

## Surgical Outcomes After Two Years of Establishing a Congenital Heart Disease Program in a Resource Limited Country Using a “Single Charity Center” Approach

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### Abstract

**Objective:** To evaluate the surgical outcomes after establishing a pediatric cardiac surgical program in Guyana.

**Design:** A retrospective review of a prospectively maintained database.

**Setting:** Georgetown Public Hospital Corporation, the largest hospital (600 beds capacity) in Guyana, a developing nation in South America. Guyana has no established congenital heart disease program nor pediatric critical care services. The mortality and morbidity of this group of diseases contributes to the country’s health burden.

**Patients:** Children who underwent primary cardiac surgery by the ICHF team between January 2015 and December 2016 in Guyana.

**Interventions:** The International Children’s Heart Foundation (ICHF), a charitable organization, undertook the challenge of establishing a congenital heart disease program in Guyana. 95 patients underwent corrective or palliative cardiac surgery under the care of a multicomponent interdisciplinary team.

**Measurements and Main Results:** 85 (90%) were children, 47 (55%) were less than 5 years old at the time of surgery. 70% of the cases returned to the pediatric intensive care (PICU) intubated and ventilated. The median time of mechanical ventilation was 120 minutes (IQR 0,247.5). Opioids infusion for the management of pain was used in 18 patients (20%). Analgesia was provided with regular paracetamol and bolus of opioids. 4 patients were receiving opioids infusion at 24 hours after admission to the PICU. Twenty-five per cent of the postoperative cases required no inotropic support. Those requiring inotropic support had a median PICU length of stay (LOS) of 3 days as compared to 2 days for those without. 30-day mortality for this cohort was 2% and remained 2% at 2 years.

**Conclusions:** Pediatric cardiac surgery can be performed with good outcomes in developing countries. The optimal use of analgesia, which may impact the duration of mechanical ventilation, institution of early mobilization and using an experienced team to supervise and train the local health care professionals may contribute to shorter PICU LOS.

**Keywords:** Congenital Heart Disease, Humanitarian, Critical Care, Surgery, Outcomes

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## Introduction

It is estimated that up to 1 in 100 children will be born with a congenital cardiac defect and this incidence may be even higher in developing nations where the capacity for antenatal care is limited or completely absent [1-2]. This disease cohort contributes to the mortality and morbidity of children in the developing countries. As childhood mortalities improve worldwide through programs developed from the millennium development goals 4 (MDG4), the burden of congenital diseases including congenital heart diseases will become more prominent [3]. From 2000 to 2012 there has been a significant reduction in the burden from childhood cluster diseases; however, the contribution to the disabilities adjusted life years (DALYs), that is overall disease burden, expressed as the number of years lost due to ill-health, disability or early death, from congenital heart disease remains constant [3]. To help reduce this developing burden to the health care system, addressing the rising rates of morbidity and mortality from congenital heart diseases in the developing countries should be a matter of urgency. Most of these countries do not have established health care systems to adequately manage congenital heart disease especially in children. In this regard, congenital heart disease specialists have a long history of humanitarian aid [2-8] Guyana, a developing nation and the only English-speaking country in South America, has no established congenital heart disease program and the mortality and morbidity of this group of diseases contributes to the country's health burden.

This report aims to document the experience and outcomes of the International Children's Heart Foundation (ICHF), a non-governmental organization that provides congenital heart surgery services to the developing world. This study looks at the country of Guyana over a two-year period. In existence since 1993, ICHF provides surgical care by assembling volunteer medical teams that provide pre-operative, operative and postoperative care during the course of two-week mission trips. These teams are composed of surgeons, anesthesiologists, intensive care doctors, cardiologist as well as intensive care nurses, respiratory therapists, perfusionists and biomedical engineers. Each team member is fully licensed to practice in their home country and most have prior humanitarian experience.

## Materials and Methods

A retrospective review of a prospectively maintained database was conducted to identify any patient who underwent surgical intervention during the course of an ICHF mission trip to Guyana. From January 2015 and December 2016, a total of 7 trips to Georgetown Public Hospital Corporation, Guyana were performed, and 85 cases were identified for analysis. Institution Review Board approval was granted by the lead author's institution and all data was de-identified prior to analysis.

The ICHF humanitarian surgical team is coordinated by its US office in conjunction with Guyana's local health ministry. Screening visits occur before the mission team's

arrival to evaluate prospective patients, referred by local physicians and cardiologists, for surgical selection. If a patient was deemed an operative candidate, the ICHF cardiologist screens the patient upon the team's arrival in country. This evaluation includes an echocardiogram and cardiac catheterization, when indicated. The patient is then presented during a multi-disciplinary conference, including surgeons, cardiologist, intensive care physicians and pediatricians both from the mission team and the local institution and a final decision on the patient's candidacy for surgery is made.

