ORIGINAL ARTICLE

Regionalization in Mexico: Experience in the Hospital de Alta Especialidad del Bajío

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In Mexico, there are a heterogenicity in the institutions of the National Health System. It is important to keep an effective interaction between them to achieve a good development in pediatric heart surgery in our country. We have 2 institutions for the integral treatment of the patient with congenital heart disease in Guanajuato; one of them is the Hospital de Alta Especialidad del Bajío (HRAEB) that offers specialized medical attention to the Bajío region. *Objective.* To show the experience of the HRAEB between 2007-2017. *Material and Methods.* Review of the hospital statistical department database, matching dates with the surgical unit database. Review of the clinical chart to gather all the included variables. *Results.* In this period, we had 1077 cardiac surgeries, in 1005 patients. An average of 97.9 surgeries per year. Most of the patients were from Guanajuato, with 856 children. Male patients were predominant with 51.2%, and for distribution of age the principal group was 1-5 years-old. The most frequent congenital heart disease is the ventricular septal defect (20.1%), persistent ductus arteriosus (17%), aortic coarctation (11.5%) and atrial septal defect (7.5%). These four heart diseases are included in the RACHS-1 scale from 1 to 3 categories. We had 193 patients with some cromosomopathy or any associated syndrome. *Conclusions.* We are an important reference center for treating children with cardiac heart disease, and we keep working to get more experience and reach the optimal surgical results for our patients. We hope to continue improving the objective of the regionalization in Mexico.

Key words: **Congenital heart disease; Congenital heart surgery; Regionalization**

En México las instituciones que conforman el sistema de salud son heterogéneas, y es muy importante la interacción efectiva entre ellas para el desarrollo de la cirugía cardiaca pediátrica en México. Objetivo. Reportar la experiencia del Hospital Regional de Alta Especialidad del Bajío durante los años 2007-2017. Método. Se solicito la base de datos en el departamento de estadística, corroborándose con la base de datos de programación quirúrgica. Se revisó el expediente clínico para obtener variables. Resultados. Se realizaron en total 1077 cirugías, en 1005 pacientes, obteniendo un promedio por año de 97.9 cirugías. De acuerdo a su origen, fueron 856 pacientes de Guanajuato, el resto de los diversos centros de referencia. De acuerdo al género, predominaron los pacientes del género masculino con un 51.2% (515 niños). En la distribución de acuerdo a grupos de edad hay un predominio de los niños entre 1 a 5 años. En nuestro medio la cardiopatía más frecuente fue la comunicación interventricular (20.1%), seguida de la persistencia del conducto arterioso (17%), coartación aórtica (11.5%) y comunicación interauricular (7.5%). Manteniéndose de acuerdo a la escala de RACHS-1 dentro de las primeras 3 categorías. Se intervinieron 193 pacientes con algún síndrome malformativo, microdeleción o cromosomopatía. Conclusiones. Somos un centro de referencia importante para la atención de niños con cardiopatía congénita, y continuamos trabajando para fortalecer la experiencia y alcanzar resultados quirúrgicos adecuados de morbi-mortalidad. Esperamos seguir mejorando para cumplir con el objetivo de la regionalización en México.

Palabras clave: Cardiopatías congénitas, Cirugía Cardiaca Pediátrica, Regionalización

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According to the World Health Organization, it is estimated that 303,000 newborns per year die during the first 4 weeks of life all across the world due to congenital anomalies. Congenital anomalies can cause chronic disabilities negatively impacting their families, health systems and society. The most frequent serious congenital disorders are cardiac malformations, neural tube defects and Down Syndrome [1]. The expected frequency of congenital malformations is around 2-3% in live births, and 15-20% in fetal deaths [2]. Administrative registers indicate that conditions around the perinatal

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period (49.9%) are the main cause of mortality in childhood. Indeed, one in four (25.1%) is coming from congenital malformations, deformities and chromosomal anomalies. Several stages are being analyzed, since their life cycle presents very different levels and causes. Children dying into pre-school age (1 to 4 years-old), with a total amount of 5,028, represents 0.8% of total deaths. The major causes were made out as congenital malformations, deformities and chromosomal abnormalities (16.8%), transport accidents (7.6%) and pneumonia (7.2%) [3].

