SHIFTS IN INPATIENT TREATMENT PATTERNS FOR CONGENITAL HEART DISEASE BEFORE AND AFTER THE INTRODUCTION OF OPEN - HEART SURGERY AT HANOI MEDICAL UNIVERSITY HOSPITAL (2015 - 2024)

Ngo Thi Hanh[1], Nguyen Lan Hieu[1,2]
Nguyen Lan Anh[1] and Nguyen Thi Minh Ly[1,2,]✉
[1]Hanoi Medical University
[2]Hanoi Medical University Hospital

Congenital heart defect (CHD) refers to structural abnormalities of the heart occurring during fetal development that require diagnosis and treatment regardless of age. Since 2019, the Center of Cardiovascular Diseases at Hanoi Medical University Hospital (HMUH), a leading center for CHD interventional treatment in northern Vietnam, has implemented open-heart surgery, marking a shift in treatment patterns. This study aims to investigate the shifts in the pattern of CHD treatment among inpatients at HMUH from 2015 to 2024 with the introduction of open-heart surgery. A cross-sectional study included 711 inpatients, divided into two phases: Phase 1 (2015 – 2019), pre-surgery (235 patients); Phase 2 (2019 – 2024), post- surgery (476 patients). In Phase 2, the mean age of patients increased significantly (34.6 ± 19.7 years old vs. 27.1 ± 20.7 years old, p < 0.001). The proportions of CHD types demonstrated a significant shift, with more atrial septal defect (ASD) (64.9% vs. 51.1%), fewer proportion of ventricular septal defect (VSD) (5.9% vs. 17%), and the emergence of complex anomalies, including atrioventricular septal defect (AVSD), tetralogy of Fallot (ToF), and coarctation of the aorta (CoA) (p < 0.001). Regarding treatment approach, 41 patients (8.6%) underwent surgical repair, and 3 patients (0.7%) received hybrid intervention. The treatment success rate declined slightly (88.9% vs.93.6%), while complications and residual shunts increased (p < 0.05). Overall, open-heart surgery expanded treatment capacity and altered CHD patterns at HMUH.

Keywords: Congenital heart disease, open-heart surgery, treatment pattern.

I. INTRODUCTION

According to the American Heart Association, CHD is defined as a malformation of the heart or great vessels present at birth, which may be diagnosed afterwards.[1] CHD is the most common birth defect, with a global prevalence of approximately 9 per 1,000 live births, showing significant geographical variation.[2] Due to advances in diagnostics, surgery, and intervention over the past decade, more than 90% of children with CHD reach adulthood.[3]

Corresponding author: Nguyen Thi Minh Ly
Hanoi Medical University
Email: minhly.ng@gmail.com
Received: 03/09/2025
Accepted: 08/10/2025

In recent decades, the treatment approach for CHD has undergone a significant shift. A study by Farooqi et al., conducted in the UK and Ireland involving 40,000 CHD patients, demonstrated that the proportion of transcatheter procedures (closure of ASD, VSD, patent ductus arteriosus (PDA)) surpassed surgical repair in 2003 - 2004, due to their minimally invasive nature and high efficacy.[4] However, for complex anomalies such as AVSD and ToF, or in cases of failed transcatheter procedures, surgical repair remains essential and irreplaceable.[5] In developing countries, including Vietnam, access to and treatment of CHD have been limited due to shortages of human resources, equipment, and specialized cardiac surgery centers. The management of CHD largely depends on the capacity of each healthcare facility, involving either catheter-based interventions or surgery. Ideally, the facility should be equipped to provide both modalities, enabling comprehensive defect correction and expanding the overall capacity for CHD treatment.

The Center for Cardiovascular Diseases at HMUH has been operating since 2010, initially providing medical and interventional treatments. In late 2019, the Center introduced open-heart surgery, enabling the delivery of comprehensive treatment for CHD.[6] However, no statistical study has evaluated CHD treatment patterns at HMUH before and after the introduction of open-heart surgery. Therefore, this study was conducted to investigate the CHD treatment patterns involving catheter-based and/or surgical procedures at HMUH over a 10-years period (2015–2024).

