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# Epidemiological, Clinical Progress Aspects of Congenital Heart Disease with Neonatal Revelation at the Mother-Child Hospital of Bingerville (HME) Concerning 98 Cases from January 2021 to December 2022 (Côte d'Ivoire)

**Adja Evelyne Akaffou-Gbery[1], Richard Azagoh-Kouadio[2*], Anne-Lise Laetitia Mobio[1], Jean-Jacques Yao Atteby[1], Serenah Marie Janice N'vrah Anoh[2], Kouassi Raoul Yao[1]**

[1]Department of Paediatrics and Neonatology, Hôpital Mère-Enfant de Bingerville (HME), Bingerville, Côte d'Ivoire
[2]Department of Medical Pediatrics and Specialties, CHU de Angré, Abidjan, Côte d'Ivoire
Email: eakaf@yahoo.fr, *azagoh.richard@gmail.com, lettice.mobio@gmail.com, attebyjj@yahoo.fr, serenanoh15@gmail.com, raoul.kouassi@hme.ci

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## Abstract

**Introduction** The distribution of congenital heart disease (CHD) in sub-Saharan Africa is highly imprecise and varies from one region to another due to the inequality of diagnostic facilities. The aim of this study was to determine the in-hospital prevalence of congenital heart disease in children at the Mother-Child hospital of Bingerville (HME) by specifying the diagnostic, therapeutic and evolutionary aspects. **Materials and methods** We conducted a retrospective, descriptive, cross-sectional study at HME of Bingerville from January 2021 to December 2022. All newborns with congenital heart disease confirmed by echocardiography were included in the study. **Results** Of 656 admissions to the neonatology department over the study period, congenital heart disease accounted for 14.9% (98/656) of cases. In our series, 76.7% were diagnosed before the 1st week of life, with a mean chronological age of 5.18 days and extremes of 0 and 46 days. There were as many male patients (50%) as female (50%), *i.e.* a sex ratio of 1. These newborns were premature in 60.2% of cases, with a mean and median gestational age of 34 weeks' amenorrhea. Most were left-right shunts (90.8%). Persistent ductus arteriosus (PDA) (48.9%) predominated, followed by atrial septal defect (38.7%), ventricular septal defect (13.3%), common trunk artery (CTA) (3.1%) and open septal pulmonary atresia (OSPA) (1%) as the primary cyanogenic heart disease. Pulmonary arterial hypertension (PAH) (50%) was primary in 38.8% and secondary (61.2%). The mortality rate was 30.6%, and all CTA patients

died (100%), with a significant statistical relationship (p = 0.027). Progression under treatment was marked by clinical stabilization (68/98) in 69.4% of cases. **Conclusion:** Congenital heart disease is relatively common at the Bingerville HME. Access to echocardiography should be facilitated in neonatology departments for rapid diagnosis and optimal management of congenital heart disease in newborns.

## Keywords

Newborn, Congenital Heart Disease, Côte d'Ivoire

## 1. Introduction

Congenital heart disease (CHD) is the most common congenital malformation [1], and the second most common cause of death in the first year of life after infectious diseases [2]. They may be defined as the malformations of the heart and/or vessels present at birth in relation to a developmental anomaly. They also include the malformations linked to the abnormal persistence after birth of structures normally present during the fetal life [3]. The distribution of congenital heart disease (CHD) in Black African is highly imprecise and varies from region to region due to the inequality of diagnostic facilities and the very limited medico-surgical management available in different countries [4] [5].

In 2018, a multicentre hospital analysis of congenital heart disease in Côte d'Ivoire revealed a hospital prevalence of 2.3‰ admissions with delayed diagnosis, before the age of 2 years, in 96.4% at the time of respiratory difficulty [6].

It is well known in Côte d'Ivoire, the Mother-Child hospital of Bingerville (HME) has seen several cases of respiratory distress in the neonatal period, or isolated cyanosis in newborns and infants raising the suspicions of congenital heart disease.

