

A Novel Private–Public Hybrid Model for Treatment of Congenital Heart Disease in Mexico

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Abstract

Mortality after surgery for congenital heart disease (CHD) in Mexico is significantly higher than in high-income countries due to structural, medical, and financial factors. In Mexico, public hospitals have a large volume of patients but inadequate quality control systems, whereas private hospitals, although having higher quality control systems, have an insufficient number of patients to build programs of excellence. We describe the creation of a novel hybrid private–public program in Mexico that leverages the advantages of both sectors while establishing an integrated multidisciplinary unit that has allowed us to improve the quality of care for patients with CHD.

Keywords

congenital heart defects, health economics and organizations, public health, health-care expenditures

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Introduction

Congenital heart disease (CHD) is the most common congenital malformation, affecting approximately six to eight in every 1,000 newborns.^{1–4} Even though the mortality from CHD has improved significantly over the last few decades in high-income countries (HICs),⁵ it remains a major health problem in low- and middle-income countries (LMICs). In Mexico, CHD represents the second cause of death among children under five years of age.^{6,7}

The high mortality from CHD in Mexico is multifactorial. The purpose of this report is to examine some of the causes and describe the creation of a novel hybrid private–public partnership program for CHD as a feasible alternative model for delivery of care to overcome the limitations of the public and private systems in LMICs.

Global State of Care for CHD

According to the Society of Thoracic Surgeons (STS) Congenital Heart Surgery Database, a platform that currently includes 95% of centers providing congenital heart surgery in the United States with almost 40,000 operations per year,⁸ the overall mortality after congenital heart surgery in the

United States is 1%, 2.8%, and 8.8% for children, infants, and neonates, respectively.⁹ Perioperative outcomes after congenital heart surgery in Europe are comparable.¹⁰ One of the factors that has been mainly responsible for the improvement in mortality from CHD in HIC has been the creation of highly specialized and multidisciplinary units for medical and surgical care of these patients.¹¹

However, in many LMICs, the situation is quite different. It is estimated that 30% of children who are born with CHD are never diagnosed and 90% receive suboptimal treatment or

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Abbreviations and Acronyms

ABC	American British Cowdray
ASD	atrial septal defect
AS	aortic stenosis
ASO	arterial switch operation
CHD	congenital heart disease
HICs	high-income countries
INP	Instituto Nacional de Pediatría
LMICs	low- and middle-income countries
RACHS	Risk Adjustment for Congenital Heart Surgery I
STS	Society of Thoracic Surgeons
TCH	Texas Children's Hospital

don't receive it at all.¹² The particular reasons for this gap vary between different countries, but some common factors might include (1) lack of access to primary and specialized centers and late referrals; (2) high financial costs for patients cared for by a bureaucratic and underfunded public health system; (3) absence of specialized and multidisciplinary units for care of patients with CHD; and (4) lack of adequately trained physicians and nurses.

The Situation in Mexico

In Mexico, approximately 18,000 to 21,000 children are born each year with a cardiac malformation.¹³ However, it is estimated that less than a third of them have access to treatment, and when available, it is frequently suboptimal. Health services for CHD have been traditionally insufficient and inadequate, and even though reliable statistics are not available, surgical mortality is believed to be much higher than in HIC. The reason for this is probably multifactorial and might include factors common to other countries, mentioned above, and factors that are unique to the Mexican health-care system and society.

The health-care system in Mexico is fragmented, with both public and private health-care providers.¹⁴ Only 5% to 8% of the population have access to private insurance receiving care in private, mostly for-profit, hospitals.^{15,16} The rest of the population receives care in public hospitals. Approximately 40% have access to specific government-run hospitals through employer-based social security coverage and the rest of the population rely on public welfare medical institutions for care, with or without a government-based social insurance ("Seguro Popular").^{14,17}

Public hospitals (including social security and public welfare institutions) have significant financial constraints and a highly bureaucratic organization that have prevented them from establishing high-quality control systems. Fixed eight-hour work shifts result in constant change in medical and nursing staff. Allocation of physicians and nurses in cardiac units is based on labor union decisions rather than professional capabilities. There is a lack of integrated teams due to different personnel depending administratively and clinically from different departments. Furthermore, due to insufficient salaries, physicians and nurses tend to have two or more jobs (some of

them in the private sector) in order to increase their income. This environment creates an unaccountable, error-prone culture that limits the ability of providers to deliver optimal care and prevents the creation of integrated multidisciplinary dedicated teams for the care of patients with CHD.