II. MATERIALS AND METHODS

1. Subjects

Study of patients who underwent interventional and/or surgical repair of CHD defects at the Center for Cardiovascular Diseases at HMUH from January 2015 to December 2024.

2. Methods

This is a cross-sectional descriptive study using data collected from the medical records of patients with CHD at HMUH. Participants' information was anonymized and kept confidential, with coded data securely stored following hospital guidelines. Data were collected from all medical records between January 2015 and December 2024. Inclusion criteria included all CHD patients who underwent surgical and/or catheter-based interventions. Exclusion criteria were CHD patients who were ineligible for surgery or catheter-based intervention, or those who required only medical management. Based on these criteria, a total of 711 CHD patients were included in the study.

Variables

The primary variable was the diagnosis of CHD, confirmed by Doppler echocardiography upon admission or before inpatient repair treatment. Final diagnoses for surgical patients were based on operative reports, while those for catheter-based interventions relied on procedural reports. Additional variables were extracted from medical records.

Data collection methods

The research team coordinated with HMUH to finalize data collection procedures. Following hospital approval, medical records were retrieved from both paper-based and electronic systems. Resident physicians on the team collected and verified data for accuracy and completeness. Records with errors or incomplete information were excluded from the study.

Statistical Analyses

Data was analyzed using SPSS software version 22.0. Qualitative variables were presented as frequencies and percentages, while quantitative variables were expressed as mean ± standard deviation. Comparisons before and after surgery were performed using the Chi-square test or Fisher's Exact test for qualitative variables, and the independent T-test or Mann–Whitney U test for quantitative variables, depending on data distribution. Statistical significance was set at $p < 0.05$.

3. Research ethics

Participants were informed about the study objectives contents, and voluntarily agreed to participate. They retained the right to withdraw at any time without discrimination or impact on their treatment. Patient information was coded to ensure confidentiality and used solely for research purposes. The study involved no intervention that could adversely affect the health of participants.

Study limitations

This was a cross-sectional study comparing two temporal phases; therefore, causal inferences regarding the introduction of open-heart surgery cannot be firmly established. Patients who received only medical therapy or were deemed ineligible for intervention were excluded, which may underestimate the prevalence and outcomes of more severe CHD. Some changes (e.g., ToF, AVSD) were based on small numbers, and the lack of confidence intervals limits effect size interpretation.

III. RESULTS

1. Demographics

Among the 711 patients included in the study, 235 (33.1%) were in Phase 1 (before the implementation of open-heart surgery) and 476 (66.9%) were in Phase 2 (after the implementation of open-heart surgery). The mean age was 32.1 ± 20.34 years old, with the oldest patient being 79 years old and the youngest 5 months old.

Females predominated in the study population (70.9%). The mean age of patients in Phase 2 was significantly higher than in Phase 1 (34.6 ± 19.7 vs. 27.1 ± 20.7; $p < 0.001$). Analysis by age group indicated a substantial increase in the proportion of patients aged ≥18 years old in Phase 2 (51.6% vs. 19.8%; $p < 0.001$). Additionally, the proportion of patients from rural and mountainous areas increased from 18.8% to 42.8% in Phase 2 ($p = 0.008$). Ethnic minority patients were first represented in Phase 2 (3.5% vs. 0%; $p < 0.001$).

Table 1. Demographics of CHD patients in Phase 1 and Phase 2

	Phase 1, n (%)/ Mean ± SD	Phase 2, n (%)/ Mean ± SD	Total, n (%)/ Mean ± SD	p-value
Gender			711 (100)	0.248
Male	75 (10.5)	132 (18.6)	207 (29.1)	
Female	160 (22.5)	344 (48.4)	504 (70.9)	
Mean Age	27.1 ± 20.7	34.6 ± 19.7	32.1 ± 20.3	< 0.001
Male			28.3 ± 20.8	
Female			33.7 ± 19.9	
Age Group				< 0.001
≤ 6 years old	56 (7.9)	62 (8.7)	118 (16.6)	
6-18 years old	38 (5.3)	47 (6.6)	85 (12)	
≥ 18 years old	141 (19.8)	367 (51.6)	508 (71.4)	
Total	235 (33)	476 (67)	711 (100)	