Private paediatric cardiology consultations at the hospital have made it possible to diagnose them, thanks to the acquisition of an echocardiograph available at the HME which is the reference instrument for CHD screening [7] [8]. However, no studies of congenital heart disease have been carried out at that hospital. This prompted the present study with the aim to identify cases of congenital heart disease diagnosed and managed at the HME in the neonatal period over a two-year period (2021-2022).

## 2. Materials and Methods

This was a retrospective, descriptive and cross-sectional study at HME of Bingerville from January 1, 2021 to December 31, 2022. All newborns with congenital heart disease confirmed by echocardiography coupled with a Doppler (General Electrique VIVID-T9 cardiovascular ultrasound machine (GE 7S probe frequency 3 to 8 MHZ)®) were included in the study. Not included in the study were neonates with only *foramen ovale* a suspected congenital heart disease un-

confirmed by Echocardiography coupled with Doppler, or non-congenital heart disease by echocardiography in neonates. All included neonates underwent a cardiovascular clinical examination, a cardiac exploration with an electrocardiogram, a chest radiography and an Echocardiography-Doppler. The ultrasound exploration was performed at the HME of Bingerville using the brand General Electrique VIVID-T9 cardiovascular ultrasound machine (GE 7S probe, frequency 3 to 8 MHZ)®. The request of other para-clinical examinations depended on the etiological orientation. Given the low prevalence of 0.8%, we did not apply the calculation formula to determine our sample size. Thus, the sample size was made up of with all the files collected during the defined study period.

Data were collected from the patient records. The following information's were retrieved: age at admission, age at diagnosis, sex, clinical features, results of complementary examinations, type of heart disease, type of treatment and the clinical progress. These data were processed and analyzed using Microsoft Word 2019, Microsoft Excel 2019 and Epi info 3.1. The Chi-square statistical test was used to analyze quantitative variables, and a $p < 0.05$ value was considered as significant.

In the present study, the heart disease was classified as congenital if the symptomatology had been evolving since birth and could be classified in one of the following four groups: left-right shunt, right-left shunt, ventricular ejection obstruction, complex heart disease.

A newborn could be admitted to the neonatology unit either from outside (out-born) via the pediatric emergency department straight from home or a referral center or from the outpatient department or from inside (in-born) directly from the delivery room or via the obstetrics department nursery. In neonatal hospitalization unit, at arrival the patient is warmly welcomed by a neonatal assistant nurse's, who then proceeded to the settlement of the patient after cleaning the baby. Thereafter, the resident neonatologist visited the patient. If a cardiac ultrasound was requested, it was then forwarded to the outpatients' secretariat who passed it on to the attending cardiologist. The requested imaging test is carried out at the patient's bedside. The report is made available to the resident neonatologist, who in the event of any abnormalities detected issued a request for a cardiology consultation to initiate the treatment or specific management of the cardiac pathology. In the case of a primary pulmonary hypertension with a PAPS greater than 40 mmHg, a treatment with Bosentan (*endothelin receptor antagonists*) 62.5 mg (oral tablet) at a rate of a quarter of a tablet in a single dose was instituted, with monitoring every 15 days until discharged from hospital. Occasionally, diuretics, notably Aldactone (*Spironolactone*) 50 mg (oral tablet), one quarter twice daily, were combined. Outpatient follow-up with a cardiologist was recommended at the end of hospitalization.

In case of left-right shunt, a simple monitoring with re-evaluation ultrasound to be performed within an average of 01 month was prescribed. However, in the event of associated heart failure or significant pulmonary leakage, digito-diuretic therapy was prescribed.

## 3. Results

**• In-hospital prevalence of congenital heart disease in newborns at Mother-Child hospital of Bingerville (HME)**

Over the study period, 656 newborn admissions were observed in the neonatology department of the HME. Among these, we recorded 98 cases of congenital heart disease, representing a prevalence of 14.9%. These newborns were premature in 60.2% of cases and born at term in 39.8%.

