

# The Challenge of Pediatric Cardiac Services in the Developing World

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**Pediatric cardiac services are too expensive for most developing nations. Problems other than cardiac disease take priority when it comes to budget allocations. Poor health infrastructure and referral systems, malnutrition, and the HIV/AIDS pandemic aggravate the situation, and the increasing economic divide is threatening what services do exist. We highlight how the practice of pediatric cardiac surgery in South Africa compares with first-world standards and outline some of the problems faced by pediatric cardiac services in developing nations.**

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**Key words: Pediatric cardiac surgery, developing world.**

Pediatric cardiac services (PCS) are a highly specialized subcategory of a particularly expensive branch of medicine. The associated financial challenges strain health budgets even in the most developed nations, while in many developing countries there is insufficient budget to mount any service at all.

In the developing world, a cardiac defect adds to an already enormous health burden the average child must face. Although the nature of our profession implies a promise to help, the increasing economic divide is pushing such expensive services still further out of reach.<sup>1</sup>

## Sub-Saharan Africa

It can be argued that Sub-Saharan Africa is the most economically challenged region of the world, in danger of further marginalization as major economies invest elsewhere.<sup>2</sup> Minimal PCS are available, and the situation seems likely to worsen.

The expense of PCS is aggravated by poor health infrastructure and referral systems, poor health education, widespread malnutrition, and the demands of the HIV/AIDS pandemic on

health budgets. Primary healthcare facilities are generally understaffed and inadequate, so referrals for cardiac lesions are commonly in the late stages of the disease process. Politics and war play a complicating role. Indeed, the economic and political problems of Africa are so enormous that cardiac services seem of secondary importance.

## Southern Africa

In South Africa as in many developing nations we suffer from a degree of scientific isolation, both because of physical separation and because of the costs involved in travel. The rapid growth in communications technology and introduction of Internet sites like CTSNet will no doubt improve the situation. The population of South Africa is about 43 million. Other southern African countries do not have pediatric cardiac surgical programs. Because of costs and pressure of numbers, we service the surrounding countries only to a limited degree. There are 8 South African units doing any PCS at all (see Table 1).

## Red Cross Childrens Hospital

The Red Cross Childrens Hospital in Cape Town, South Africa, is the academic pediatric hospital of the University of Cape Town, serving children under 13 years of age only. In March 1959 Christian Barnard conducted Africa's first pediatric cardiac operation using cardiopulmonary bypass at this hospital when he operated on a child to close her atrial septal defect (ASD). Today the

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1043-0679/02/1404-0000\$35.00/0  
doi:10.1053/stcs.2002.35298*

**Table 1.** Pediatric Cardiac Services in South Africa Compared to the UK

	South Africa		United Kingdom <sup>3</sup> Per Million
	Per Million	Total	
Number of units doing any PCS	0.18	8	0.22
Number of surgeons doing PCS	0.27	12	0.6
Operations per annum (children)	28	1300	50

Abbreviation: PCS, pediatric cardiac services.

Christiaan Barnard Childrens Heart Unit at the hospital is the busiest in Southern Africa (over 300 operations annually), offering a full range of PCS with mortality rates acceptable by first-world standards.

### The Red Cross Experience Over the Past 5 Years

To illustrate our practice, we briefly outline our experience over the past 5 years with selected procedures. Mortality and case number comparisons have been made with results from the UK as an example of a developed nation<sup>3</sup> (see Table 2).

#### Palliative Surgery

The role of palliative surgery (specifically pulmonary artery banding and systemic-pulmonary shunts) has gradually become more restricted, because of the limitations and risks of the procedures themselves as well as to the evolution of corrective surgery in small infants and better understanding of the underlying conditions.

Palliation remains an option for unfavourable anatomy or frail condition. In malnourished populations the latter is common: 75% of infants presenting to our unit are below the 3rd centile for weight, and about half of them have concom-

itant respiratory infections.<sup>4</sup> This is often complicated by referral in the late stages of the disease.