Among congenital malformations, heart diseases are the most frequent, with a worldwide prevalence from 2.1 up to 12.3 per 1,000 newborns. In Mexico, congenital heart disease has a prevalence of 8 cases per 1,000 live births. It is the most frequent congenital malformation. Based on the annual birth rate in Mexico, 2 million children are born on average (INEGI 2013). This includes around 160,000 children would have some type of cardiac malformation [4], being the second place in children under one year of age, and the first one in children between 1 and 4 years old [4].

In the State of Guanajuato, 1, 218 deaths were reported in children under one-year-old in 2016. Total population in Guanajuato is 5, 853, 677 (representing 4.9% of the national population). Male/female ratio of 93.4 per 100 women, with a median age of 26 years-old. In this setting, health services are integrated as follows: Seguro Popular 58.5%, Instituto Mexicano del Seguro Social 35.4%, ISSSTE 5.4% [5].

Congenital heart disease is the second cause of death in children of less than 1-year-old in Guanajuato, with a total of 360 patients per year [6]. We have a mortality rate of 12.19 children under one-year-old per 1,000 births. The main causes of death are: endocrine, nutritional, metabolic diseases of the cardiac, circulatory and digestive systems [7]. A clear structural anomaly of the heart or of the great intrathoracic vessels with a real or potential repercussion is taken as a definition of heart disease, according to Mitchell et al [8]. Real and true prevalence of congenital heart disease in our country is rather unknown. It has been expanding reaching up the second cause of mortality in 2005. Diagnosis of congenital heart diseases is becoming earlier, even prenatally, thanks to technological breakthroughs and specialists that have facilitated their detection, like echocardiography allowing the identification of anatomical alterations, which in previous decades required a cardiac catheterization study[6].

Given the heterogeneous nature of the institutions that make up the Health System and the lack of effective interaction between them, one of the obstacles to the development of pediatric cardiac surgery in Mexico has been the lack of information about the number and type of congenital heart disease, surgical procedures performed, degrees of complexity, morbidity and mortality, amongst many other things [9].

In Guanajuato we have two High Specialty Hospital Centers performing congenital cardiac surgery. Both of them are located in León city. One is the Hospital de Alta Especialidad del Bajío (HRAEB) by the federal Ministry of Health, and the other one is the IMSS T48 Unit. HRAEB is a decentralized public entity dependent of the Ministry of Health (federal) that provides specialized medical care to patients in the Bajío region (Guanajuato, Aguascalientes, Jalisco, Zacatecas, Michoacán and Querétaro) [10]. It has been actively performing Pediatric Cardiac Surgery since its inception, and currently continues working for regionalization in our country.

The objective of this work is to show the information obtained from the HRAEB experience from 2007 to 2017.

MATERIAL AND METHODS

Database from Department of Statistics of our institution was requested, and matched with the Surgical Program Database. Names and diagnoses of the patients underwent some type of cardiac surgery were provided. Clinical records and flies were reviewed to gather some variables such as age, gender, place of origin, diagnosis, type of performed operations, elective or emergent procedure, use of cardiopulmonary bypass, risk classification (RACHS-1 and basic Aristotle), morbidity and mortality. Categorical variables are presented as number and percentage in relation to the population studied. Continuous variables are presented with average and percentage.

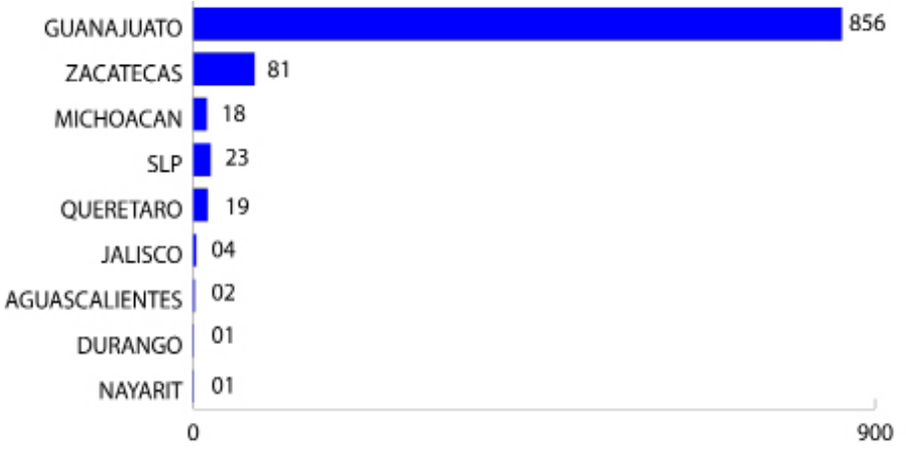

Figure 1. Patients per State (Federative Entity)

