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A Team-Based Approach to Surgical and Anaesthetic Care for Children with Congenital Heart Disease in a Low Resource Setting in Ghana West Africa

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ABSTRACT

Background: Congenital heart disease (CHD) is one of the leading causes of perinatal and infant death from congenital malformations. Incidence of CHD ranges from 6 to13 cases per 1,000 live births with a higher absolute number in developing countries. The insufficient infrastructure adds to the list of obstacles to open-heart surgery (OHS) in this region. Africa has one centre for 50 million inhabitants. Komfo Anokye Teaching Hospital (KATH), Kumasi provide surgical and perioperative care to CHD patients going for OHS from Ashanti region, other regions of Ghana as well as neighbouring countries. Practising OHS in such a resource-poor setting has peculiar challenges. The purpose of this study was to describe the types of surgeries performed in last ten years, to compare the change in trends before and after 2014, to assess the efficiency and quality of care provided by the cardiac anesthesiologist in the delivery of this care in a low resource setting in Ghana.

Methods: This study was performed through retrospective chart review cared from 2007 to 2016. 118 patients from either sex, undergoing elective OHS under general anaesthesia were selected for the study. Patients with insufficient data were excluded from the relevant analysis. Institutional approval for the study was obtained from the Komfo Anokye Teaching Hospital committee on human research publications and ethics.

Results: Demographic profile of the study population as patient age, weight, body surface area were 5.65 ± 1.03 years, 16.92± 0.67 Kg and 0.58 ± 0.13 m^2 respectively. The male to female ratio was 1:1.75. Mortality percentage 2.5% with Aristotle comprehensive complexity (ACC) mean of 7.1 that represents to ACC level 2. Postoperative percentage of patients extubated in the operating room were 7.2% and 39.2% before 2014 and after 2014 which statistically significantly improved in after 2014 ($P<0.05$). The duration of postoperative mechanical ventilator support in hours, average ICU Length Of Stay (LOS) in days, and average hospital LOS in days were (82.35±11.71 and 23.49±7.93), (3.15±2.37 and 1.37±2.85), and (6.86±3.50 and 4.21±3.67) before 2014 and after 2014 respectively. Postoperative chest tube drainage in the first 48 hours was significantly less after 2014 (95 ± 20.3 ml) as compared with before 2014 (133 ± 28.4 ml).

Conclusion: Cardiac anaesthesiologists were an essential part of a team, who provided safe and effective perioperative care in KATH to over 100 Ghanaian children with advanced CHD. Efforts by the cardiac anaesthesia team to avoid anaesthetic complications by the selection of simple cases, minimize post-operative bleeding through aggressive use of tranexamic acid, on-table extubation and rational use of inotropic drugs. All contributed to the efficient and cost-effective care of these patients in this low resource environment. Given its success in serving as a model for others those wish to develop a program aimed at providing surgical care for patients with congenital heart disease in low resource environments.

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KEYWORDS: Anaesthesia, cardiac surgery, congenital heart disease, low resource environment.

Introduction

Congenital heart disease (CHD) is one of the leading causes of perinatal and infant death from congenital malformations. The incidence of CHD is 6-13 per 1000 live births. In Ghana, the estimated burden of CHD is in the region of 372 per million of the population [1]. According to the world health organization (WHO), rheumatic heart diseases attack more than four million people and cause about 90,000 deaths per year, [2] which is quite different from the developed world. In addition, during the next 20-40 years, developing countries will be confronted with the persistence of both rheumatic cardiac diseases and atherosclerotic cardiovascular diseases [3]. The high fertility rate in much of sub-Saharan Africa leads to a disproportionate number of children born with CHD in this part of the world. Many of such children have no geographical or financial access to surgical treatment. Consequently, cardiovascular diseases and its complications have become the number one cause of morbidity and mortality in Ghana. Traditionally associated with developed countries, some 80% of all cardiovascular deaths now occur in low and middle-income countries [4].