In the past 5 years, we have banded the pulmonary trunk to restrict flow in 61 patients with 8 (13%) hospital deaths. Included were 11 for isolated ventricular septal defects and 21 for atrioventricular septal defects. The remainder were for more complex defects. Thirteen patients required tightening of the band at a subsequent procedure, with 2 deaths. This highlights a secondary problem of banding in the infant with respiratory infection: the band is commonly too loose because of decreased respiratory function at the time. In 3 patients referred late with truncus arteriosus, bilateral bands were applied to the branch pulmonary arteries because of severe pulmonary vascular disease associated with repeated pneumonia. One of these patients has since had successful correction of the defect.

During the same period 133 systemic to pulmonary artery palliative shunts have been conducted with 15 hospital deaths (11%). These included 21 central shunts from the ascending aorta (5 of the deaths), and 108 modified Blalock-Taussig shunts (72 on the right and 36 on the left). Mean age for palliative shunts was 12.4 months, which is older than the accepted age for correction for many conditions, in particular Tetralogy of Fallot. This high-

**Table 2.** Five Years Experience at Red Cross Children's Hospital, Comparing Selected Procedures with Stark J, et al.

Operation	Red Cross: 1 Unit, 5 Years		UK: 5 Units, 1 Year <sup>3</sup>	
	Number	Mortality (%)	Number	Mortality (%)
All operations	1334	5.1	1378	4.0
Isolated VSD	162	1.2	168	0.6
Fallot's Tetralogy	115	3.5	88	2.3
Switch (Simple TGA)	15	6.7	67	0
Complete AVSD	58	7	55	3.6

Abbreviations: VSD, ventricular septal defect; TGA, transposition of the great arteries; AVSD, atrioventricular septal defect.

lights how late referral and underlying malnourishment often dictate management.

### ***Isolated Ventricular Septal Defects***

We close ventricular septal defects through an incision in the right atrium parallel and close to the atrioventricular (AV) groove, rather than the more usual oblique incision, giving excellent exposure of the defect through the tricuspid valve orifice. We use autologous pericardium, treated for 10 minutes in 0.6% glutaraldehyde solution, for patch material. This is readily available and easy to work with. It is inserted with a continuous horizontal mattress suture of 5-0 polypropylene without the use of pledgets. The mattress sutures hold well in the muscle without the need for pledgets.

In the past 5 years we have closed 162 isolated perimembranous ventricular septal defects (VSDs) with 2 deaths (1.2%). One patient required reoperation for a residual defect. There have been no incidences of iatrogenic heart block or other significant early morbidity.

The simplified approach of autologous pericardial patch with continuous suture without pledgets is quick (average bypass time under 25 minutes) and saves significantly on the cost of synthetic patch material.

### ***Tetralogy of Fallot***

Although previous palliation continues to play a lifesaving role, we have attempted to follow the trend toward earlier primary correction when possible, to avoid secondary hypertrophy in the right ventricle.<sup>5,6</sup> Correction is done transatrially when possible, using glutaraldehyde-treated pericardium for the VSD patch.

In the past 5 years we have operated to fully correct Tetralogy of Fallot in 115 patients with 4 hospital deaths (3.5% mortality). Of these, 58% (67 of 115) of patients had a repair fully through the right atrium. Three patients required a homograft to reconstruct the right ventricular (RV) outflow. Previous palliative shunts had been conducted in 67 (58%) of the children. Sixteen patients underwent later surgery for residual defects, 1 of whom died; in 2 of these a residual VSD was the significant problem, whilst in the other 14 a residual outflow gradient required relief.

Overall the average age for correction was 29 months, compared with a recommended 3 to 11 months in the developed world.<sup>5</sup> The number of repairs per capita population compares favorably with the developed world (see Table 2) despite late referrals and low diagnosis rate in the mostly rural circumstances of African medicine.

### ***Transposition of the Great Arteries***

Reflecting our poor health infrastructure, a significant number of patients with transposition of the great arteries (TGA) die before a correct diagnosis is made or before reaching a specialist center, or arrive late in the disease process with involution of the left ventricle. Balloon atrial septostomy to promote mixing and prostaglandin E<sub>1</sub> infusion to maintain ductus patency before surgery are standard practice, though the prostaglandin adds significant expense.