	Phase 1, n (%)/ Mean ± SD	Phase 2, n (%)/ Mean ± SD	Total, n (%)/ Mean ± SD	p-value
Residence				0.008
Urban	101 (14.2)	162 (22.8)	263 (37)	
Rural	134 (18.8)	304 (42.8)	438 (61.1)	
Mountainous	0 (0)	10 (1.4)	10 (1.4)	
Ethnicity				< 0.001
Kinh	235 (33.1)	451 (63.4)	686 (96.5)	
Minority	0 (0)	25 (3.5)	25 (3.5)	

2. Treatment approaches and patterns of CHD in Phase 1 and Phase 2

Chart 1 shows that interventional procedures were the predominant treatment, accounting for 81.6% of cases. The proportion of interventional procedures increased from 7.6% in 2015, peaked at 19.6% in 2023, and slightly decreased to 18% in 2024. Surgical treatment first appeared in 2020, representing 9.5% of cases, increased to 19% in 2021, and remained relatively stable over the following four years. Hybrid intervention (combination of surgical and interventional techniques) emerged in 2020 and continued through 2022, with one patient treated per year; no additional hybrid interventions were recorded from 2023 onward, accounting for only 0.7% of patients treated in Phase 2.

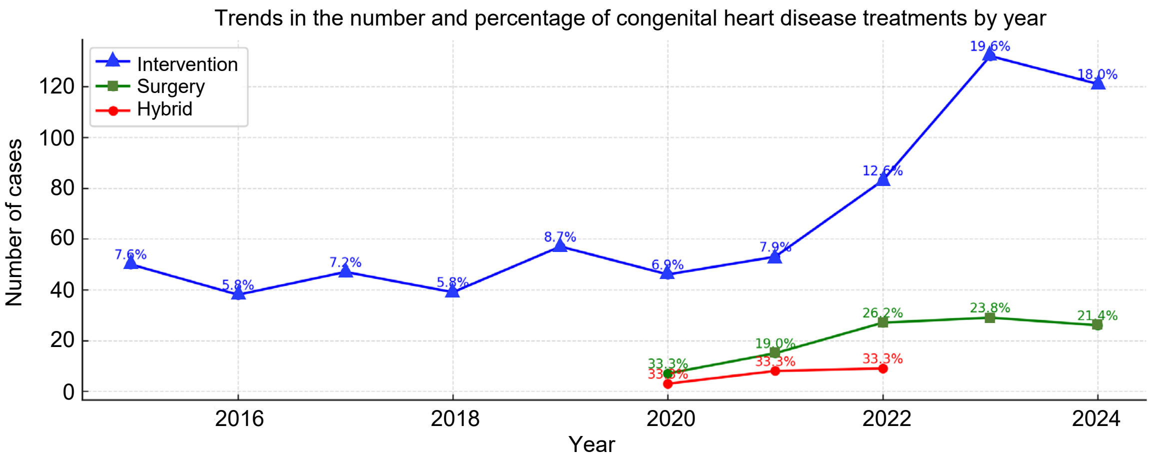

Chart 1. Annual trends in CHD treatment approach

Table 2 summarizes the three most common CHDs treated by interventional and/or surgical technique, including: ASD, 60.3%, VSD, 19.3%, and PDA, 9.6%, collectively accounting for 89.2% of cases. Significant changes were observed between Phase 1 and Phase 2 ($p < 0.001$): the proportion of ASD increased from 51.1% to 64.9%, while PDA decreased from 17% to 5.8%. More complex defects, including ToF and AVSD, and CoA, began to emerge in Phase 2. The proportion of patients with combined CHDs slightly increased from 3% to 3.6%.