The ICHF team seeks to complete as many successful operations as clinically possible within a 2-week time with a heavy focus on training the local team. The multidisciplinary team includes 15 to 30 volunteers, including licensed medical doctors, nurses, allied health professionals, biomedical personnel, and administrative staff to manage logistical concerns. All teams included an experienced cardiac surgeon, cardiologist, cardiac anesthesiologist, pediatric intensive care physician, operating room and intensive care nurses, perfusionists as well as biomedical personnel.

The ICHF team collaborates with local medical and nursing staff on all aspects of patient care. Education and training are aimed at eventual in situ capability. Funds to cover the costs of trip are completely met by donations from individual volunteers, medical companies, grants and the local health ministry whenever possible.

Statistical analysis was completed using SPSS software (IBM, Inc, Armonk, NY). Continuous variables are expressed as median  $\pm$  the interquartile range. Categorical variables are expressed as percentage and were analyzed using  $\chi^2$  test or the Fisher exact test when appropriate.

## Results

A total of 95 patients underwent corrective or palliative cardiac surgery over the 2 years period. Eighty-five (90%) were children (<18 years) and 47 (55%) were less than 5 years old (Median age = 5.05 years, range: 1.7-13.9). The range of cardiac diagnosis and interventions were comparable to those of established programs in developed countries, with single lesions (atrial septal defect (ASD), ventricular septal defect (VSD), patent ductus arteriosus (PDA), tetralogy of Fallot and single ventricle lesions) comprising most of cases (n=65, 76%) Table 1.

The average patient age was 5.05 years (1.7-13.9), with 47 patients (55%) being under 5 years of age. The average weight was 15.6 kg (8.5-31) and 42 patients (49%) were male. Twenty-five patients (29%) were clinically malnourished as determined by the clinicians participating in the patient's care. The Risk Adjusted Classification for Congenital Heart Surgery score (RACHS-1) is a measure frequently used to stratify a patient, and their corresponding surgery's, complexity with lower scores corresponding to less complex lesions. The score is between 1 and 6. Most patients had a RACHS-1 score  $\geq$  than 2 (n=58) Table 1.

Operative interventions included repair of single lesions

in 41 patients (48%), repair of tetralogy of Fallot in 13 patients (15%), repair of single ventricle lesions in 11 patients (13%) and repair of other complex cardiac lesions in 20 patients (24%). The median cardiopulmonary bypass time was 100 minutes (72.3-127) and the median cross-clamp time was 59 minutes (33-86.5) Table 2.

Postoperative complications included bleeding events requiring transfusion in 11 patients (13%), reoperation 5 patients (6%), delayed sternal closure in 2 patients (2%) and surgical site infection in a single patient (1%). Additional complications included reintubation in 5 patients (6%), pulmonary hypertension in 5 patients (6%), temporary cardiac pacing in 5 patients (6%) and junctional ectopic tachycardia in a single patient (1%). The in-hospital mortality rate was 2% (n=2) and the mortality rate at two years of follow up remained 2% (n=2) Table 3.

Seventy percent of the cases returned to the pediatric intensive care (PICU) intubated and ventilated post-surgery. The median time of mechanical ventilation after admission was 120 minutes (0,247.5). Opioids infusion for the management of pain was only used in 18 patients (20%). Analgesia was provided with regular paracetamol and bolus of opioids. Only 4 patients (5%) were receiving opioids infusion at 24 hours after admission to the PICU. Twenty-five per cent of the post-operative cases required no inotropic support during their PICU admission Table 4. Those requiring inotropic support had a median PICU length of stay (LOS) of 3 days (2-4), which is significantly longer than those who arrived without vasopressive support; 2 days (1.25-3), p=0.03.

### Discussion

Guyana is a developing nation in South America without a dedicated congenital heart disease program and/or center. The International Children’s Heart Foundation assists in this regard by performing ongoing surgical mission coupled with education aimed at eventual site independence. Over the course of the first two years of the program the outcomes have been excellent as compared to the predicted mortality by RACHS-1 score.

A review of the preoperative demographics demonstrates and case mix, as stratified by RACHS-1 score and primary pathology, similar to the developed world. However, a significant portion of these patients, 29%, were malnourished and patients frequently presented late, with advanced pathology. Further, advanced technologies such as ventricular assist devices and inhaled nitric oxide where are not available in Guyana. This suggests that outcomes would most likely be worsened in this arena as compared to North America and Western Europe.

