EPIDEMIOLOGICAL ASPECTS OF CONGENITAL HEART MALFORMATIONS IN CHILDREN AND THEIR IMPLICATIONS IN DEVELOPING A CLINICAL MONITORING REGISTRY

Mariana Puiac (Ciorba)[1], Mihaela Opriş[2], Rodica Toganel[3], Marius Ciorba[4], Horatiu Suciu[5], Klara Brinzaniuc[6]

[1]IOSUD, University of Medicine and Pharmacy, Targu-Mures
[2]Internal Medicine Department, University of Medicine and Pharmacy, Targu-Mures
[3]Pediatrics Department, University of Medicine and Pharmacy, Targu-Mures
[4]1st Internal Medicine Department, University of Medicine and Pharmacy, Targu-Mures
[5]1st Surgery Department, University of Medicine and Pharmacy, Targu-Mures
[6]Anatomy Department, University of Medicine and Pharmacy, Targu-Mures

ABSTRACT

Introduction. With an estimated incidence of 6 cases to 1000 births worldwide, congenital cardiac malformations (CHM) are one of the main causes of death during the first year of life. The main issues regarding CHM management in Romania are the lack of data that describe the true incidence on population level, lack of standardized diagnosis and CHM reporting at national level. In Romania we see only local attempts at establishing such a CHM registry.

Objectives. Measuring and analysing the incidence of CHM in children within the Pediatric Cardiovascular center of the Emergency Cardiovascular and Transplant Institute in Targu Mures (IUBCvT) in order to determine de rate of enrollment, conturing the registration and follow-up form for CHM.

Material and methods. We have conducted a retrospective, descriptive study concerning children discharged between 2008-2013, with a main diagnosis or comorbidity belonging to the category Q20-Q28 (Congenital cardiac malformations – ICD 10 AM), belonging to the Pediatric Cardiovascular center of IUBCvT. The study group was made up of 839 new-borns discharged from the Neonatology clinic of the Mures County Emergency Clinical Hospital (SCJU) and 2181 children discharged from IUBCvT.

Results. The incidence of CHM in new-borns discharged from SCJU varied between 5.23% and 11.47%. Of the total 839 new-borns, 139 underwent surgery in the IUBCvT within the first 30 days of life. The most frequent malformations found were interatrial communication (46.52%), persistent ductus arteriosus (22.10%), interventricular communication (9.04%). Disease group based morbidity within the IUBCvT demonstrates the large share of interventricular communication (20.05%), interatrial communication (15.98%) respectively of persistent ductus arteriosus (13.05%). Of the 1255 children that underwent surgery, the most frequent procedures (17.93%) were conducted for interatrial communication.

Conclusions. Establishing a CHM clinical registry is important for the screening, diagnosing, monitoring of congenital cardiac malformations as well as aiding in choosing the right treatment path.

Keywords: congenital cardiac malformations monitoring, clinical registry, cardiology

ACKNOWLEDGEMENT: This paper is supported by the Sectorial Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the contract number POSDRU/159/1.5/S/133377/

Corresponding author:
Mariana-Anisoara Ciorba, Emergency Institute for Cardiovascular Diseases and Transplantation, 50 Gh. Marinescu Street, Targu-Mures
E-mail: marianaanisoara.ciorba@yahoo.com

INTRODUCTION

Congenital heart malformations (CHM) still represent a challenge for the medical world, due to the frequency with which this pathology is seen in pediatrics and due to the difficulties undergone by the attending physician in the mangement of these cases.

They detain the main part of cardiovascular pathology and represent a major cause of mortality during childhood.

Based on epidemiological data, western countries have established that CHM are a prioritary problem of public health, being 25% of all malformations.

The incidence of CHM in children varies between geographical areas: Africa has the lowest (1.9‰), while Asia hold the highest (9.3‰). In Europe, the incidence of CHM has an estimated insidence of 8.2‰ (1).