Table 2. Patterns of CHD in Phase 1 and Phase 2

CHD	Phase 1 n (%)	Phase 2 n (%)	Sum n (%)
ASD	120 (51.1)	309 (64.9)	429 (60.3)
VENTRICULAR SEPTAL DEFECT	40 (17.0)	28 (5.9)	68 (9.6)
PDA	47 (20)	80 (18.9)	137 (19.3)
PVS	14 (6)	17 (3.6)	31 (4.4)
CoA	0 (0)	1 (0.2)	1 (0.1)
PFO	2 (0.9)	4 (0.8)	6 (0.8)
CAF	5 (2.1)	3 (0.6)	8 (1.1)
ToF	0 (0)	2 (0.4)	2 (0.3)
AVSD	0 (0)	5 (1.1)	5 (0.7)
Combined CHDs	7 (3)	17 (3.6)	24 (3.4)
Total	235 (100)	476 (100)	711 (100)

CHD, congenital heart disease; ASD, atrial septal defect; VSD, ventricular septal defect; PDA, patent ductus arteriosus; PVS, pulmonary valve stenosis; CoA, coarctation of the aorter; PFO, patent foramen ovale; CAF, coronary artery fistula; ToF, tetralogy of Fallot; AVSD, Atrioventricular septal defect

3. Treatment Outcomes

Treatment outcomes differed significantly between Phase 1 and Phase 2 (p = 0.036). While most patients achieved favorable outcomes in both phases, this proportion decreased slightly following the introduction of surgery, from 93.6% to 88.9%. The rate of complications exhibited an upward trend, increasing from 0.8% to 2.5% in Phase 2, with the most common complications shown in Chart 2. Furthermore, the incidence of residual shunts rose significantly from 5.5% to 7.7%.

Table 3. Treatment outcomes in Phase 1 and Phase 2

Treatment outcomes	Phase 1 n (%)	Phase 2 n (%)
Successful treatment	218 (93.6)	425 (88.9)
Complications	2 (0.8)	14 (2.9)
Residual Shunt	13 (5.5)	37 (7.7)
Unsuccessful treatment	0 (0)	2 (0.5)
Mortality	0 (0)	0 (0)

Chart 2 shows that in Phase 1, only three patients experienced complications, accounting for 0.8% of cases. These included one patient with arrhythmia, one with hematuria, and one with heart failure following intervention. In Phase 2, the complication rate increased to 2.9%, comprising 13 events, of which arrhythmia accounted for 9 out of 13 cases.

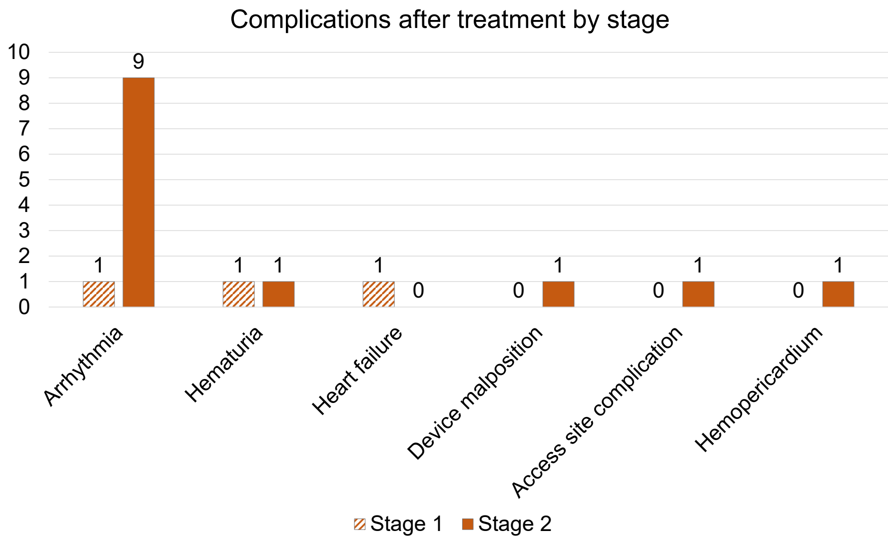

Chart 2. Treatment complications in Phase 1 and Phase 2

IV. DISCUSSION

This study represents the first investigation at HMUH examining patterns of inpatient treatment for CHD. Over the 10-years study period, notable changes were observed in both CHD treatment approaches and CHD types, including an increase in the number of treated cases, shifts in the distribution of CHD types, the emergence of more complex defects receiving treatment, and the introduction of hybrid intervention approaches for CHD repair.