On the contrary, private hospitals tend to have better quality control systems but they have a small number of patients with CHD, preventing them from developing specialized and financially sustainable cardiac units. As such, they have adopted a model of allowing multiple surgical groups (with their own medical and surgical staff) to perform sporadic congenital heart surgery at their hospitals. This has created a chaotic system with "nomad" groups performing surgery at different institutions with nonuniform standards of care and has precluded the development of the integrated approach that has proven successful in improving outcomes for patients with CHD in HIC.

Kardias Foundation

In response to some of the aforementioned problems, the Kardias Foundation was created in 2000 with the aim of improving the quality of care for children with CHD at the Instituto Nacional de Pediatría (INP), one of the largest public referral centers in Mexico. The vision was to develop a specialized unit in a public hospital, with adequate infrastructure and supplementary economic compensation in order to create a dedicated and highly functional team. The Foundation lobbied the Ministry of Health to approve 40 new full-time positions in order to hire congenital heart surgeons, anesthesiologists, cardiologists, intensivists, perfusionists, psychologists, social workers, and specialized nurses functioning under a novel single clinical and administrative unit, different from the traditional structure in public hospitals where each clinical area depends from a different department. Through funds raised by the Kardias Foundation, an independent cardiac intensive care unit was created, remuneration for physicians was increased, and a program for training physicians and nurses abroad was established.¹⁸

Over the ensuing decade, with the unique structure and training, the INP program was able to significantly decrease the mortality for less complex surgeries. However, the overall perioperative mortality remained high at 15%, mainly due to the higher mortality for more complex procedures (categories 3-6 of the consensus-based Risk Adjustment for Congenital Heart Surgery I [RACHS-1]¹⁹; see Table 1). It became clear that despite the significant advances achieved, a different paradigm was necessary.

The Inception of the Private–Public (Hybrid) Program

In order to create a center of excellence for the care of children with CHD in Mexico, the Kardias Foundation, the American British Cowdray (ABC) Medical Center (a private nonprofit hospital that by charter dedicates 7.5% of its profits to the development of public assistance programs), and the medical–surgical team from INP, with the support of the Ministry

Table 1. Examples of Procedures Classified According to Risk Adjustment for Congenital Heart Surgery I and STS/EACTS Category.

		STS/EACTS category				
		1	2	3	4	5
RACHS-I	1	- Atrial Septal defect repair - Coarctation repair	- Patent ductus Arteriosus surgery			
	2	- Tetralogy of Fallot, no transannular patch, repair - Ventricular septal defect repair	- Tetralogy of Fallot, transannular patch repair - Right ventricular outflow tract repair - Glenn procedure - Fontan procedure		- Repair of total anomalous pulmonary veins	
	3			- Complete atrioventricular canal repair - Arterial switch operation	- Repair of double-outlet right ventricle - Systemic to pulmonary artery shunt	
	4			- Rastelli operation	- Arterial switch operation with ventricular septal defect repair - Aortic arch repair	
	5					- Truncus with interrupted aortic arch repair
	6					- Norwood procedure - Damus-Kaye-Stansel procedure

Abbreviations: EACTS, European Association of Cardiothoracic Surgery; STS, Society of Thoracic Surgeon.

of Health, decided to develop an innovative program combining, in a hybrid manner, elements from the private and public sectors. The program would leverage the high volume of patients seen at public hospitals and the resources and high-quality control standards of a private hospital, which is certified by the Joint Commission International.

In addition, in an effort to create appropriate protocols and provide the best possible care for children with CHD, a twinning agreement was established between Texas Children’s Hospital (TCH) and our hybrid program settled at the ABC Medical Center.²⁰ Twinning refers to the strategy of establishing a close partnership between a specialized center of excellence (usually in an HIC) and an evolving program (usually in an LMIC) with the goal of improving the quality of care.²¹ By participating in the development of programs at LMIC, twinning has a more enduring and comprehensive impact in clinical care than other forms of support from HIC programs such as medical missions and medical tourism.