The last three decades have represented a substantial leap in the management of CHM, with a reduction of mortality by 39% in western countries and North America. One of the main steps that has lead to this decrease was the lowering of corrective surgery age, with the elaboration of the concept of critical congenital heart malformation (malformation that requires surgical or interventional sanction during the first month of life) (2). Despite this fact, in the same countries, heart malformations are still responsible for around 30% of deaths due to malformations and 5.7% of overall infant mortality, 57% of these deaths occuring in the first month of life (2,3). In Romania we do not hold any information in this regard.

By merging data published by the National School for Public Health, Management and Improvement in the Health Sector in Bucharest and discharges afferent to diagnosis groups characteristic to CHM: F68Z (AR-DRG v.5) or F3090 (RO DRG v.1), also surgery specific to these diagnosis and age group: F03Z, F04A, F04B, F05A, F05B, F06A, F06B, F07A, F07B, F08A, F08B, F09A, F09B (AR-DRG v.5), F1030, F1041, F1042, F 1051, F1052, F1061, F1062, F1071, F1072, F1081, F1082, F1091, F1092 (RO DRG v.1), the incidence of cases discharged with CHM varied between 9.73‰ (2008), 9.64‰ (2009), 8.11‰ (2010), 9.58‰ (2011), 9.9‰ (2012) and 10.02‰ (2013).

MATERIALS AND METHODS

We measured CHM incidence in new-borns by conducting a retrospective study, as an observational epidemiological enquiry, on two groups of patients, by studying the clinical observation charts of 3070 children.

By measuring the incidence and determining the epidemiological characteristics of the two groups we determined the anual enrollement rate at neonatal, cardiological and cardiovascular surgery level, and, also, the follow-up rate needed for the initiation of a Clinical Monitoring Registry.

Inclusion criteria: CHM diagnosis, either main or secondary at admittance. In case of two diagnosis meeting this criteria, the most severe one was chosen (3).

Exclusion criteria: diagnosis of de foramen ovale, prematurity associatind persistent ductur arteriosus, Marfan syndrome, mitral valve prolaps, congenital cardiomyopathies and arithmias.

Patient data collected in Microsoft EXCEL™ represented the initial database from which we extracted the specific information of this study.

Research has conducted with the agreement of the ethics comitees of the Tg. Mures County Emergency Clinical Hospital (CECH) and of the Tg. Mures Emergency Cardiovascular and Transplant Institute (IUBCvT).

The first part of th research was carried out by analysing clinical charts of 839 children born in the maternity ward of the Tg. Mures County Emergency Clinical Hospital between 2008 and 2013.

We need to mention the the CHM diagnosis was set based on a protocol developed in colaboration with the Paediatric Cardiology Clinic of the Tg. Mures Emergency Cardiovascular and Transplant Institute (IUBCvT), which included: clinical examination, blood pressure measuring (on the right arm) by vital signs monitor, cutaneous oxygen saturation (right arm and left foot) by pulsoxymeter attached to the same previous monitor, 12 way ECG and echocardiography (5).

The analisys of the clinical profile of the CHM child, by type and severity of the heart defect, with the highlighting of those surgically corrected, appreciation of follow-up by rate of readmittance, was also done through a retrospective study, a descriptive epidemiological enquiry, on a second group of 2181 children with CHM, hospitalized between 2008-2013, îin the Paediatric Cardiology and Paediatric Cardiovascular surgery departments of IUBCvT, based on the analisys of the 4423 clinical observation charts of the subjects.

RESULTS

During 2008-2013, CHM incidence within the Neonatology clinic varied between 5,23% (2008),

7.32% (2009), 11.47‰ (2010), 7.11% (2011), 7.18% (2012) and 7.47% (2013).

Gender distribution was 51% males and 49% females.

Distribution by different CHM was as follows: 473 with a diagnosis of Q21.1 (atrial septal defect), 94-Q21.0 (ventricular septal defect), 82-Q25.0 (persistent ductus arteriosus), 59-Q20.0 (common arterial trunk), 19-Q20.3 (discordant atrio-ventricular communication), followed by other CHM diagnosis (Table 1).