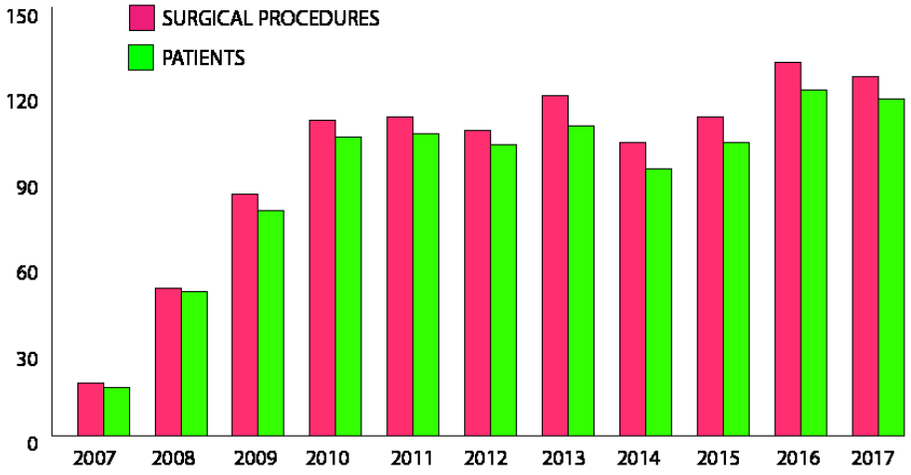

Figure 2. Total number of surgical procedures and patients per year

RESULTS

A total amount of 1,077 surgeries were performed on 1,005 patients, getting an average of 97.9 surgeries per year, with 15.8% being re-operated, corresponding to 171 patients. According to State of origin, there were 856 patients from Guanajuato, 81 from Zacatecas, 23 from San Luis Potosí, 19 from Querétaro, 18 from Michoacán, 4 from Jalisco, 2 from Aguascalientes, 1 from Durango and 1 from Nayarit (**Fig. 1**).

Figure 2 shows the ratio of patients operated on per year, which has progressively increased, remaining over 120 cases in the past 2 years. According to gender, there were 515 male patients and 490 female patients. According to age, the distribution was as follows: 102 under 1 month (10.1%), 304 between 1 and 11 months (30.2%), 406 between 1 and 5 years (40.3%), 128 between 6 and 11 years (12.7) %) and 65 from 12 to 18 years (6.4%) (**Fig. 3**).

Figure 4 shows the number of surgeries according to etiology. The most frequent operation was closure of ventricular septal defect, followed by closure of the ductus arteriosus, aortic coarctation, patent ductus arteriosus, total anomalous connection of pulmonary veins, tetralogy of Fallot, among others.

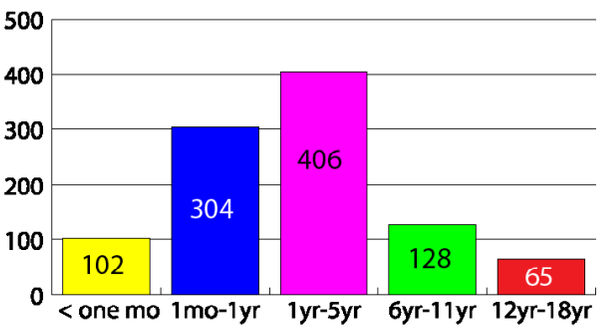

Figure 3. Surgical procedures according to age group

Regarding the distribution by indication of surgery, in 768 patients the operation was as elective, corresponding to 71.3%, and corrective in 808 patients (75%). Extracorporeal circulation was required in 497 patients (46.1%). Our overall mortality was 12.9%, which is detailed in **Figure 5.** Mortality according to surgical risk scales are fully detailed in **Table 1.**

One hundred ninety-three patients were operated on with some malformation syndrome, microdeletion or chromosomopathy. The malformation syndromes considered or detected were VACTERL, CHARGE and Pentalogy of Cantrell. Among the microdeletions were considered 22q11 (DiGeorge), 12q22 (Noonan) and 12q (Holt Oram). The chromosomopathies included were Trisomy 21, 45 XO among others. Of our total population of 1, 005 patients, 145 children have Down Syndrome, 9 with DiGeorge, 5 with Holt Oram, and 5 with Turner Syndrome.

