

# Pediatric Cardiac Surgery in Developing Countries

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**Abstract** Pediatric cardiac surgery in developing countries is a major challenge. It is a challenge to employ evolving methods to cater to the surgical needs of a very large number of children with congenital heart defects while dealing with severe budgetary constraints, finding funding to maintain the program, and maintaining quality in the backdrop of constant turnover of trained medical, nursing, and other paramedical personnel. Choosing the best procedure to achieve maximum palliation at lower cost and, when possible, giving priority for one-stage corrective procedures, albeit at a higher risk, calls for practice modifications. Despite improved infrastructure and surgical skills in recent years, in some developing countries, logistics, affordability, late presentation, nutritional issues, staffing, and unfavorable economics continue to negatively influence the overall results compared to those of developed nations.

**Keywords** Third world · Congenital heart surgery

## Introduction

Pediatric cardiac surgery made its foray in developing countries nearly two decades later than in developed nations. During this period, it has matured into a

separate subspecialty fuelled by the large numbers of children needing surgical corrections. The most important reason why further growth in developing countries has been limited the cost of surgery and its affordability by the population at large.

## Extent of the Problem

If we consider India as reasonably representative of the problem in developing countries, at any given time there appears to be approximately 1–2 million children with congenital heart disease waiting for surgery [9]. This is in addition to the rheumatic burden. It has been estimated that approximately 80,000 children need very early surgery, and approximately 10,000 new cases of transposition every year [9]. Because these figures are unaudited statistics, the problem could be of a larger magnitude. Taking into account the situation in Africa, the rest of Asia, and the developing countries of Eastern Europe, the population needing congenital heart surgery certainly assumes great significance.

## Affordability

Of these numbers, approximately 5% or less can afford the surgery [9]. With state health insurance nonexistent in the majority of developing countries, and health insurers not covering congenital heart surgery, the burden is borne inadequately by the government; some philanthropic organizations, local or international; or mostly by the patients, organizing funding through charities, loans, donations, and, in extreme cases, by

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pawning ornaments or selling family-owned property to obtain the finances necessary for the surgery.

This creates an enormous burden on the decision-making process of the attending surgeon and other caregivers, particularly with regard to the financial fallout if staged or multiple surgeries are needed.

### Is Congenital Heart Surgery a Priority?

From a developing country's standpoint, infectious diseases, nutritional disorders, and AIDS are priority health issues. Congenital heart disease and congenital heart surgery, with all its resource needs and expense, obviously are not a priority. Indeed, the economic and political problems of some areas of the world such as Africa are so enormous that cardiac services seem of secondary importance [4].

However, with mortality from infectious diseases declining families becoming smaller and a child's value increasing as a result, and improvement of outcomes following congenital heart surgery in infants and neonates, the proportion of infant mortality from congenital heart disease has begun assuming to assume significance as seen in India. Global approximately 7% of all neonatal deaths are attributable to major congenital malformations, of which at least 25% are due to severe forms of congenital heart disease [6, 11]. Congenital heart surgery and, recently pediatric cardiological interventions are, emerging as major specializations in providing holistic care for children's health in developing nations, especially India, other South Asian nations, Eastern Europe, and some countries of Africa.

### Funding and Economics

Finding funding to set up and run a pediatric cardiac surgical facility is paramount in a developing country. In the absence of dedicated "children's only" hospitals, the pediatric cardiac surgical program is usually an "appendage" to an adult cardiac program, sharing the facilities and funded to varying extents with the latter. The governments have budgets for health and may set up the infrastructure in a federal or state/province-level government hospital. Notwithstanding this, personnel, operating costs and maintenance of expensive equipment, upgradation, and other relevant issues arise after the initial few years of the "honeymoon period" and the unit either closes or degrades to unviable levels when these are not addressed. Outcomes deteriorate, and the program runs the risk of shutting down.

Although there are instances of organizations and hospitals run by governments and philanthropic institutions performing "free" surgeries, in the long term this is an unviable proposition because the scope and number of surgeries are severely limited due to fiscal constraints. It therefore appears that the way to sustain a quality congenital heart surgical unit in a developing country is to charge reasonably, with a small subsidy at first from the government, a large philanthropic organization, or a busy adult program, and gradually evolve methods and protocols for cost containment that will help the program to fund itself. This is possible for any new unit after a few years of gestation if it is committed to achieving excellence, as has been the author's experience at the Amrita Institute of Medical Sciences (AIMS), Kochi, India. Congenital heart surgery, being an "academic" subspecialty rather than a "commercial" one, is best based in a tertiary referral university hospital or a very highly specialized cardiac center to achieve optimal results. Availability of other subspecialties helps to further improve outcomes. This is particularly true for developing countries, where volumes of patients need to be done and where resources personnel, and basic infrastructure could be centralized, not requiring duplication, which could scale up the capital outlays.