The mean age of patients increased significantly from 27.1 ± 20.7 to 34.6 ± 19.7 years old ($p < 0.001$), with a marked rise in the proportion of patients aged ≥ 18 years old (from 19.8% to 51.6%). This is consistent with Marelli et al., whose study reported that adults with ACHD account for 54% – 66% of cases.[7] This trend aligns with findings from Vietnam, which demonstrate that adult CHD patients are increasingly diagnosed and treated due to improvement in diagnostic capabilities and treatment indications, with females predominating (70.9% vs. 29.1% males).[8] Furthermore, because the Center primarily treats adult patients including CHD, the average age in this study is relatively higher compared with the study by Marelli et al., where the mean patient age was 11 years old in 1985 and 17 years old in 2000.[9] Patients undergoing interventional and surgical treatment were predominantly of Kinh ethnicity (96.5%) and originated from urban and rural areas (98.6%), where healthcare services are more accessible. Patients from mountainous regions and ethnic minority groups only began receiving treatment following the implementation of open-heart surgery, highlighting the improved accessibility of care for severe cases from remote areas. This trend aligns with reports from India, where tertiary cardiovascular centers have expanded access to patients from underserved areas following the implementation of open-heart surgery.[10]

ASD (60.3%), VSD (9.6%), and PDA (19.3%) were the most frequently treated CHDs by interventional and/or surgical techniques at HMUH, which is consistent with previous studies from the UK, Ireland [4] and Denmark.[11] The predominance of ASD also aligns with earlier research in Vietnam by Tuan et al. (15 – 31.9%).[12] Following the introduction of surgical techniques, more complex CHDs, including ToF (0.4%), AVSD (1.2%), and combined CHDs (3.6%), were documented, reflecting the expansion of both procedural capabilities and treatment indications. The emergence of surgical and hybrid interventions since 2020 demonstrates the center's efforts to adopt advanced treatment modalities, particularly for patients with complex, high-risk defects. After the implementation of surgery, the number of surgical cases remained stable; however, interventional procedures increased markedly, consistent with reports from the UK and Ireland.[4] CHD patients have treatment indications; they tend to choose hospitals that can offer both surgical and interventional therapies so their defects can be treated by either method. This partly explains why the number of CHD cases treated at HMUH doubled during the latter 5-years phase. Although hybrid procedures accounted for a small proportion (0.7%), they represent a potential area for future development as the center continues to enhance its technical capacity, given their crucial value in cases of failed interventions. The proportion of hybrid procedures in this study was lower than that reported by Varrica et al., who observed a rate of 1.2% over a 13-year follow-up at their center.[5]

Treatment outcomes were generally favorable, aligning with findings by Hung et al. at the Vietnam National Heart Institute. Naturally, as more cases were treated, particularly those with complex lesions, the success rate tended to decrease, and complications increased. With a success rate of up to 93.6% and a slight decrease to 88.9% after the introduction of the surgical technique. The overall complication rate demonstrated a modest increase from 0.8% to 2.9%, with the most common adverse events being arrhythmia, heart failure, and device migration. In Phase 2, three interventions were unsuccessful: one case of large secundum ASD associated with septal aneurysm, one case of large VSD with a high-pressure gradient, and one case of ASD complicated by immediate post-closure device migration, which was managed immediately by surgical repair (accounting for 0.7% of cases). The incidence of residual shunt rose from 5.5% to 7.7% ($p = 0.036$), likely due to the increased proportion of technically challenging and complex cases in the latter phase.

Our hospital is a general hospital that provides care mostly for adults; therefore, most of our CHD patients were adults (ACDH). Unlike CHD in children, ACHD patients often present with residual lesions, arrhythmias, and age-related comorbidities. Secundum ASD is the most frequent diagnosis in adults, whereas complex duct-dependent lesions are typically seen in childhood. Therefore, management in ACHD requires not only repair of structural defects but also lifelong surveillance for arrhythmia, pulmonary vascular disease, and complications of prior interventions, as emphasized in recent ESC and AHA/ACC guidelines.[13,14]

Our study indicates that in HMUH, interventional procedures have remained the predominant treatment for simple left-to-right shunt, both before and after the introduction of open-heart surgery. After the introduction of open-heart surgery, only 10.18% of patients with CHD undergoing definitive treatment received surgery. The establishment of a surgical program is an important milestone, providing options for complex lesions beyond catheter-based techniques, but it complements rather than replaces interventions. As highlighted in a recent study from Korea by Jae Sung Son et al., the importance of interventional procedures in the management of simple CHD was emphasized.[15]