DISCUSSION

In our institution our staff is composed by 6 cardiothoracic surgeons, out of them 2 with specialty in congenital heart disease, 2 perfusionists, 6 cardiovascular anesthesiologists, 1 pediatric hemodynamicist, 3 pediatric cardiologists, 1 of them with high specialty in echocardiography. In 2007, when our hospital began to work there were just two cardiac surgeons, who were in charge of both pediatric as well as adult cardiac surgery, 1 hemodynamicist and 1 pediatric cardiologist. As the volume increased, more human resources were added to the current staff.

Our country México has averaged between 70 to 690 congenital cardiac operations per center and per year [11]. Our center maintains an average of 97 surgeries per year. In our setting, the most common congenital heart disease was ventricular septal defect (20.1%), followed by patent ductus arteriosus (17%), aortic coarctation (11.5%) and atrial septal defect (7.5%). Comparing with other national centers, we found out the same sitiation, although the percentages can

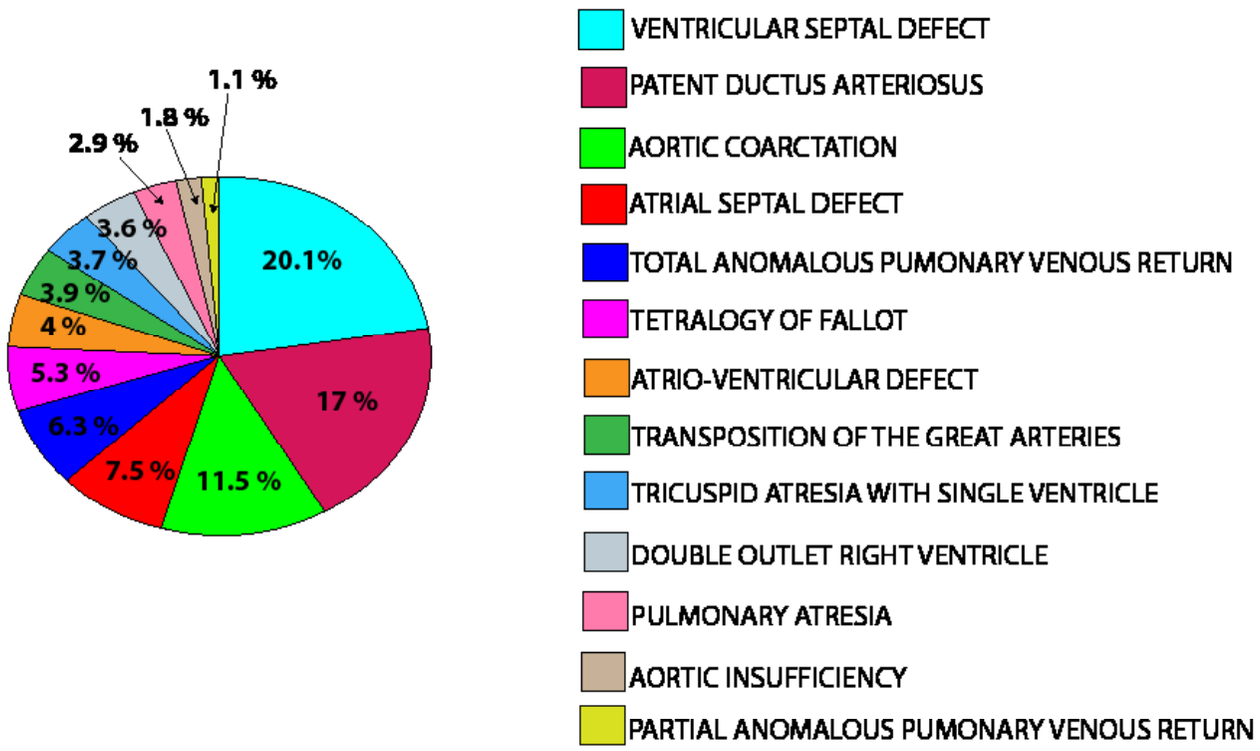

Figure 4. Most frequent congenital heart diseases

be slightly different from one institution to another. All these pathologies are representing the 56.1% of the total amount of pathologies treated in our unit, staying according to the scale of RACHS-1 within the first 3 categories, and only 5% within category 4.