In the past 5 years we have conducted 15 arterial switch operations for simple TGA with 1 death. Compared to reported UK figures (see Table 2), more than four times this number would be appropriate for the population we serve, reflecting our poor diagnostic and referral infrastructure. A further seven switch operations were done for more complex TGAs in which group there were 3 deaths. Four patients not included above had pulmonary artery banding to 'prepare' the left ventricle. Of these, 1 died, 2 have had a subsequent switch, and in 1 the band had to be removed for hypoxia despite an adjuvant pulmonary-systemic shunt, and an atrial baffle procedure was done. During this period four other atrial baffle (Mustard) procedures were conducted with 1 death, and 3 RV conduit ('Rastelli') procedures with no deaths, for complex TGA anatomy. The atrial baffle option has remained a valuable tool when LV preparation is deemed unfeasible due to malnourishment and repeated respiratory infection.

For the well-nourished patient referred early we can follow proven treatment algorithms, but many patients fall outside these parameters and individualised treatment plans have to apply.

### ***AV Canal***

For the repair of AV canal defects we use a double patch technique.<sup>7</sup> The anterior left AV

valve “cleft” is always closed up to the first primary chordal support.

In the past 5 years we have conducted 58 repairs of isolated complete AV canal defects, with 4 hospital deaths (6.9%). Eighteen patients had a previous PA band. Late referrals and the need for prior palliative procedures resulted in a mean age for our patients of 18 months (4 to 85 months), somewhat older than most reports.<sup>8</sup>

Down’s syndrome children accounted for 78% (44 of 58) of our patients. Many units in this country and elsewhere consider Down’s syndrome a contraindication to repair of cardiac defects, as a way of reducing waiting lists and costs.

A standard two-patch technique was used in 51 (88%) of the patients. In 6 selected patients the VSD was closed by direct suture as a time-saving measure, as described in recent reports.<sup>9,10</sup> In a further 3 patients with very shallow but complete defects we have combined this with direct suture of the ASD as well, using no patch material at all with good results and no AV valve regurgitation. The advantage when this is possible is significant saving of bypass times.

In addition to closure of the cleft, work on the left AV valve was necessary in 13 of our patients in order to achieve competency: a partial suture annuloplasty was conducted on 11 and the posterior leaflet was augmented with an autologous pericardial patch in 2.

Two patients had significant residual left AV valve regurgitation requiring reoperation and repair, and a further two required revision of the VSD patch. There were no incidences of heart block.

### ***Rheumatic Valve Damage***

Unlike congenital cardiac defects, rheumatic carditis is a “socio-economic” disease, and by far the majority of patients with rheumatic heart disease are from socially disadvantaged communities.<sup>11,12</sup> Further complicating the costs of PCS in developing nations is the constantly rising cost of prosthetic valves. This is a result of continual improvement, a necessity in view of our difficulties with follow-up and anticoagulation control, which is almost impossible in rural areas, efficient transport to main centers being rare. The option of individualized but fixed-dose warfarin therapy has been explored locally, but the results are not optimal.<sup>13</sup>

The cost of prosthetic valves in Africa has more than quadrupled in about 7 years, causing a significant drop in the number of patients receiving valves. This cost, together with the problems of anticoagulation in our population, has promoted repair techniques for rheumatic damage to the mitral valve.

In the past 5 years we have replaced valves for rheumatic damage in 43 children under 13 years old (20 mitral, 12 aortic, and 11 double valve replacements). In the same period we have repaired the mitral valve for rheumatic damage in 51 patients. There has been no hospital mortality. Of the patients having mitral repairs, 2 had repeat repairs and 9 have required subsequent replacements.

The ability to repair the majority of mitral valves has been a significant change in our practice over the past decade. Long-term results of pediatric rheumatic repairs are still awaited, but with encouraging medium term outcomes we will persist in view of cost saving and avoidance of anti-coagulation.

### ***Conjoint Twins***

In the past 5 years we have separated 2 sets of thoracopagus conjoint twins in whom there was a shared left ventricle. One survivor was obtained from each pair by means of deliberately sacrificing the other twin and moving all the ‘joint’ cardiac structures into the expanded chest cage of the remaining twin. One survivor died of aspiration 2 months after surgery. The remaining survivor is well 3 years after separation, with normal cardiac function despite a “three-ventricle” heart.

Despite the cost and time pressures on our unit, such unusual surgery captures the attention of the public and is effective in publicizing the unit and its level of expertise, and one of the avenues through which funding, support and better referral can be attracted.