Figure 1 describes the structure of the program. Care is provided at the ABC Medical Center by the integrated medical–surgical team from the INP. An important aspect of the program is to have a high enough volume of cases, at a private hospital. To achieve this, some patients are referred from the INP, which tends to be at capacity, others from different public hospitals with which agreements were signed to facilitate reference from this sector, and a small percentage are directly referred from the private sector. Patients from INP are assigned

for their surgery to the INP or ABC Medical Center, depending on the availability of beds at any time at both institutions. In addition to the salary provided by the INP, the medical team receives a supplement from the Kardias Foundation in order to allow physicians to dedicate themselves exclusively to the INP and the hybrid programs, and TCH provides training and programmatic support. The TCH provides training and programmatic support in exchange for a nominal consulting fee.

The project is financed by a combination of resources from the federal government (through the “Seguro Popular” or popular insurance), the ABC Medical Center, and the Kardias Foundation (ie, from public, private, and societal funds). In Mexico, in addition to the regular budget that each public hospital receives, the popular insurance program provides each hospital a fixed amount of additional funds for each child undergoing surgery for CHD, regardless of complexity. The Kardias Foundation and ABC Medical Center made an arrangement with the federal government to allow the popular insurance program to pay those additional funds to ABC Medical Center for each patient with popular insurance cared for as part of the program. These governmental funds are used directly for the care of the patients rather than for overall hospital support, which would be the case if the funds were allotted to the public institutions instead. In addition, the development of this center of excellence has led to an increase in the number of private cases, contributing to the self-sustainability of the program.