Only three West-African countries have a regular open-heart surgery activity, including centres in Ghana, Senegal and Cote d'Ivoire. The average number of operations performed in these three countries is insignificant, faced with the yearly number of cardiovascular patients in West-African countries [2]. The insufficient infrastructure adds to the list of obstacles to open heart surgery (OHS) in this region. Compared with the United States of America (USA) where there is one OHS centre for 150 thousand population inhabitants or Europe with one for one million inhabitants, Africa has one centre for 50 million inhabitants [5]. Ghana is one of the few low-to-middle-income countries in West Africa able to consistently sustain a cardiothoracic program for more than one decade at Komfo Anokye Teaching Hospital (KATH), Kumasi, Ashanti region. Ashanti region is a third large administrative region in Ghana with a population of more than 2 million [6]. KATH provide surgical and perioperative care to these patients with CHD going for OHS from Ashanti region, other regions of Ghana as well as neighbouring countries. In spite of challenges, human and economic potential enables us to anticipate positive developments, including rapid as well as prolonged growth of OHS in Ghana. Our efforts have primarily focused on simple cases with a life expectancy of less than 1-2 years without corrective surgery. Expectedly, practising cardiothoracic surgery in such a resource-poor setting has peculiar challenges. There is a paucity of literature on challenges in developing OHS centres in low resources developing countries of West Africa. The purpose of this study was to describe the types of surgeries performed in last ten years, to compare the change in trends before and after 2014, to assess the efficiency and quality of care provided by the cardiac anesthesiologist in the delivery of this care in a low resource setting.

Methods

This study was performed through a retrospective chart review of all 118 patients cared from 2007 – 2016. Patients with insufficient data were excluded from the relevant analysis. Institutional approval for the study was obtained from the Komfo Anokye Teaching Hospital committee on human research publications and ethics. This study describes the types of surgeries performed in last ten years, to compare the change in trends before and after 2014, to assess the efficiency and quality of care provided by the cardiac anesthesiologist in the delivery of this care in a low resource setting in Ghana at KATH Kumasi.

Results

A comprehensive demographic profile of the study population shown in table 1. Average patient age, weight, body surface area were 5.65 ± 1.03 years, 16.92± 0.67 Kg and 0.58 ± 0.13 m^2 respectively. The male to female ratio was 1:1.75.

Table 1. Distribution of patient's demographic profile:

Parameter	Mean ± SEM
Average Patient Age (years)	5.65 ± 1.03
Average Patient Weight (kg)	16.92± 0.67
BSA (m^2)	0.58 ± 0.13
Sex M:F	1:1.75 (36.5%:63.5%)

Data are presented as means ± Standard Error of the Mean (SEM), Kg-Kilogram, Body surface area-BSA, F- Female, m- meters, M- Male

The types of surgeries that have been performed from 2007 till 2016 at Komfo Anokye Teaching Hospital including ventricular septal defect (VSD) closure, atrial septal defect (ASD) closure, patient ductus arteriosus (PDA) ligation, Double outlet right ventricle (DORV) repair and others as shown in table 2 and figure 1.

Table 2. Type of Surgeries:

Type of Surgery	Total Number Performed (n=118)
VSD + Sub PS resection + infundibular patch (non transannular)	28
PDA ligation	28
VSD	15
VSD + sub PS resection + transannular patch	12
VSD + subaortic membrane resection	4
VSD + Sub PS resection + infundibular patch (non transannular) + BT Shunt Takedown	3
ASD closure	3
VSD + PFO	2
VSD + Sub pulmonic stenosis resection + pulmonary valve replacement	2
ASD closure + PDA ligation	2
ASD + pulmonary valvulotomy	2
VSD + DORV repair	2
DORV repair	1
VSD + PDA	1
VSD + ASD	1
VSD + ASD + Sub PS resection + infundibular patch (non transannular)	1
VSD + ASD + mitral valve annuloplasty + cleft mitral valve repair	1
VSD + PFO + PDA	1
VSD + Sub aortic membrane resection + Mitral Valvuloplasty	1
VSD + Pulmonary valve commisurotomy	1
VSD + Aortic Valve Reconstruction	1
Subaortic membrane takedown	1
Pulmonary Valve commisurotomy + PFO Closure	1
AP window resection	1
Posterior Mitral Valve annuloplasty (cosgrove band + closure of mitral valve cleft)	1
Repair of partial nomalous pulmonary venous return + ASD repair	1
Sub Pulmonic stenosis resection + transannular patch	1