TABLE 1. *Distribution by different congenital heart malformations*

Diagnosis code ICD 10 AM	Diagnosis name	No. of cases
Q21.1	Atrial septal defect	473
Q21.0	Ventricular septal defect	94
Q25.0	Persistent ductus arteriosus	82
Q20.0	Common arterial trunk	59
Q20.3	Discordant ventrico-auricular communication	19
Q25.1	Aortic isthmus coarctation	14
Q22.8	Other malfomation of the tricusp valve	11
Q21.2	Atrio-ventricular septal defects	9
Others		78

4,05% of children born with CHM between 2008-2013, presented cyanotic cardiac disease, the most severe CHM (4) (Table 2).

TABLE 2. *Distribution by different cyanotic heart disease*

Diagnosis code ICD 10 AM	Diagnosis name	No. of cases
Q22.0	Pulmonary valve atresia	7
Q21.9	Unspecified congenital malformation of a heart septum	6
Q20.4	Double ventricular orifice	5
Q20.8	Other congenital malformations of heart cavities and orifices	5
Q25.5	Pulmonary artery atresia	5
Q26.2	Total aberrant pulmonary venous connection	5
Q25.6	Pulmonary artery stenosis	1

In the Cardiology and Cardiovascular surgery departments, gender distribution showed a higher rate of CHM in females rather than males: 1063 (49%) to 1118 (51%).

Case distribution by main discharge diagnosis showed a high rate of ventricular septal defects (19.3%), atrial septal defects (18.75%) and tetralogy of Fallot (11.55%) (Table 3)

TABLE 3. *Distribution of different congenital heart malformations*

Diagnosis code ICD 10 AM	Diagnosis name	No. of cases
Q21.0	Ventricular septal defect	421
Q21.1	Atrial septal defect	409
Q21.3	Tetralogy of Fallot	252
Q21.2	Atrio-ventricular septal defect	146
Q25.0	Persistent ductus arteriosus	139
Q25.1	Aortic isthmus coarctation	109
Q20.3	Discordant ventrico-auricular communication	97
Q20.1	Double orifice of the right ventricle	80
Q23.0	Congenital aortic valve stenosis	74
Q22.1	Congenital pulmonary valve stenosis	66
Q20.4	Double ventricular orifice	45
Q23.1	Congenital aortic valve insuffieciency	29
Q20.5	Discordant atrioventricular communication	28
Q22.4	Congenital tricusp valve stenosis	26
Q20.0	Common arterial trunk	24
Others		236

Of the 2181 treated cases, 472 (21,64%) represent cyanotic CHM.

In the perspective of age group distribution, we noticed a high number of admittances for patients under 1 year of age (843), with a decreasing tendency towards older age groups, 6-10 yo age group being almost half (379) (Fig. 1).

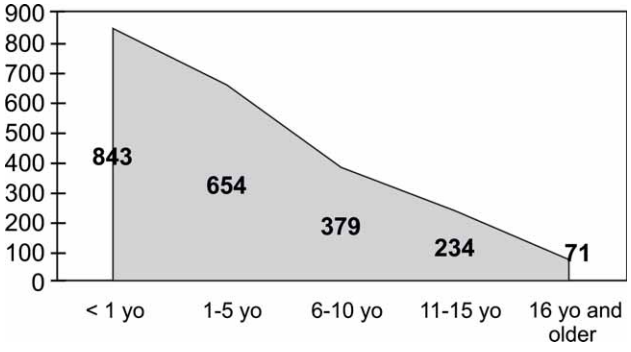

FIGURE 1. *Age group distribution of CHM patients*

In the IUBCvT study group, 1302 patients were admitted a single time, 513 were readmitted once and 366 were admitted multiple times.

Of the 2181 patients, 66 died, 20 in the first month (30%), 51 by the age of 1 year (77%), 12 between 1 and 2 yo (18%) and 10 over 2 yo (15%).

975 patients of the total CHM group underwent adequate corective or palliative surgery: 928 patients underwent a single surgery, 39 two and 8 were operated on 3 times.

Of the 21 children operated right after birth, 12 were diagnosed with cyanotic CHM (57%) Of the children that underwent surgery immediately after birthm 6 died, 3 with a diagnosis of Discordant ventriculo-auricular communication, 2 with Aortic isthmus coarctation and one due to Pulmonary artery stenosis.