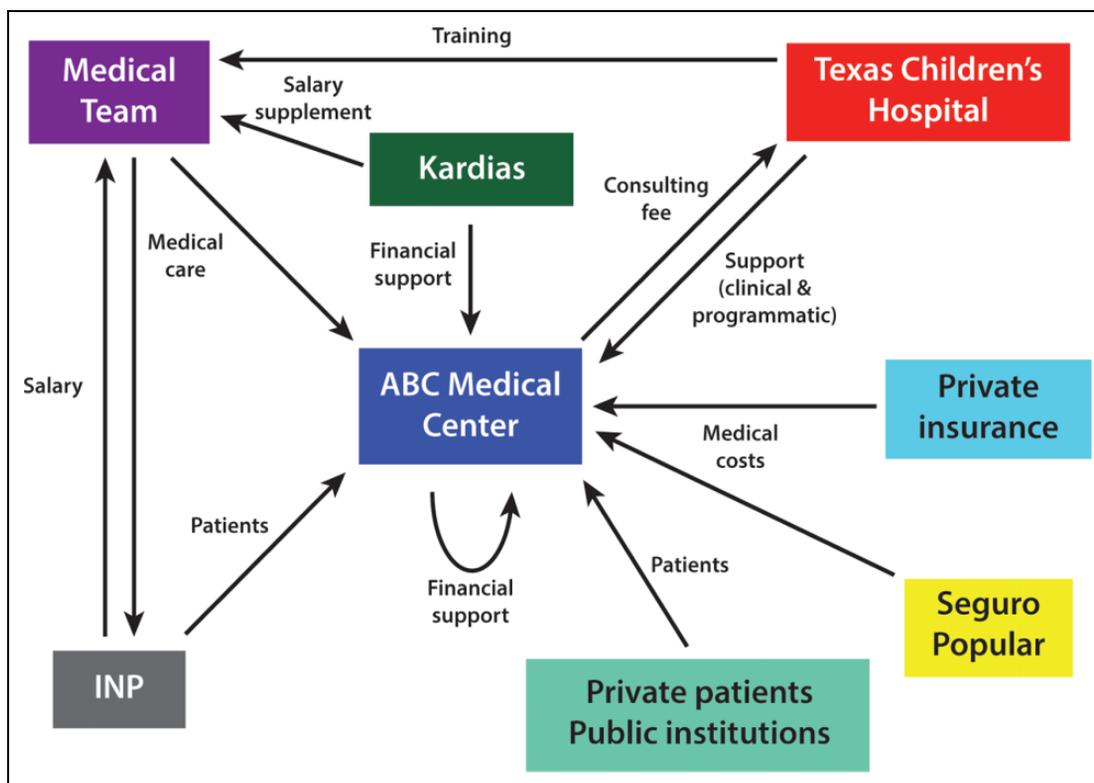


Figure 1. Structure of the Kardias/American British Cowdray/Texas Children’s Hospital hybrid private–public program for congenital heart disease. Financial support is provided by Kardias, “Seguro popular,” and American British Cowdray (ABC) medical center (as part of its social programs). Kardias also provides financial support through supplementary salaries and training expenses. Instituto Nacional de Pediatría (INP) provides most of the medical team members, patients, and long-term follow-up for most patients. Texas Children’s Hospital (TCH) provides clinical and programmatic support to ABC and training to the medical and nursing team. Additional patients for the program are private and those referred by other public institutions. Private patients, through their insurance, contribute also to give financial support to the program.

Evolution of the Hybrid Program

As part of the initial pilot program, a fully equipped operating room and a three-bed dedicated cardiac intensive care unit were built. Management protocols and strict quality control systems were developed.

A medical–surgical team committed to working only at the public and hybrid programs was selected. Selection of the medical team was undertaken based on clinical, academic, and leadership capabilities. Changes in the personnel with time have been made based on evolving needs. At present, the medical team consists of three surgeons, three cardiologists/echo-cardiographers, two interventional cardiologists, eight cardiac anesthesiologists, six intensivists, one psychologist, and two social workers. Due to the still relatively low number of cases, anesthesiologists and intensivists, although committed to the program and its protocols, are still allowed to combine their participation in it with shifts in other units or programs. Dedicated nurses were assigned to the program and trained. A psychosocial program was established to provide support for children and their families. The main medical group at the advising HIC center includes two surgeons, a cardiologist/intensivist, a cardiac intensivist, two cardiac anesthesiologists, a perfusionist, a nurse practitioner, and a nurse, with the participation of other physicians and nurses as needed.

As part of the twinning process, the entire advising team from TCH makes at least one visit per year to make observations, analyze protocols, and provide specific recommendations. Several additional visits are made by smaller teams, as needed. Similarly, the local team visits TCH, the advising center, once or twice a year to observe and emulate practice.

One of the backbones of the program is the weekly telemedicine rounds in which the medical and nursing teams interact with the advising team (usually two intensivists and a surgeon). The teams round on the patients admitted to the intensive care unit and discuss particular cases being considered for surgical intervention.

The decision was made to start in 2012 by performing low-complexity procedures (categories 1 and 2 in the RACHS-1 classification; see Table 1) in order to refine the logistics and structure of the unit. After the first year, the complexity of cases has slowly increased and the program now performs cases of all complexities.

As part of quality measurement and improvement policies, a database was created and the program joined the International Quality Improvement Collaborative for Congenital Heart Surgery in Developing World Countries. This international initiative is intended to reduce 30-day mortality from CHD in developing world countries by using quality improvement

Table 2. Patient Demographics and Preoperative Characteristics.

	n	%
Gender		
Female	235	52.5
Male	212	47.5
Age at surgery		
<30 days	27	6
1-12 months	60	13.4
1-18 years	360	80.6
Underweight	116	25.9
Down syndrome	70	15.6
Previous cardiac surgery	52	11.6
Prematurity	33	7.4
Preoperative ventilation	13	2.9

methodology, providing comparative benchmarks to the participating centers (of which there are currently 44 sites) through the use of a database, and creating a collaborative framework for quality improvement in these centers.^{22,23}

Results of the Program

Since the inception of the program in 2012, a total of 447 patients have undergone surgery: 379 from the public sector and 68 private. Demographic data are shown in Table 2. During the first 18 months, only RACHS-1 category 1 and 2 cases were performed, with 0% mortality. The yearly number of cases and their complexity has progressively increased at the hybrid program (Figure 2A). Figure 2B depicts the increasing percentage of cases of moderate–severe complexity (RACHS-1 categories 3-6) with time, and Table 3 shows the number and type of procedures performed.