In their work analyzing mortality as compared to RACHS-1 scores Jacobs et. al. studied 45,635 cases from North America that had been submitted to the Society for Thoracic Surgery (STS) national database and stratified these cases’ mortality by RACHS-1 score. They found that a RACHS-1 score of 1 corresponded to a mortality rate of 0.6%, a RACHS-1 score of 2 corresponded to a mortality rate of

**Table 1:** Preoperative Demographics.

Demographics	
Age -yrs (median, IQR)	5.05(1.7-13.9)
Age below 5 years	47
Weight-kgs (median,IQR)	15.6 (8.5-31)
Male	42
Malnourised	25
RACHS-1	20
RACHS-2	36
RACHS-3	20
RACHS-4	4
Diagnosis	n=85
Single Lesions(ASD/VSD/PDA/AVSD)	41
Single Ventricle Lesions	11
Tetralogy of Fallot	13
Other Complex Cardiac Lesions	20

IQR: interquartile range; kg: kilograms; RACHS: risk adjusted congenital heart surgery score.

**Table 2:** Operative Interventions and Data.

Operative Data	
Surgery:	n=85
Single Lesions	41
Complete Tetralogy of Fallot Repair	13
Single Ventricle Palliative Procedure	9
Other complex procedures	22
CPB Time (minutes) (median, IQR)	100 (72.3-127)
ACX Time (minutes) (median, IQR)	59 (33-86.5)

ACX: aortic cross clamp; CPB: cardiopulmonary bypass; IQR: interquartile range.

**Table 3:** Postoperative Complications.

Complications (n= 37)	
Reintubation	5
Reoperation	5
Pulmonary Hypertension	5
Bleeding requiring transfusion	11
Temp Epicardial pacing	5
Junctional ectopic tachy	1
Delayed chest closure	2
Surgical site infection	1
Death	2

**Table 4:** Postoperative Infusions

Post-Operative Care (On Admission) n=85	
Epinephrine Infusion	26
Milrinone infusion	50
Dopamine infusion	10
Analgesia infusion	18
Invasive ventilation	55
No inotropic infusion	22

1.4%, a RACHS-1 score of 3 corresponded to a mortality rate of 4.1%, a RACHS-1 score of 4 corresponded to a mortality rate of 8.7% and a RACHS-1 score of 5 or 6 corresponded to a mortality rate of 20.2% [9]. Fifty eight of the 85 patients in our series had a RACHS-1 score of 2 or above and we observed a discharge and 2-year mortality rate of 2%. Thus, our observed mortality rate is closely aligned with that of North America.

We believe that the success of the program is grounded in both interdisciplinary communication, including in-country physicians, the intensive care team, the surgical team as well as the patient's family, and a significant investment in critical care resources.

This process begins with the preoperative evaluation of the patient. A forward team performs screening visits ahead of the surgical team's arrival and identifies potential operative candidates. These patients are then evaluated by both a volunteer cardiologist and an in-country cardiac specialist. Next, an interdisciplinary conference is held to discuss operative candidate and complete surgical planning. We have made it a policy that anesthesiologists, intensivists and ICU practitioners are part of this discussion. This has allowed us to identify potential candidates for early extubation, potentially resulting in a shorter length of stay and improved outcomes as described by other centers [10]. Minimizing ICU length of stay is also of importance in the developing world, as ICU beds are frequently a very limited resource.

Further, other institutions have noted improved outcomes and reduced ICU lengths of stay when a dedicated cardiac care team is utilized [11]. This concept has been implemented in Guyana in that dedicated ICU beds are assigned during each mission trip and the volunteer team includes enough intensivist coverage to ensure that all patients are managed by an ICU physician 24 hour a day. This permits constant adjustment and titration of the patient's medications and likely reduces overall LOS.

In addition to the above-mentioned policies, it has been our practice to utilize judicious bolus analgesia rather than infusions, when possible. We believe that this leads to earlier extubation and mobilization and, ultimately, better outcomes [12]. It has also been our group's practice to involve the patient's family early and frequently to assist with patient mobilization. This includes ambulation with the assistance of nurses and family members twice a day, when medically appropriate as well as pulmonary physiotherapy performed by the respiratory therapists prior to being performed by

the patient's family after adequate instruction. We have observed a positive response from patients in this regard and believe the practice has assisted greatly reducing ICU LOS through mobilization.

## Conclusions

Pediatric cardiac surgery can be performed with good outcomes in developing countries. Structured training missions such as those conducted by ICHF may benefit more children in developing countries. Transferable skills gained through simulation training using a multidisciplinary approach may benefit local team development. In addition, the optimal use of analgesia, which may impact the duration of mechanical ventilation, institution of early mobilization and using an experienced team to supervise and train the local health care professionals may contribute to shorter PICU LOS and increased flows through the PICU. Follow up studies are required to quantify the impact of these programs on the morbidity and mortality in the developing countries.

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