27.33% of surgery performed was done for patients under the age od 1 year,14.91% between 1-2 yo 8.3% between 2-3 yo and the rest of 49.57% for ages over 3 years.

The main CHM for which surgery was preformed indicate the preponderance of corrective techniques for atrial septal defect (14.66%), ventricular septal defect (14.08%) and tetralogy of Fallot (11.94%) (Table 4).

TABLE 4. *Distribution of CHM by surgery performed*

Diagnosis code ICD 10 AM	Diagnosis name	No. of cases	Percentage
Q21.1	Atrial septal defect	151	14.66%
Q21.0	Ventricular septal defect	145	14.08%
Q21.3	Tetralogy of Fallot	123	11.94%
Q25.0	Persistent ductus arteriosus	86	8.35%
Q25.1	Aortic isthmus coarctation	82	7.96%
Q20.3	Discordant ventriculo-auricular communication	81	7.86%
Q21.2	Atrio-ventricular septal defect	72	6.99%
Q20.1	Double orifice of the right ventricle	49	4.76%
Q23.0	Congenital aortic valve stenosis	34	3.30%
Q20.4	Double ventricular orifice	23	2.23%
Q22.1	Congenital pulmonary valve stenosis	20	1.94%
Q22.4	Congenital tricusp valve stenosis	18	1.75%
Q22.0	Pulmonary valve atresia	16	1.55%
Q20.5	Discordant atrioventriculara communication	15	1.46%
Q25.6	Pulmonary artery stenosis	13	1.26%
Others		92	10.00%

Of the total surgery performed 157 were for cyanotic congenital disease (15.39%). Out of the 975 operated on, 58 died, the survival rate being 94%. 43 deaths occured in the first year of life (76%), 8 in the second year of life (14%) and 7 at ages ranging 2-11 yo (12%). 44% of the causes of death are represented by cyanotic CHM.

DISCUSSIONS

Congenital heart malformations, the main cause of death in the first year of life, represent a main issue of public health. They are responsible for 6-10% of the total of 20-40% of infant deaths due to congenital malformations (3).

The correct diagnosis and timely surgical treatment represent the only chance of life for these children.

In Romania, a National Clinical Registry for the Monitoring of CHM does not exist, thus the specific mortality and morbidity of these affections cannot be correctly estimated nor the impact on childrens' health (5).

The incidence of congenital malformations, at national level, ranges between 8.1‰ and 10.2‰ of live births, different than data found in published literatue, possibly due to diagnosis protocol and methods (unavailable echocardiography, impossibility or limitation of adressing a paediatric cardiology center) and the tendency of over-coding the discharge diagnosis.

The incidence of CHM in the first group ranged between 3.4‰ and 7.43‰ of live births, similar to data found in literature, that being between 6-8‰ of live births.

We appreciate that CHM rates discharged from the neonatal ward of the CECH are due to the high adressability of the UGON level III maternity ward, integral part of the Paediatric Cardiovascular Center (PCC) of the IUBCvT and do not indicate a real incidence of CHM, but can be orientating towards the nubmer ot enrollments in the Clinical Monitoring of CHM in children Registry (5) at neonatal level.

The most frequent CHM are in over 50% of cases ventricular and atrial septal defects, data concurring with those of the EUROCAT statistics (6), cyanotic CHM with a percentage of 4.05%, being considered first in order of gravity (4).

Critical heart malfomations, defined as those cardiopathies that require surgical intervention by classic methods in the first year of life, represented 27.33%; this percentage is similar to those found in literature, which aproximate critical forms at 25% of all CHM.

The most numerous CHM in the studied group were those noncyanotic, 78.36%, followed by cyanotic malformations (21.64%).

Prevalența MCC pe tipuri de afecțiuni,arată o pondere crescută a cazurilor cu Defect septal ventricular (19,3%), Defect septal ventricular (18.75%) respectiv Tetralogie Fallot (11.55%) indicând defectul septal ventricular ca cea mai frecventă afecțiune, în concordanță cu studiile vizând prevalența MCC în Atlanta, SUA (7.8).