The overall mortality of the hybrid program is 2.9%, and although its rate has slightly increased as expected due to the increase in complexity, it has remained low throughout the years (Figure 3). On the other hand, the mortality at the public institution decreased from 16.3% in 2012 to 9.4% during the first seven months of 2018, probably due to an indirect consequence of the quality improvement projects at the hybrid program. As a result, the overall mortality of both programs combined decreased from 15% in 2012 to 6.6% during the first seven months of 2018 ($P = .018$; P value obtained using χ^2 test for trend).

Table 4 shows our mortality rates and postoperative length of stay stratified by the consensus-based RACHS-1 category and the newer empirically based risk-adjusted score developed by the STSs and the European Association of Cardio-Thoracic Surgery, compared with the last outcomes reported in literature using the same scales.²⁴⁻²⁶

Discussion

The care of patients with CHD in LMIC continues to be a significant challenge.²⁷ This is the first report of a public/private and twinning partnership to demonstrate improvement in

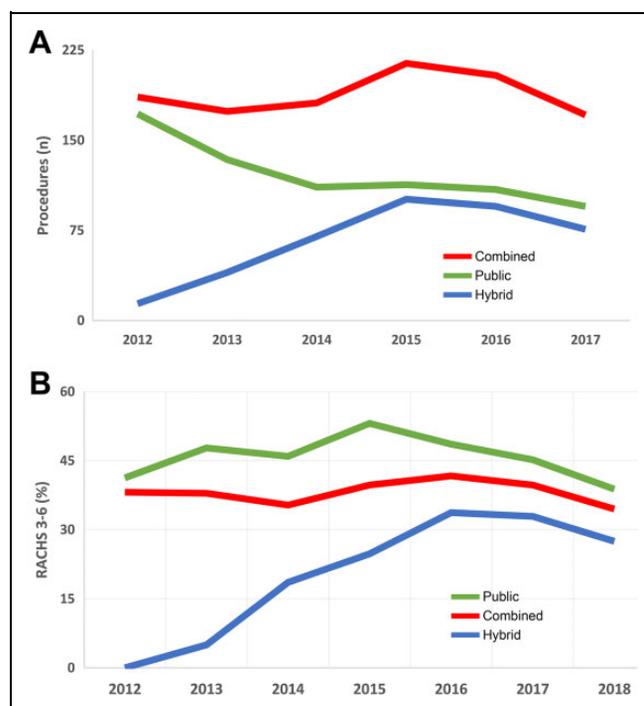


Figure 2. A, Number of procedures by year. B, Percentage of moderate–severe complexity procedures performed by year. The different lines correspond to the Kardias/American British Cowdray (ABC) private–public hybrid program (blue), the Instituto Nacional de Pediatría (INP) public program (green), and both programs combined (red).

the outcomes of children undergoing surgery in this population. Each society is unique and complex, and therefore, recommendations cannot be universally applied. However, based on the experience in HICs that have shown a decrease in mortality of patients with CHD over time, we believe that there are certain fundamental tenets that should be included as part of a solution. Two of the most important include (1) the creation of multidisciplinary teams that can work full time, with adequate compensation, in a referral center with a high volume of patients, and (2) the development of an environment with adequate quality control systems.

In Mexico, due to the prevalent conditions in the public and private systems, it has been very difficult to develop units that can fulfill these characteristics. It has therefore become mandatory to “think outside the box,” shift the current paradigm, and find alternative ways to provide care. By creating this hybrid alternative with programmatic support by a well-established advising center via twinning, the program was able to achieve outcomes largely comparable to benchmarks in the United States and Europe,²⁴⁻²⁶ and probably much lower than previously achieved in Mexico.

The advantages of each of the different sectors were exploited to create a better model. The program has a relatively high volume of patients, as the public institutions have, but in a private hospital that allows for higher quality control systems and a smaller bureaucratic footprint that translates into efficiency and integration of all disciplines under a single

Table 3. Type and Frequency of Procedures Performed in the Program.