**• Sex ratio and mean age of congenital heart disease at Mother-Child hospital of Bingerville (HME)**

There were as many male (50%) as female (50%) newborns, with a sex ratio of 1 (Table 1). The mean age of congenital heart disease was 5.18 days, with extremes of 0 and 46 days. Diagnosis was made before the 1st week of life (0 to 6 days) in 76.7% of cases. More than half (60.2%) of our patients were premature with a gestational age of less than 37 weeks' amenorrhea (Table 1), with a mean and median gestational age of 34 weeks' amenorrhea.

**• Prenatal and postnatal characteristics of congenital heart disease at the Mother-Child hospital of Bingerville (HME)**

The mothers were between 30 and 39 years of age in 67.3% of cases, with an average age of 31 years and extremes of 15 and 42 years. The various prenatal serological tests were inadequately performed in most of the mothers of children with CC. Rubella serology was positive in 1% of cases when it was performed. The newborns had been exposed during pregnancy to HIV, alcohol and heroin

Table 1. Distribution of newborns according to socio-demographic and clinical characteristics.

| Parameter | Variable | Effectifs (n = 98) | Percentage |
|---|---|---|---|
| Sex | Male | 49 | 50 |
| | Female | 49 | 50 |
| Newborn | Premature | 59 | 60.2 |
| | Born at term | 39 | 39.8 |
| Trophicity | Eutrophic | 54 | 55.1 |
| | Macrosomic | 10 | 10.2 |
| | Hypotrophic | 34 | 34.7 |
| Circumstances of discovery | Antenatal | 0 | 0 |
| | Postnatal | 100 | 100 |
| Admission weight | <1000 g | 2 | 2.0 |
| | 1000 - 1499 | 19 | 19.4 |
| | 1500 - 2499 | 41 | 41.8 |
| | 2500 - 3499 | 23 | 23.5 |
| | 3500 - 3999 | 7 | 7.1 |
| | ≥4000 | 6 | 6.1 |

respectively in 1% of cases. In 75% of cases, the mothers of these newborns had no chronic pathologies while 25% of them had. Sickle-cell anemia, gestational hypertension, gestational diabetes, asthma and breast cancer were present in 9.2%, 7.1%, 5.7%, 2% and 1% of cases respectively.

These newborns were eutrophic (55.1%), hypotrophic (34.7%) and macrosomic (10.2%). The newborns had an average weight of 2296 g on admission, with extremes of 855 g and 4830 g (Table 1).

**• Circumstances of discovery of congenital heart disease at at the Mother-Child hospital of Bingerville**

All these congenital heart diseases were discovered in the post-natal period (100%). Respiratory distress (42.8%) was by far the first functional sign of neonatal CC at HME of Bingerville, while heart murmur (11.2%) was the main physical sign observed. Cyanosis was found in only 9.2% of cases.

**• Mechanisms of congenital heart disease and main clinical pictures**

The main anatomo-physiopathological mechanisms of congenital heart disease in newborns were: a left-right shunt (90.8% of non-cyanogenic heart disease) and a right-left shunt (9.2%). Pulmonary arterial hypertension (PAH) (50%) leads the way followed by patent ductus arteriosus (PDA) (48.9%), atrial septal defect (ASD) (38.7%), ventricular septal defect (VSD) (13, 3%), common trunk artery (CTA) (3.1%) as the first cyanogenic heart disease, double outlet right ventricle (DORV) (1%) and open septal pulmonary atresia (OSPA) (1%). The mean time to Echocardiography-Doppler was 3 days in hospitalization, with extremes of 0 and 46 days. And 93.1% of in-born HME neonates had an echocardiographic diagnosis within the first week. Here, the diagnosis within less than 7 days was statistically related to in-born origin (p = 0.002) (Table 2).

**• Surgical co-morbidities of neonatal congenital heart disease**

The most frequently encountered are esophageal atresia (20%), unruptured omphalocele (16%), duodenal atresia (12%), inguino-scrotal hernia (12%) and anal imperforation (12%).

