electrolyte, urea and creatinine	Full Blood Count(Hb, WBC, Platelets)
3	Echocardiography	Fasting Blood Sugar	Urinalysis
4	Coronary angiography	Retroviral Screening	Serum protein(total and differential)
5	Cardiac catheterization	HBsAg, Hcv Ab	
6	C-reactive protein		
7	Antistreptococcal(ASO) titre		
8	Erythrocyte Sedimentation Rate(ESR)		

Table 5: **Diagnostic investigations**

Radiologic	Nonradiologic
Chest x-ray	Electrocardiogram(ECG)
Echocardiography	Antistreptococcal titre(ASO)
Coronary angiography	Erythrocyte Sedimentaion Rate(ESR)
Cardiac Catheterization	C-reactive protein
CT angiography	Blood culture for infective endocarditis

DISCUSSION

Open heart surgical patients are one of the most extremely investigated groups of patients that cardiothoracic surgeons and cardiac anesthesiologists encounter [9,10]. In our protocol, preoperative investigations are usually considered in 3 categories, namely: 1. Diagnostic investigations – these are done to confirm the clinical diagnosis as dictated by the pathology and medical history, 2. Investigations done to rule out or determine the extent of co-morbidities and 3., the investigations to assess patients' fitness for the intended surgery.

At varying period in our center, open heart procedures were done, see table 4. A total of 251 cases have so far been done, with 28.3% mortality. However, the mortality rate for the period of 1974-2000 was 49% and for 2003, the mortality rate was 66% while the mortality rate for the period of 2013 to 2017, was 11%. From the diagnostic armamentarium, the progressive reduction in the rate of mortality is thought to be the acquisition of the state-of-the art equipment over time to make accurate diagnosis and rule out co-morbidities, thus improving patient selection before surgery before surgery.

Through the efforts of Nigerians in diaspora, the Tertiary Educational Trust Fund (TETFUND), and Non-governmental Organizations, our institution acquired the-state-of-the art equipment, which enabled the safe cardiac operations within the period of March, 2013 to February, 2017. The adoption of cardiac mission model by our institution coupled with oversea training of some our staff [11, 12], led to the successful creation of a preoperative investigative protocol for patients undergoing open heart surgeries in our institution, table 4. In the protocol the investigations are divided into 3 parts: 1. Diagnostic tests, 2. Functional capacity tests and patients' fitness tests. The diagnostic tests are subdivided into radiologic and non-radiologic, table 5.

One of the foremost radiologic-diagnostic investigations is chest radiograph. This test can reveal boot-shaped heart of Tetraology of Fallot(prominent pulmonary bay and up-turnement of left ventricle apex) and egg on stick appearance of Transposition of Great Arteries[13]. In addition, chest x-rays provides information on enlarged cardiac silhouette/cardiomegaly, congestive cardiac failure with pulmonary oedema, pleural or pericardial effusions [14]. Other radiologic tests like Echocardiography, whether Transthoracic/Transesophageal, provides information of cardiac anatomy, ventricular and valvular functions as well as global and septal wall motions including presence or absence of intra-atrial clots in patients with chronic atrial fibrillation [15]..

In both congenital and acquired heart diseases, left heart catheterization may indicate coronary angiography, aortography, left ventriculography and manometry. This provides information about sites and severity of coronary artery disease, mitral and aortic valve functions, left ventricle morphology and function. Likewise, right heart catheterization permits measurement of pulmonary artery pressure and cardiac output, calculation of transpulmonary gradient and vascular resistance. In cases of shunts between systemic and pulmonary systems, serial blood sampling allows computation of shunt fraction [16,17,18]). With this, congenital cardiac defects like Atrial Septal Defect (ASD), Ventricular Septal Defect (VSD) and Atrioventricular Canal defect (AVCD are diagnosed. Computerized (Ct) scan and magnetic resonance (MR) angiography are employed in our protocol aids in making accurate diagnosis of ascending aortic aneurysm including aortic dissection.

In sub-Saharan African countries like Nigeria, rheumatic heart diseases and infective endocarditis are the commonest indications of intra-cardiac operations in adults [19]. To this extent, estimation of Antistreptococcal O antigen(ASO titre), Erythrocyte Sedimentation Rate(ESR) and C-Reactive Protein(CRP) is employed in our protocol while evaluating patients with valvular heart diseases and infective endocarditis preparatory for open heart surgery. Positive titres indicate active disease at that point in time and subsequently patient is denied surgery until appropriate treatment is done.

Complete blood count (CBC), is used in estimating presence or absence of anaemia including the quantitative platelet and white blood cell abnormality [20,21]. Baseline coagulation panel (prothrombine time(PT); International Normalized Ratio(INR) and Activated Partial thromboplatin Time (APTT) is estimated and recorded because of the use of anticoagulants both intra-and postoperatively. Any abnormality detected is treated before surgery. Furthermore, patients on anticoagulants like warfarin will have their medications stopped about a week before surgery and switched over to fractionated heparin [22,23]. The same applies to those on aspirin.
Chronic diuretic therapy decreases serum sodium, potassium and urea. Hypokalaemia is a common finding in cardiac patients and hypokalaemia is infrequently associated with hypomagnesemia [24]. In view of this, preoperative estimation of serum electrolytes including urea and creatinine in our protocol is justified.

Other appropriate preoperative investigations that may lead to successful intra-operative and postoperative outcome as may be detected by co-morbid diseases include respiratory function test, arterial blood gas (ABG) estimation, carotid artery ultrasound and angiography. These tests among the others enumerated above constitute our institutional preoperative protocol for patients undergoing open heart surgery.

On the basis of the above investigations, an accurate diagnosis is made and patient's operative risk assessment is determined using the established criteria, New York Heart association[19], Canadian Cardiovascular score [20] and Duke [21].

The adoption of the protocol has worked out well because judging from the outcome of 2013-2016 data, table 3, mortality rate appears to be on the decline. The differences in the mortality rate among the 3 phases are statistically significant($P > 0.05$).

CONCLUSION

Preoperative assessment in cardiac surgery is a veritable way of aiding clinical evaluation in making accurate diagnosis, determining preoperative risks which usually have great bearing in the operative and postoperative events. The adoption of ASO titre, ESR and CRP as well as blood culture with regard to rheumatic heart disease and infective endocarditis has imparted positively on the outcome of our procedures.

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