ASD-atrial septal defect, DORV- double outlet right ventricle, PDA- patient ductus arteriosus, PFO- patent foramen ovale, PS-pulmonary stenosis, VSD-ventricular septal defect,

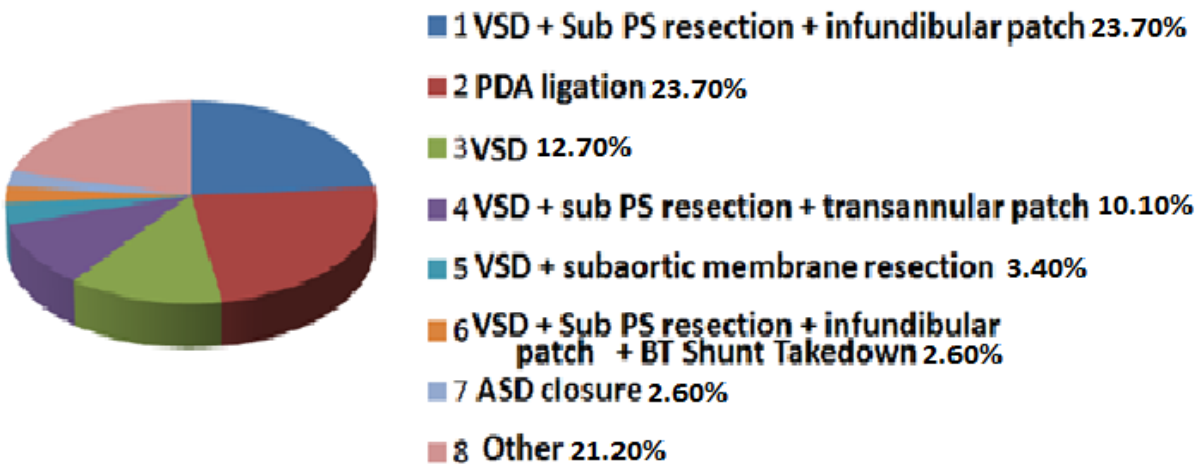

Figure.1 Type of cardiac Surgeries performed during the last ten years at KATH

Only three patients died in the perioperative period out of 118, which shows a mortality rate of 2.5% as shown in figure2. All mortalities occurred before 2014, first mortality was the result of cerebral malaria, the second was in association with a ventilator failure and the aetiology of the third mortality unclear.