**• Medical pathologies associated with congenital heart disease at Mother-Child hospital of Bingerville**

Neonatal bacterial infection (76.5%) was the pathology most associated with CC in newborns, followed by neonatal hypoxo-ischemic encephalopathy (14.3%)

Table 2. Cross-tabulation between origin and age at diagnosis.

| | | Age at diagnosis | | p |
|---|---|---|---|---|
| | | ≤7 Days | >7 Days | |
| **Origin** | In-born babies | 54 | 4 | 0.002 |
| | | 93.1% | 6.9% | |
| | Out-born babies | 28 | 12 | |
| | | 70.0% | 30.0% | |

and neonatal malaria in 4.1% of cases. 12.2% of these newborns were free of associated pathologies. A malformative assessment was requested in 51% of cases that highlighted associated cerebral, digestive, abdominal, urogenital or musculoskeletal malformations.

• **Therapeutic and progress aspects of congenital heart disease at Mother-Child hospital of Bingerville**

Therapeutic abstention was applied in 81% of cases. However, in cases of associated heart failure or significant pulmonary leakage, digito-diuretic therapy was prescribed. In cases of primary pulmonary hypertension with a PAPS greater than 40 mmHg, a treatment with **Bosentan 62.5 mg** (oral tablet) at a dosage of a quarter tablet in a single dose was instituted and monitored every 15 days until discharge from hospital. In three patients, a decision to transfer them to a cardio-surgical service was made. The treatment was instituted within less than 24 hours following the diagnosis in 6% of cases, A maximum delay of 144 hours was noted in three patients. Antibiotics were used to treat associated pathologies in 76.5% of cases. Surgery for associated malformations was performed in 16% of cases.

The mortality rate was 30.6%, and all TAC patients died (100%), with a statistically significant relationship ($p = 0.027$). Death occurred on average 5.43 days after initiation of treatment, irrespective of the nosological type of congenital heart disease. Progression under treatment was marked by clinical stabilization (68/98) in 69.4% of cases. The mean age at the end of their stay was 15.32 days with extremes ranging from 1 to 60 days chronological age. Of the 68 survivors with CC, 35.3% of patients were seen again at outpatient cardiology follow-ups while 64.7% of newborns were lost to follow-up.

## 4. Discussion

### 4.1. Epidemiological Aspects

In this study, hospital prevalence was 14.9%. This is higher than that of Cao (0.6%) [9] in Yunnan Région of China, of Kinda in Burkina Faso (0.98%) [7] and those of several African authors, with prevalences ranging from 0.23% in Côte d'Ivoire in a multicenter study [6] to 6% in Burkina Faso [10]. This disparity in prevalence can be explained by methodological differences.

### 4.2. Gender Distribution

As many male (50%) as female (50%) newborns were observed, with a sex ratio of 1, in contrast to the predominance of males in several studies [11] [12]. The current literature identifies some gender differences among congenital heart diseases. Male predominance has been observed for critical congenital heart disease (transposition of the great vessels and aortic valvular narrowing), and less so for other malformations such as left ventricular hypoplasia, pulmonary atresia with intact septum, double outlet right ventricle, abnormal pulmonary venous return and tetralogy of Fallot [13].

Female predominance is observed only in atrioventricular canals and atrial septal defects [13]. Here, neonatal congenital heart disease was gender-neutral, confirming the findings of authors in Saudi Arabia [14].

### 4.3. Distribution According to Age at Diagnosis

The age of onset of heart disease varies. This age depends on the degree of circulatory adaptation to life outside the uterus [15] but also on the type of cardiopathy. Left-right shunt malformations may be silent in the neonatal period, manifesting themselves only after an interval [16]. Here, the mean age of congenital heart disease was 5.18 days, with extremes of 0 and 46 days. The diagnosis was made before the 1st week of life (0 to 6 days) in 76.7% of cases. The hospital data in this study are similar to those of other authors [17]. It should be noted that the age distribution differs from author to author, depending on the inclusion criteria. The mean time from admission to diagnostic confirmation was 3.06 days with a minimum of less than 24 hours and a maximum of 4 days. Our result differs from that of Banou, who found a delay of 18 days [18]. The average time between admission and confirmation of diagnosis suggests that the HME of Bingerville has a rapid diagnosis process. This could be explained by the presence of a permanent resident cardiologist at the Mother-Child hospital of Bingerville who performs echocardiograms within a short timeframe. This is confirmed by the high rate of diagnosis in the first week of life among in-born patients, 93% versus 70% ($p = 0.002$) (**Table 2**).