Operations were considered as elective in 71.3%, and corrective in 75%. A total percentage of 46.1% were carried out with extracorporeal circulation. Closure of patent ductus arteriosus, closure of ventricular septal defect, coartectomy, and pulmonary artery banding, all of them represent up to 52.3% of surgeries performed in our surgical center. Categories 1, 2 and 3 of the RACHS scale are the most frequent; however, the highest mortality was observed in patients with RACHS-1: 4.

In 1995, the first study was carried out in the field of pediatric cardiac surgery, which aimed to look for any direct relationship between surgical volume and operative mortality. One group of 2,833 children was included, coming from 37 hospitals in California and Massachusetts. They divided all these aforementioned centers into several groups according to the number of pediatric cardiac surgeries per year; those who performed more than 300 per year, another between 100 and 300, and finally from 10 to 100 surgeries per year. The result was a significant decrease in operative mortality in hospital centers having a greater surgical volume (more than 300) [6]. In 1998, another study was published examining the relationship between the volume of pediatric cardiac surgery, both in hospital and by surgeon, and its relation to in-hospital mortality, which was staged in 16 hospitals in New York. Similarly, it was observed that in hospitals with less than 100 surgeries the mortality was higher (8.26% vs 5.95% of large centers), and as for surgeons, the one with less than 75 surgeries per year had a mortality of 8.77. % vs 5.9% of surgeons with more than 75 surgeries.

Closing down this round of articles, in England a study was conducted including 12 hospitals and found that mortality in children over 1 year was 14.7%, especially in hospitals with low surgical volume, with an average of 40 cases per year [12].

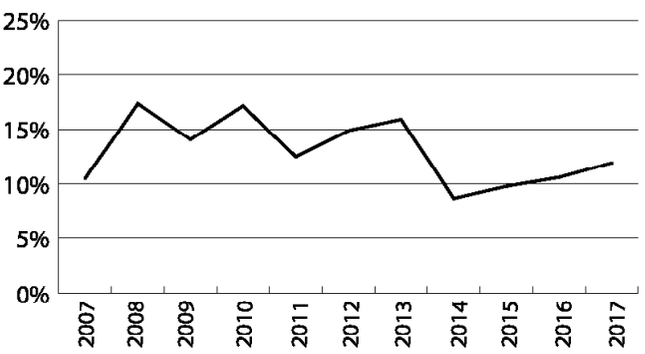

Figure 5. Operative mortality over the years

Table 1. Mortality according to surgical risk scale (RACHS-1)

RACHS-1	1	2	3	4	5	6	N/A
Operated patients	360	314	300	54	0	2	47
Deceased patients	8	31	59	35	0	1	6
	(22%)	(9.8%)	(19.6%)	(64.8%)		(50%)	(12.7%)

According to the EACTS committee, the following recommendations are considered to perform cardiac surgery into a tertiary hospital: i) the minimum number of patients operated per year should be 250; ii) each cardiac surgeon must perform at least a minimum of 3 operations per week and 126 per year; iii) High Specialty hospitals with a volume of operated patients less than 250 per year, can be considered as functional ones as long as their results are similar to those of experienced centers, provided that they fulfil the aforementioned volume [13].

Finally, our overall mortality is 12.9%. Last year operative mortality was 11.9%, still higher than one of the main reference centers in the country (Instituto Nacional de Cardiología Ignacio Chávez), being of 6.1% [13].

At the thought of the great efforts that have to be made, we present herein our information, since the very beginning of our institution, until now through 11 years of experience.

New improvements are getting in our institution to gather better and more competitive personnel, especially focused on imaging analysis, such as topographies and cardiac magnetic resonances. We are on the way forwards.

In addition, the American Academy of Pediatrics emphasizes the need to participate in a regional health network and to maintain an adequate number of cases that allow achieving admissible outcomes. Our center is working as an important reference center for treating this set of children with congenital heart disease. We keep continuing working to strengthen the experience and achieve adequate surgical results in morbidity and mortality. We hope to continue improving to meet the aim of regionalization in Mexico.

Making our best, we are already registered in the global base of the WSPCHS.

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