### Late Presentation and Nutritionally Challenged Children

A congenital heart surgeon practicing in a developing country cannot escape seeing naturally selected patients with simple and complex congenital heart problems presenting in adolescence and adulthood. Ventricular septal defects (VSDs) with severe pulmonary hypertension bordering on eisenmengerization [7]. Tetralogy of Fallot in adults, VSD with pulmonary atresia and major aortopulmonary collateral arteries Ebstein's anomaly, VSD with aortic regurgitation, truncus arteriosus and corrected transpositions are some of the complex malformations encountered in adolescence and adulthood. Many cyanotic adult patients present with severe polycythemia, with hematocrits ranging from 60 to 70% and other associated complications, such as brain abscesses, stroke, and infective endocarditis.

On the other hand, it is also equally common to find marasmic and nutritionally depleted infants due to large left-to-right shunts needing emergency surgery due to ventilator dependence following respiratory infection [1, 6].

Transport of a sick child is a challenge given the meager facilities for safe transport, chaotic roadways non-availability of ambulances and trained transport teams, the cost and expense involved, and the distance of a tertiary center in a vast country such as India. These are also true for varying degrees for other developing countries. Thus, many children do not reach these centers in time or do so too late in a very moribund condition beyond salvage. Coupled with this, the bias against a girl child in general, and particularly so against those with heart problems, seen in certain parts of India adds, to the mortality before any form of treatment is sought.

### **Cost Containment and Overstays**

Cost containment is another “mantra” that is very relevant to performing congenital heart surgery (CHS) in developing countries. Although this is true for modern medicine in general, it is more relevant in the case of CHS, because escalating costs may threaten its survival as a viable specialty in India or for that matter, anywhere in the Third World. Every new intervention or practice needs to be weighed against its impact on the cost of the procedure or hospitalization. Unless a conscious attempt is made toward this end, patient bills could get out of control rapidly, and the program could become uncompetitive and nonviable and may have to subsidize huge amounts of unpaid bills [8].

One of the most unpredictable events that could inflate costs after CHS is overstay in intensive care unit (ICU) for various reasons. The usual causes of overstays are sepsis, central nervous system issues, lung and pulmonary hypertensive issues, phrenic palsies, mediastinitis, renal failure, and residual lesions. Every effort needs to be made to prevent these in order to keep the costs under control [8]. Hence, investment in infection control, which reduces usage of expensive antibiotics, pays rich dividends in the long term. Regulation of the use of higher antibiotics in the community and its abuse, as is commonly seen in developing nations, could go a long way in curbing proliferation of “antibiotic-resistant” microorganisms.

Reuse of disposables such as cannulae used for arterial and venous cannulation and cardiac catheters, and judicious usage of modified ultrafiltration (because hemoconcentrators are expensive) and expensive gases such as nitric oxide also help in cost control.

Taking measures to reduce unnecessary and expensive “routine” laboratory investigations and reduction in usage of blood products will not only scale down the costs but also make the surgery safer for the patient

because they reduce exposure to blood-borne infections. Another important aspect to consider is the use of expensive imported disposables. Given the unfavorable currency conversion rates and its frequent fluctuations, the price of imported disposables increases frequently, playing havoc with the constrained budgets under which many programs function in developing countries. In terms of equipments, these unfavorable economics lead to shortfalls in standards prescribed by the American Academy of Pediatrics’ [4, 10].

In the long term, given the increasing consumption, trying to fabricate and manufacture these items locally could substantially reduce the cost of the procedure to the patient. Brazil has pioneered this aspect and has shown the way which needs to be emulated by all developing countries, especially the “developed” ones among them as regards congenital heart surgery, such as India and South Africa, which have the necessary industrial infrastructure to do so.

### **Staffing the Units**

In the absence of a pediatric cardiac Intensivist (who is considered a luxury in developing nations), the surgeon, Pediatric cardiologist, and anesthesiologist form the core team of postoperative caregivers. However, it is usually the surgeon who assumes the overall responsibility of postoperative care in addition to the responsibility of conducting the surgery. This makes it very stressful, particularly when called upon to do high volumes. Thus, building a cohesive team with shared responsibilities translates into excellence in results.

The other factor that hampers excellence in the ICU is the “brain drain” that bleeds the units in the developing countries. The constant drain of trained staff, from nurses to physiotherapists to surgeons and others, by the lure of better remuneration elsewhere is too great. Some go into the private sector, whereas a majority of them, particularly nurses and physiotherapists, go overseas to the developed nations, leaving the units in developing countries acutely short and inadequately staffed and thus leading to compromise in ICU care, which affects the overall results.

### **Practice Modifications**

The practice of CHS in developing countries varies greatly from that in developed nations. The economics and local cultural influences mainly dictate the age and type of intervention, whether palliative or definitive. This occasionally goes against the norm or published

practice guidelines as published from developed countries.