### 4.4. Gestational Age Distribution

More than half (60.2%) of our patients were premature with a gestational age of less than 37 weeks' amenorrhea, and a mean and median gestational age of 34 weeks' amenorrhea. Our findings confirm those of other authors [19] [20]. Some of these authors have shown that premature newborns have 2 times the risk of cardiovascular anomalies [19]. This risk of prematurity varies according to the category of congenital heart disease concerned [21] [22]. Our results can be explained by the fact that the study was carried out in a neonatal unit.

### 4.5. Age Distribution of Mothers

In this study, 67.3% of the mothers were between 30 and 39 years of age, with a mean age of 31 ± 5.380 years, extremes of 15 and 42 years and a modal age of 31 years. But there was no statistical association between maternal age and congenital heart disease ($p = 0.435$). This study does not confirm maternal age as a risk factor for congenital heart diseas, as noted in the literature by several authors [23] [24].

### 4.6. Diagnostic Aspects

The link between certain infectious diseases, such as rubella [25], HIV [26], and congenital heart disease is well established. Authors have already shown that

maternal alcohol exposure (OR = 1.16; 1.05 - 1.27 [95% CI]) was significantly associated with the risk of congenital heart disease in the offspring [27]. Here, 25% of the mothers of these newborns had a chronic pathology. Sickle cell disease, gestational hypertension, gestational diabetes, asthma and breast cancer were present in 9.2%, 7.1%, 5.7%, 2% and 1% of cases respectively.

Some authors [28] have found that mothers with the following chronic diseases, the overall prevalence of congenital heart disease in their offspring's was significantly higher than for mothers without these diseases: type 1 diabetes mellitus (ORa = 2.32; 1.66 - 3.25 [95% CI]), type 2 diabetes mellitus (ORa = 2.85; 2.60 - 3.12 [95% CI]), hypertension (ORa = 1.87; 1.69 - 2.07 [95% CI]), anemia (ORa = 1.31, 1.25 - 1.38 [95% CI]), connective tissue disorders (ORa = 1.39; 1.19 - 1.62 [95% CI]). The same pattern applies to benign forms of congenital heart disease [28]. A higher prevalence of severe congenital heart disease has been observed only in children of mothers with congenital heart defects or type 2 diabetes [28].

• **Reasons for admission, circumstances of discovery and physical signs**

The main circumstances of discovery of these neonatal CCs were respiratory distress (42.8%), heart murmur (11.2%) and cyanosis (9.2%). Our results corroborate those of other authors in 2019 in different proportions [7] [9] [12]. This difference can be explained by the different methodologies used in each study, which described either functional symptomatology and physical signs in combination, or functional signs in isolation in the one hand, and physical signs on the other, explaining this variability in the prevalence of their observations. The clinical expression of left-right shunts is still dominated by bronchopulmonary signs, ranging from simple dyspnea during breastfeedings to recurrent bronchitis [29]. Heart murmur (11.2%) and cyanosis (9.2%) remain frequent reasons for consultation in paediatric cardiology, which we found in many of our patients. In this study, hypotrophy was found in 34.7% of newborns as noticed by several authors [30]. However, there was no association between the birth weight and the congenital heart disease ($p = 0.222$).

### 4.7. Types of Congenital Heart Disease

Non-cyanogenic heart disease was the most frequent type, accounting for 90.8% of all cases in our study. These results are similar to those of several authors [9] who found 72.6% of non-cyanogenic heart disease in their study.