V. CONCLUSION

Our study identified a shift in the treatment pattern of CHD at HMUH over 10 years (2015–2024), across two phases: before and after the introduction of open-heart surgery. The treatment capacity doubled in the latter phase, with interventional repair remaining the predominant approach. Notably, complex CHD cases emerged and were successfully treated. Hybrid intervention, a combination of interventional and surgical techniques, was employed in cases where interventions failed or when both techniques were required concurrently to complete defect closure. These findings highlight the rationale and effectiveness of developing CHD centers that integrate both interventional and surgical techniques alongside medical management.

REFERENCES

1. American Heart Association. About Congenital Heart Defects [Internet]. Dallas (TX): American Heart Association; 2025. Available from: https://www.heart.org/en/health-topics/congenital-heart-defects/about-congenital-heart-defects

2. Van der Linde D, Konings EE, Slager MA, et al. Birth Prevalence of Congenital Heart Disease Worldwide. *JACC*. 2011 Nov 15;58(21):2241-7.

3. Moons P, Bovijn L, Budts W, et al. Temporal Trends in Survival to Adulthood Among Patients Born With Congenital Heart Disease From 1970 to 1992 in Belgium. *Circulation*. 2010 Nov 30;122(22):2264-72.

4. Farooqi M, Stickley J, Dhillon R, et al. Trends in surgical and catheter interventions for isolated congenital shunt lesions in the UK and Ireland. *Heart*. 2019 July;105(14):1103-8.

5. Varrica A, Lo Rito M, Generali T, et al. Surgical rescue after transcatheter interventional procedures in congenital heart disease patients: an existing problem. *EuroIntervention*. 2017 Feb 20;12(14):1724-9.

6. Vu Ngoc Tu. Surgical management of congenital heart disease in adults. *Journal of Medical Research*. 2022 Jun 1;153(5):49-58.

7. Marelli AJ, Ionescu-Ittu R, Mackie AS, et al. Lifetime Prevalence of Congenital Heart Disease in the General Population From 2000 to 2010. *Circulation*. 2014 Aug 26;130(9):749-56.

8. Le Xuan Hung, Nguyen Thi Hoa, Kim Ngoc Thanh, et al. Tinh hinh benh tim bam sinh nguoi lon dieu tri noi tru tai Vien Tim mach Viet Nam giai doan 2018 - 2020. *Journal of Vietnamese Cardiology*. 2022 Sept 1;(101):30-6.

9. Marelli AJ, Mackie AS, Ionescu-Ittu R, et al. Congenital Heart Disease in the General Population. *Circulation*. 2007 Jan 16;115(2):163-72.

10. Iyer KS, Sivalingam S. Congenital heart disease in low- and middle-income countries: can India show the way? *Indian J Thorac Cardiovasc Surg*. 2025 June 1;41(6):657-63.

11. Larsen SH, Olsen M, Emmertsen K, et al. Interventional Treatment of Patients With Congenital Heart Disease. *Journal of the American College of Cardiology*. 2017 June 6;69(22):2725-32.

12. Xuan Tuan H, The Phuoc Long P, Duy

Kien V, et al. Trends in the Prevalence of Atrial Septal Defect and Its Associated Factors among Congenital Heart Disease Patients in Vietnam. *Journal of Cardiovascular Development and Disease*. 2020 Mar;7(1):2.

13. 2020 ESC Guidelines for the management of adult congenital heart disease. European Heart Journal. Oxford Academic. Accessed July 23, 2024. https://academic.oup.com/eurheartj/article/42/6/563/5898606

14. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. 2019;73(12):1494-1563. doi:10.1016/j.jacc.2018.08.1028

15. Son JS, Kim SJ, Ha KS, et al. Population-Based Study on Epidemiological Trends in Interventions for Congenital Heart Disease in Korea Using Nationwide Big Data. *Journal of Interventional Cardiology*. 2025;2025(1):8815137. doi:10.1155/joic/8815137