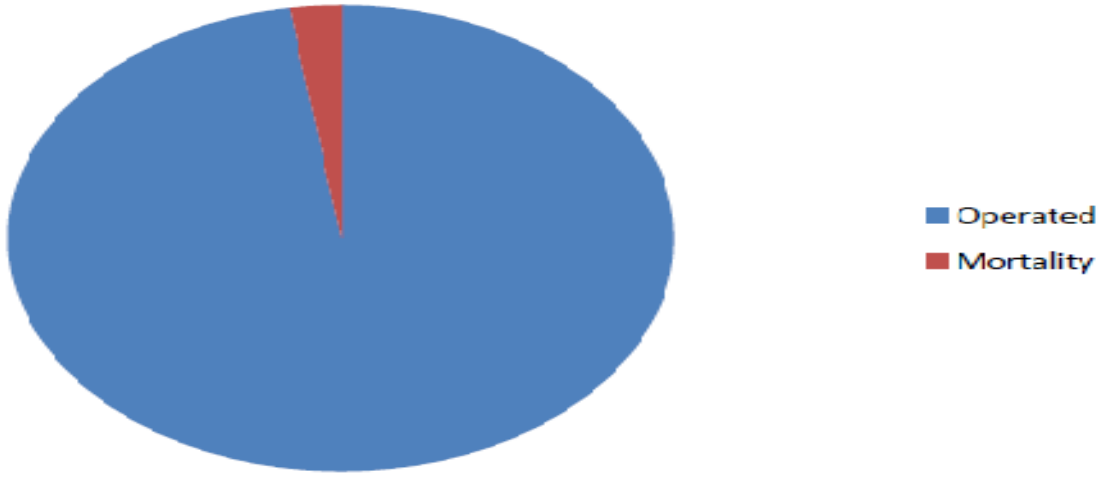

Figure.2 Mortality rate post cardiac surgery in the last ten years at KATH

Aristotle comprehensive complexity (ACC) level and NYHA / Ross pre-operative functional class are shown in Table.3. The complexity level of cardiac operations performed had a mean of 7.1 that represents ACC level 2 as it represents 6.0 - 7.9.

Table 3. Complexity Level:

ACC Level (mean ± SME)	7.1 ± 0.37
NYHA / Ross pre-operative functional class	
I	47 (39.8%)
II	64 (54.3%)
III	7 (5.9%)

Aristotle comprehensive Complexity - ACC, New York Heart Association –NYHA

Postoperative percentage of patients extubated in the operating room were 7.2% and 39.2% before 2014 and after 2014 which statistically significantly improved in after 2014 (P<0.05). The duration of postoperative mechanical ventilator support in hours, average ICU Length Of Stay (LOS) in days, and average hospital LOS in days were (82.35±11.71 and 23.49±7.93), (3.15±2.37 and 1.37±2.85), and (6.86±3.50 and 4.21±3.67) before 2014 and after 2014 respectively. Postoperative chest tube drainage in first 48 hours was significantly less after 2014 (95 ± 20.3ml) as compared with before 2014 (133 ± 28.4 ml) as shown in table 4 (P<0.05).

Table4. Comparison of mechanical ventilation and Length of Stay (LOS):

Clinical Variables	**Before2014**	**After 2014**	**P-value**
% of Patients extubated in OR	7.2%	39.7%	**
Average Duration of Post-Operative mechanical ventilator support in (hrs)	82.35±11.71	23.49±7.93	**
Average ICU LOS in days	3.15±2.37	1.37±2.85	**
Postoperative chest tube drainage (ml) in the first 48 hours	133± 28.4	95± 20.3	**
Average Hospital LOS in days	6.86±3.50	4.21±3.67	*
Patients developed central line infection	-	1	NS

Data are presented as means ± standard deviation (SD), and percentages. Operating room-OR, hours-hrs, Intensive Care Unit-ICU, Length of Stay-LOS, P-*Significant; ** highly significant; NS -Not significant (>0.05)

The number and duration of inotropes administered before 2014 and after 2014 groups shown in Table 5. Adrenaline was the most commonly used and Milrinone the least commonly used inotrope. However, the number of hours adrenaline and dopamine required were significantly lesser after 2014 group ($p < 0.05$) as shown in table 5.