### ***The African Challenge***

Vast differences in healthcare infrastructures exist throughout the world, but the perspective in Africa is that the disparity is increasing. The visible “gap” in education and healthcare standards is but a reflection of a more fundamental problem: the economic gap. After the tragic

events of September 11, 2001, donor security concerns and the focus on terrorism looks like further reducing aid to Africa, where per capita aid has reduced 40% over the past decade.<sup>14</sup>

In terms of cardiac surgery, the more than 4000 cardiac units worldwide serve at most 7% of the world's population.<sup>15</sup> Sub-Saharan Africa is the worst-served region of the world, and pediatric services are the least available.

In reality, the "third world" cannot afford pediatric cardiac surgery as it is known in the developed world. This is not always an *inability* to mount a service, but primarily a matter of finance. Constant progress in new technology and techniques mostly serves to further elevate costs. Improvements in echo technology might save something in terms of fewer catheterisations being needed, but the concomitant boom in transcatheter device placements has not occurred in poorer nations because the devices are prohibitively expensive, duties and taxes sometimes pushing prices higher than they are in the "first" world.

Many suggestions have been made to improve the situation, inter alia by James Cox in his Presidential address to last year's AATS meeting.<sup>16</sup> However, most suggestions are aimed at training personnel, sharing knowledge and expertise, and using the internet and other modern technology.<sup>17</sup> Although such efforts are appreciated by developing groups, they only go a small way toward a solution. How long African services can be maintained is in doubt for three reasons:

1. Health budgets are crippled by foreign debt, the HIV pandemic, and government priorities lying elsewhere. They are further divided amongst a number of small units. James Cox suggested the development of regional surgical "hubs."<sup>16</sup> Such regionalization makes good sense in terms of improved outcomes and streamlined costs.<sup>18-20</sup> Dedicated pediatric units also attract a degree of "emotional" protection. Few third-world units can achieve the volume of cases required to ensure reasonable standards of practice, and many do not have fully equipped pediatric intensive care unit facilities.<sup>19</sup> A system of National Health Insurance is another possible way to improve finances.

However, political stability is a prerequisite for any regionalization and development. This may

be on the horizon with the "New Plan for Africa's Development" (NEPAD), which was launched in June 2002 at the World Economic Forum's Africa Economic Summit. It is an initiative by African leaders offering the developed world a commitment to democracy, good governance, and peace, in return for debt relief, increased aid, investment, and trade opportunities. The hope is that this home-grown plan will accomplish what the developed world has failed to: reverse the economic decline of Africa.

2. The cost of equipment and consumables continues to soar whilst exchange rates deteriorate. In terms of equipment, we fall short in a number of areas of the American Academy of Pediatrics "Guidelines for Pediatric Cardiovascular Centers" published this year.<sup>21</sup> Much of what we do have is long overdue for replacement. Project-bound, dedicated partnerships between NGOs and the corporate world of cardiac surgical consumables and equipment is the single most high-impact improvement one could envisage for African countries that have established pediatric heart centers. Although expertise often remains at the highest standards, imported items are a major drain on finances.
3. There is a constant "brain drain" of trained staff, from nurse to perfusionist to surgeon: the lure of better remuneration elsewhere is too great. Some go to the relatively small private sector (medical insurance), but many go to developed nations, leaving us short-staffed. At present our intensive care trained nurses commonly supervise the care of 3 patients at once.

The widespread practice of visiting teams spending a week or two doing a handful of procedures in a needy area does not make much impression on the problem. Ultimately, a financial or socio-economic solution is needed, something we surgeons can do little about.

The socio-economic problem for pediatric cardiac surgery is best seen in terms of the incidence of rheumatic carditis in third world countries that is higher than that of congenital heart disease.<sup>22</sup> Our continued use of high numbers of palliative procedures is another indication. Palliation remains a life-saving tool in developing nations, much as it did in the early years in the developed world. Rather than high-profile low-

impact visits from first world teams doing complex surgery, palliation on a wide scale could be far more effective where access to cardiac surgery is negligible; excellent palliation can be achieved relatively cheaply, keeping patients alive with reasonable quality of life while hopefully government and international leaders improve the healthcare standards to where cardiac surgery can be offered.<sup>23</sup> Where there is a surgical unit, help with purchase of consumables, in particular prosthetic valves, may be more appropriate.

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