40% of children admitted to IUBCvT underwent surgery. CHM for which surgery was performed

were mostly atrial septal defect (14.66%), ventricular septal defect (14.08%) and tetralogy of Fallot (11.94%), similar to data obtained in Belgium by a study on CHM prevalence on 111.224 new-borns. This study indicates a death rate of 4% consecutive to surgery, with a high rate of interventions for univentricular heart, tetralogy of Fallot, common arterial dukt and transposition of greater vessels. Of the total of surgically treated afflictions, 157 were cyanotic (15.39%).

58 of the 975 patiens died, the survival rate being 94%. 43 deaths occured in the first year of life (76%), 8 in the second year of life (14%) and 7 at ages ranging 2-11 yo (12%). 44% of the causes of death are represented by cyanotic CHM.

CONCLUSIONS

Measuring CHM incidence and prevalence in children, respectively the efficacy and effectiveness of diagnosis and therapeutic methods, represent the first steps in conturing and structuring a National CHM Monitoring Registry.

Presently, in Romania, there are no records of a National CHM Registry for the paediatric population (0-18 yo) and, in consequence, we cannot objectively estimate the scale and impact of this pathology over infant morbidity and mortality indicators, although there have been previous attempts in this respect.

The study allowed for an estimate of the prospective study cohort which will initiate the CHM Clinical Monitoring Registry: an approximate enrollment rate of 130 cases per year at neonatal level, respectively one of 300 cases per year at paediatric cardiology and cardiovascular surgery level.

REFERENCES

1. **Denise van der Linde, MSC, Elisabeth E.M. Konings, BSC, Maarten A. Slager, BSC, Maarten Witsenburg, MD, PHD, Willem A. Helbing, MD, PHD, Johanna J.M. Takkenberg, MD, PHD, Jolien W. Roos-Hesselink, MD, PHD** Rotterdam, the Netherlands Journal of the American College of Cardiology Vol. 58, No. 21.
2. **Schultz A.H., Localio R.A., Clark B.J., Ravishankar C., Videon N., Kimmel S.E.** Epidemiologic features of the presentation of critical congenital heart disease: implications for screening. *Pediatrics,* Apr 2008; 121: 751 - 757.
3. **Wren C., Reinhardt Z., Khawaja K.** Twenty-year trends in diagnosis of life-threatening neonatal cardiovascular malformations. *Arch Dis Child Fetal Neonatal* Ed. 2008; 93(1):3-7.
4. **Julien I. E. Hoffman, Samuel Kaplan.** The Incidence of Congenital eart Disease. Journal of the American College of Cardiology, Vol. 39, No. 12, 2002
5. **Togănel R., Făgărăşan A. Paşc S., şi alţii.** Registrul Regional al Malformaţiilor Cardiace Congenitale, Revista Română de Cardiologie. 2010; 25(4):235-241
6. **Helen Dolk, DrPh; Maria Loane, M.A., Ester Garne, MD,** a European Surveillance of Congenital Anomalies (EUROCAT) Working Group, „Congenital Heart Defects in Europe - Prevalence and Perinatal Mortality, 2000 to 2005", *Circulation.* 2011; 123: 841-849
7. **Bjornard K., Riehle-Colarusso T., Gilboa S.M., Correa A.** Patterns in the prevalence of congenital heart defects, metropolitan Atlanta, 1978 to 2005. *Birth Defects Res Part A Clin Mol Teratol.* 2013; 97(2):87-94.
8. **Oyen N., Poulsen G., Boyd H.A., Wohlfahrt J., Jensen P.K.A., Melbye M.** Recurrence of congenital heart defects in families. *Circulation.* 2009; 120;295-301.
9. **Philip Moons (Philip.Moons@med.kuleuven.be), Thierry Sluysmans, Daniel De Wolf, Martial Massin, Bert Suys, Abraham Benatar, Marc Gewillig.** Congenital heart disease in 111 225 births in Belgium: birth prevalence, treatment and survival in the 21st century. *Acta Pædiatrica* ISSN 0803–5253.
10. **Togănel R., Făgărăşan A. Paşc S., şi alţii.** Registrul Regional al Malformaţiilor Cardiace Congenitale, Revista Română de Cardiologie. 2010; 25(4):235-241