Table5. Comparison of inotropic drugs infused:

Variable	Before2014	After 2014	p-value
Adrenaline	56.7±10.4 hrs (84%)	22.6±5.7 hrs (79%)	**
Milrinone	32.5±5.3 hrs (6%)	36.8 ±6.4 hrs (4%)	NS
Dopamine	13.2±6.5 hrs (20%)	6.5±3.1 hrs (13%)	*
No or 1Inotrope	43.7%	81.9%	**
2 or more inotropes	66.3%	18.1%	**

Data are presented as means ± standard deviation (SD), and percentage, hrs= Hours; P-*Significant; ** highly significant; NS - Not significant (>0.05)

Discussion

Anaesthesia is a speciality with a severe deficit in many developing countries of Africa and anaesthetic services are often underdeveloped [7]. Similarly, it is a well-known fact that the number of trained paediatric cardiac anesthesiologist in developing countries is very few [8]. Anaesthesia is a technology-based speciality and relay on functioning monitoring devices and equipment [9]. Providing anaesthesia in developing countries becomes highly challenging because more than 19% of operation theatres in this part of the world have no pulse oxymeter [10], basic equipment and drugs.

The main focus of our anaesthetic team is to reduce total perioperative and anaesthetic related mortality with the help of evidence-based best practice.

The appropriate selection of cases including patients with simple cardiac defects is one of the most important contributing factors for decreasing morbidity and mortality rate in paediatric cardiac surgery patients in developing countries [11]. We selected simple cases as visible from Aristotle comprehensive complexity (ACC) level we had a mean of 7.1 for our cases which represent ACC level 2.

As proved in some studies that fast track surgery and early extubation reduced mortality [11]. Before 2014 on table extubation rate was 7% as compared to after 2014 which was 39%. In our study due to ventilator failure there was 0.8% mortality before 2014. Simplification of the care and early extubation reduced mortality after 2014.

In cardiac surgery postoperative bleeding is associated with an increased incidence of surgical re-exploration to identify the source of bleeding. Increased use of blood causes significant morbidities such as renal failure, sepsis, arrhythmias, prolonged requirement for mechanical ventilatory support, longer hospital stay and increased mortality [12].

The main focus of our anaesthetic team was to reduce post-operative complication of bleeding and re-exploration. As many studies suggested the use of tranexamic acid (TXA) safe in pediatric cardiac surgery, TXA effectively reduces postoperative blood loss as well as re-exploration [12, 13]. As an evidence-based best practice, we use TXA as a bolus of 20 mg/kg after anaesthetic induction and 20 mg/kg after protamine during major surgeries. Postoperative chest tube drainage in the first 48 hours reduced significantly with TXA use after 2014.

Low cardiac output syndrome is a common complication in cardiac surgery patients [14] and inotropic support is frequently initiated to improve post bypass ventricular function. Inotropes may improve haemodynamics, but there is a potential risk for increased myocardial oxygen and energy consumption [14,15]. It has been suggested that increase in contractility of the hibernating but viable myocardium by low doses of inotropes can lead to a perfusion contraction mismatch with activation of anaerobe glycolysis and eventually myocardial necrosis [16, 17]. Thus the use of inotropes has been associated with adverse clinical outcomes as shown in a few studies [18, 19]. In a study by Fellahi et al. use of dobutamine was associated with increased postoperative morbidity. This has resulted in an ongoing debate on the value or harm associated with the use of inotropes in cardiac surgery [18, 20]. The number and duration of inotropes administered before 2014 and after 2014 in our study showed a significant reduction in their use as well as reduced mortality and morbidity of patients. Thus, clinical practice in inotrope management is highly dependent on the patient requirement. The risks must be weighed against potential benefits on a per-patient basis.

Conclusion

Cardiac anaesthesiologists were an essential part of a team, who provided safe and effective perioperative care in KATH to over 100 Ghanaian children with advanced CHD. Efforts by the cardiac anaesthesia team to diligently avoid anaesthetic complications by appropriate selection of cases, minimize post-operative bleeding and re-exploration through aggressive use of tranexamic acid, on-table extubation and per-patient basis use of inotropic drugs with caution. All these contributed to the efficient and therefore cost-effective care of these patients in this low resource environment. Given its success, it is reasonable for our group's experience to serve as a model for others that wish to develop a program aimed at providing surgical care for patients with congenital heart disease in low resource environments.

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