Procedure	n	%
VSD repair (+ASD/PDA/AS)	118	26.4
ASD repair (+PDA)	93	20.8
TOF repair	44	9.8
Fontan procedure	28	6.2
PDA surgery	23	5.1
Repair of complete AVC	20	4.5
Repair of HAA	19	4.3
Repair of TAPVR	15	3.4
Glenn procedure	15	3.4
Systemic to pulmonary artery shunt	12	2.7
Subaortic stenosis resection	11	2.5
Repair of DORV	9	2
ASO	6	1.3
Norwood procedure	4	0.9
CoA repair	4	0.9
RVOT reconstruction	3	0.7
RV to PA conduit	2	0.5
DKS procedure	2	0.5
TV repositioning for Ebstein	2	0.5
Others (AP window/aortic valvotomy/Warden procedure/ PA banding/vascular ring)	17	3.8
Total	447	100

Abbreviations: AS, aortic stenosis; ASD, atrial septal defect; ASO, arterial switch operation; AVC, atrioventricular canal; DKS, Damus-Kaye-Stansel; DORV, double-outlet right ventricle; HAA, hypoplastic aortic arch; PDA, patent ductus arteriosus; RVOT, right ventricular outflow tract; VSD, ventricular septal defect; TOF, tetralogy of fallot; TAPVR, total anomalous pulmonary venous return; Coa, coarctation of aorta; RV, right ventricle; TV, Tricuspid valve.

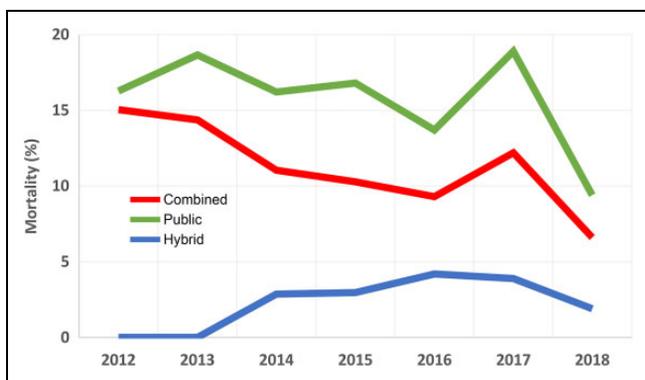


Figure 3. Mortality trends with time. Different lines depict the mortality for the Kardias/American British Cowdray (ABC) hybrid program (blue), the Instituto Nacional de Pediatría (INP) public program (green), and both combined (red).

administrative and clinical umbrella. At the same time, it off-loads some of the excessive clinical volume of the public institution and increases the experience of the medical and nursing teams at the private hospital.

We believe that one of the major factors that played a role in the initial success of this program was the careful creation of an integrated team of physicians and nurses that do their work

Table 4. Risk-Stratified Mortality and Postoperative Length of Stay.^a

	Total Cases, n (%)	Median PLOS, days, (expected ²⁴)	Mortality 2012-18, n (%)	Mortality, STS/EACTS ²⁵⁻²⁷ (%)	Mortality, IQIC Project 2010-17 (%)
RACHS-I category					
1	122 (27)	4	0 (0)	–	0.7
2	211 (47)	7	4 (1.9)	–	2.2
3	83 (19)	13	5 (6)	–	6.6
4	22 (5)	10	2 (9.1)	–	16.5
6	6 (1)	66.5	2 (33.3)	–	39.2
STS/EACTS category					
1	186 (42)	5 (4)	1 (0.5)	0.5-0.78	–
2	155 (35)	8 (6)	2 (1.3)	1.4-2.1	–
3	29 (6)	13 (8)	5 (17)	2.4-3.4	–
4	71 (16)	12 (11)	3 (4.2)	6.6-8.5	–
5	6 (1)	66 (25)	2 (33)	15.7-19.9	–

Abbreviations: IQIC, International Quality Improvement Collaborative; PLOS, postoperative length of stay; RACHS-I, Risk Adjustment for Congenital Heart Surgery I; STS/EACTS, Society of Thoracic Surgeons/European Association of Cardiothoracic Surgery.