However, the nosological type found in our study was PAH (50%), whether or not associated with another nosological type. Indeed, we considered that the existence of PAH in a newborn in the absence of obstructive heart disease would be considered a CC until proven otherwise. This PAH leads to very high supra-systemic pulmonary resistance responsible for elevated pulmonary artery and right ventricular pressures, and a right-to-left shunt through the patent ductus arteriosus and foramen ovale. Pulmonary flow is greatly reduced, and myocardial ischemia is frequent, contributing to tricuspid leakage. These newborns are cyanotic and in varying degrees of respiratory distress.

In this study, the prevalence of patent ductus arteriosus (PDA) was 48.9%, atrial septal defect (ASD) 38.7% and ventricular septal defect (VSD) 13.3%]. This finding corroborates that of other authors [11] [31].

Pulmonary hypertension (PAH) in CC is secondary to left-to-right shunt defects or obstructive left heart disease causing post-capillary hypertension [32].

Common defects include VSD, atrial septal defect (ASD) and persistent ductus arteriosus. Studies have shown that the size of the defect influences whether or not patients develop PAH [33]. More complex lesions such as the truncus arteriosus often develop PAH early in life. In this study, common truncus arteriosus (CTA) (3.1%) was the leading cyanogenic heart disease, followed by double outlet right ventricle (DORV) (1%) and open septal pulmonary atresia (OSPA) (1%). The mean time to perform an Echocardiography-Doppler was 3 days in hospital, with extremes of 0 and 46 days. 93.1% of in-born HME neonates had an echocardiographic diagnosis within the first week. Here, the diagnosis within a timeframe of less than 7 days was statistically related to the origin of the newborns ($p = 0.002$).

Thus, a clinical and echocardiographic monitoring was prescribed for the newborns.

### 4.8. Therapeutic and Clinical Progress Aspects

The hygienic dietary measures, diuretics, iron supplementation, digitalis, blood transfusion in cases of severe anemia and antibiotic therapy were the main treatments found in our series within less than 24 hours of ultrasound diagnosis. Some authors in Abidjan also used these therapeutic measures in 2019 [9]. Therapeutic abstention was prescribed in 81% of our neonates with ASD, PDA, mild or mild IVC with follow-ups and echocardiographic monitoring lasting from 1 to 3 months. In 69.4% of cases, echocardiographic cardiac abnormalities remained stable without complication under treatment. Three patients were referred to the Abidjan Heart Institute for cardiac surgery. This referral is explained by the fact that the Mother-Child hospital of Bingerville has no cardiovascular surgery department with a technical platform suited to perform this type of operation that requires an extracorporeal circulation and a good postnatal resuscitation. In 30.6% of cases, the newborn died on average 5.43 days after the start of treatment. This mortality was attributable to these congenital cardiopathies known as irreparable because the complexity of the lesions making no hope for any anatomical reconstruction by surgical treatment: CTA, DORV and OSPA. These neonates died before transfer. The mortality of these newborns was also due to prematurity and comorbidities as well as postoperative complications in newborns who had undergone surgery for associated visceral malformations: oesophageal atresia, unruptured omphalocele, duodenal atresia, inguino-scrotal hernia and anal imperforation.

## 5. Study Limitations

Due to the retrospective nature of this study, data were collected from medical

records. Some of the parameters studied were not accessible or available for all patients. In fact, this was a cross-sectional survey and the content of the survey form was based on the completion of the patient's medical records. The ultrasound machine used to diagnose infantile heart disease was equipped with a GE 7S probe with a frequency of 3 to 8 MHZ® for all the age groups in the study.

## 6. Conclusion

Neonatal congenital heart disease is common in our practice. Its early detection by echocardiography improves its management through rapid, non-invasive diagnosis in the neonatal period. Our study showed that congenital heart disease is dominated by PAH. Survival was influenced not only by the nosological type of congenital heart disease, but also by associated medical and surgical pathologies. Early diagnosis of congenital heart disease in newborns enables follow-up and management to be organized, and may also help to understand the early deaths that were previously unexplained. Both palliative and curative surgical management of this disease is difficult in Côte d'Ivoire. Their evolution is unpredictable, fraught with complications and high mortality. An increase in the medical-surgical technical platform will improve their diagnosis and management.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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