Very frequently, a good palliation with a Blalock shunt in neonates or early infancy, followed by a definitive repair at a later stage, serves to improve the overall results of total correction for tetralogy of Fallot and appears more practical given the ICU setting. Also, a shunt is a cheaper procedure that can be expeditiously performed with less need of sophisticated ICU care, offering a great degree of palliation and allowing the child to undergo an intracardiac repair with much less risk at a later age than during the neonatal period or in early infancy. This is one reason why neonatal repairs of tetralogy are not practical in a developing country. Although arterial switch operation (ASO) is universally accepted as a definitive surgery for transposition of the great arteries with intact ventricular septum in neonates, the place of ASO beyond neonatal age with a regressed left ventricle is controversial. Even though the rapid two-stage ASO has been reported to give good results [2], longer ICU stays and higher perioperative mortality, and concern of late left ventricular dysfunction, have tempered wider application of this procedure [2]. In the developing country setting, a straightforward Senning procedure that gives excellent long-term palliation with a low mortality and quicker recovery appears more appealing and hence continues to be practiced as a procedure of choice in transposition of the great arteries with intact ventricular septum presenting beyond the neonatal age or in infancy.

Clearly, in much of the developing world, the focus should be on health care delivery with an aim to reach the greatest proportion of affected patients. For example, it may not be appropriate to perform multi-staged palliative operations with a doubtful long-term survival or neurodevelopmental outcome (such as in hypoplastic left heart syndrome) when there are many infants with relatively straight curative conditions such as VSDs that need a single corrective operation [5]. Given the resource constraints and the constant battle of stretching the budget, many treatment protocols need to be prioritized. Procedures with a “one-stage fix” such as a simple VSD closure [12], good repair of tetralogy of Fallot, or even an arterial switch appear most appealing in developing countries because they more or less give “cure” with excellent long-term outcomes [12].

Technology and human endeavor should be directed toward this end. Surgical palliation for hypoplastic left heart syndrome is thus of a very low priority, as are conditions such as neonatal Ebstein’s anomaly, tetral-

ogy with absent pulmonary valve syndrome with severe respiratory compromise in neonates or in very early infancy, or single ventricles with heterotaxy and atrioventricular valve regurgitation. Transplantation is not an option in almost all instances. In the case of very complex lesions leading eventually to a single ventricle palliation after multiple staged surgeries, and the family unable to afford the treatment, counseling in accepting the natural history of the disease to safeguard the interests of a normal older sibling is more practical in a developing country setting, whereas it might not be an acceptable practice in a developed country.

Further more, the widespread practice of visiting teams spending a week or two doing a handful of procedures in a needy area does not significantly impact the problems prevalent in a developing country. Many suggestions have been made to improve the situation, as detailed by James Cox in his presidential address at the 2001 AATS meeting [3]. Most suggestions are aimed at training personnel, sharing knowledge and expertise, and using the Internet and modern technology. Although the developing country groups appreciate such efforts, they go only a small way toward a solution. Ultimately, a financial or socioeconomic solution is needed—something surgeons can do little about [4].

## Conclusion

The practice of pediatric cardiac surgery in a developing country is a major challenge. Finding funding to run a program, sustaining it, and retaining trained staff, especially medical, nursing, and other paramedical staff, from migrating to better pastures in developed countries make the quest to achieve excellence a challenge of a very tall order. Although surgical skills have become available in many developing countries such as India, Sri Lanka, and South Africa, the basic problem in achieving results matching those achieved in Western countries centers around ICU care, availability of trained manpower and the ability to rapidly institute and financially support cost-intensive resuscitatory procedures such as extracorporeal membrane oxygenation or implantation of a ventricular assist device. Hence, despite an increased number of procedures being performed on almost all varieties of congenital lesions across all age groups, the results from even the best of centers from a developing country such as India will not be able to match those reported from developed nations. It has been the experience at AIMS that given a good infrastructure,

team, and taking the realities and logistical issues of a developing country into account, the overall mortality for congenital heart surgery can be reduced to approximately 5% across all age groups and types of lesions. However, to reduce overall mortality below this level, in complex cases or in neonates, the constraints begin to appear and at least at the present time it appears almost impossible to do so.

On the other hand, operating in a developing country setting behooves the surgeons to innovate to reduce costs of surgery, plan cases intelligently to manage available resources taking into consideration the constraints in infrastructure and ICU care, and select the appropriate types of procedures, palliative or definitive, with lower risk that give the child a long-lasting palliation with a reduced chance of redo or revision surgeries and a reasonable quality of life. Initial low-cost and low-risk palliation and postponing definitive surgery to a later date when risks are lower are perhaps in order.

The demand for quality pediatric and congenital heart surgery is growing in developing countries such as India, with the society accepting it and the small nuclear family norm being the order of the day. Rising incomes, a more wealthy and literate middle class, and the priority accorded to health care of children by these families are compelling caregivers to match their expectations and deliver world-class results.

Despite all this, in reality the Third World cannot afford pediatric cardiac surgery as it is known to the developed world. It is not always an inability to begin a service but primarily a matter of finding adequate funding for sustenance. Introduction of newer technology almost always serves to increase costs. Improvements in echo technology have somewhat lowered the costs and morbidity by reducing cardiac catheter studies, but this has not translated into a major increase in the number of device placements because the latter are prohibitively expensive, making surgery still cheaper. This might change in the future if the cost of the devices offered for developing countries decreases.

With the advent of pediatric cardiological interventional techniques and “hybrid” surgeries for a great many lesions, it remains to be seen whether the overall cost of the procedures will be reduced or increased. It is this factor alone that will determine whether all these advancements have any relevance with regard to the practice of pediatric cardiac surgery in developing countries.

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