^aExpected data were obtained from recent literature. The last column includes the aggregate mortality rates reported by all sites that form part of the International Quality Improvement Collaborative.

exclusively at the institutions associated with the program. Similarly, due to the complexity of care for patients with CHD, it is extremely important to limit the care of these patients at a particular institution with an integrated group. Even though this is widely practiced in the United States and Europe, the structure of private hospitals in Mexico allows physicians from multiple groups to be credentialed at multiple institutions. This translates into different medical–surgical groups potentially performing operations at the same hospital. Thanks to the strong support for the program by the hospital administration, care for patients with CHD at this hospital was limited to a single medical–surgical group. This paradigm change is imperative in order to provide consistent and high-quality care for these patients.

Twinning with an established program with proven excellence was key for the successful development of the program. Some of the areas that have particularly benefited from this process include the creation of management protocols, detailed recommendations based on observations by the advising team, discussion of complex cases, training of nursing staff, and weekly telemedicine rounds in the intensive care unit.

Another important aspect of the project is the financing of care. By closely engaging the federal government, an agreement was reached where the public funds that would otherwise be used to treat a patient in a public hospital are redirected to the private institution to allow care of the patient. Additional funding is obtained from the Kardias Foundation and the American British Cowdray Medical Center. Even though the project continues to depend to a certain extent on philanthropic support via the Kardias Foundation, it is the hope that as the program grows, a larger proportion of private patients (with private

insurance) are treated, therefore eventually making the program more self-sustaining. Additional strategies may be used to reduce the cost of the program, emulating the success on reducing costs by countries such as India and Brazil.²⁸

This program's success is partly due to the financial contributions of the Kardias Foundation and the nonprofit nature of American British Cowdray Medical Center, since the funding provided by the federal government is insufficient to cover the medical costs of the patients. As such, funding may be a barrier when trying to develop similar programs in for-profit hospitals in Mexico that do not have the structure or incentives necessary to devote funds to public assistance programs. Potential ways to overcome this barrier include limiting the implementation of programs like this to hospitals that devote at least part of their profits to public assistance, increasing governmental financial support, or legislating changes in the structure of for-profit hospitals in Mexico to mandate or encourage through incentives and the allocation of funds to public assistance activities.

Health care in Mexico continues to be highly fragmented. It is possible that experiments such as this may prove that a radical reform in public health care where the government pays private institutions to provide care may be an optimal paradigm, especially for complex diseases such as CHD. Other countries in Latin America, such as Chile and Colombia, have succeeded in establishing these kinds of systems and could be emulated.²⁹ Models like these allow physicians and other health-care professionals to be remunerated according to their productivity instead of receiving fixed low salaries, facilitate the creation of highly specialized units with full-time dedicated personnel, and let private hospitals increase their income and strengthen their infrastructure, while the foundations optimize their contribution to improve the overall care of patients. Although the public health-care system in Mexico has helped to bring medical attention to a significant proportion of the population, especially for primary care, it is probably time to rethink the optimal structure needed to treat patients with complex diseases, such as CHD. The size, complexity, and bureaucracy of the public health-care system are important impediments to the delivery of optimal care for these complex patients. Restructuring of the system to allow for better integration and coparticipation of the public and private sectors may provide a better alternative for delivery of care.

Based on the success of this initial pilot program, some of the next steps include the creation of a ten-bed cardiac intensive care unit, continue to increase the complexity of cases while maintaining strict quality control checks in order to prevent a significant increase in mortality, and cement the relationship between the different entities involved. We also believe that this paradigm may be reproducible in other centers in Mexico.

Conclusion

In conclusion, the creation of novel hybrid private–public models may provide an adequate solution to the challenge of

delivering optimal care for patients with CHD in LMIC, in particular in Mexico and Latin America. However, due to the existing obstacles within the Mexican health-care system, reproducibility and self-sustainability of programs like this may need a radical structural reform of the health-care system in order to allow for a more streamlined and productive coparticipation of the public and private sectors. It is clear that only by shifting traditional paradigms and instituting creative solutions, will we be able to improve the care of patients with CHD in Mexico and other LMICs.

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