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Original Article

Common Pattern of Congenital Heart Disease with Outcome in Sick Term and Preterm Neonates Admitted in NICU

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ABSTRACT

Introduction: *Congenital Heart Disease (CHD) is a significant cause of neonatal morbidity and mortality, often associated with complications such as respiratory distress and infections. Early diagnosis and appropriate management are crucial in improving neonatal outcomes, particularly in resource-limited settings. This study aimed to assess the prevalence, types, associated clinical complications, and management approaches of CHD in neonates.* ***Materials & Methods:*** *This retrospective study was conducted between January 2023, and December 2023, and included 61 neonates diagnosed with CHD. Data were obtained from medical records and included demographic information, echocardiographic findings, associated clinical complications (infant of diabetic mother, neonatal sepsis, pneumonia, preterm low birth weight, respiratory distress, perinatal asphyxia), and medical management, including oxygen therapy and pharmacological agents.* ***Result:*** *Of the 61 newborns, 22 (36.1%) had atrial septal defect (ASD), 15 (24.6%) had ventricular septal defect (VSD), 12 (19.7%) had patent ductus arteriosus (PDA), and 8 (13.1%). had patent foramen ovale (PFO). The most common associations were respiratory distress (38, 62.3%), pneumonia (21, 34.4%), jaundice (17, 27.9%), and preterm low birth weight (14, 23.0%) and IDM (13, 21.3%). Oxygen therapy was administered to 42 (68.9%) newborns and paracetamol therapy was administered to 19 (31.1%) newborns diagnosed with PDA.* ***Conclusion:*** *Congenital heart disease (CHD) continues to be a major health problem in infants, often accompanied by respiratory and infectious complications, with higher incidence in infants of diabetic mothers. Early diagnosis and prompt treatment with echocardiography can enhance prompt treatment and improve outcomes, especially for patients with Patent Ductus Arteriosus (PDA).*

Keywords: *Congenital Heart Disease (CHD), Neonatal morbidity and mortality, Atrial Septal Defect (ASD), Respiratory distress, Neonatal sepsis*

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INTRODUCTION

Congenital Heart Disease (CHD) is one of the most prevalent congenital anomalies, affecting approximately 4 to 10 per 1,000 live births globally, with a higher prevalence reported in Asia, including Bangladesh, where incidence rates range from 7.8 to 25 per 1,000 births [1]. Among affected neonates, preterm infants face higher risks due to immature cardiopulmonary function, leading to increased complications such as respiratory distress (62.3%) and pneumonia (34.4%), which can further impact survival and long-term health outcomes [2]. CHD encompasses a diverse group of structural cardiac and great vessel abnormalities that manifest at birth and often lead to significant morbidity and mortality. Common CHD types include atrial septal defect (ASD), ventricular septal defect (VSD), and patent ductus arteriosus (PDA), each contributing to altered hemodynamics and increased clinical complications [3,4]. Atrial septal defect (ASD), ventricular septal defect (VSD), patent ductus arteriosus (PDA) is congenital heart defects that disrupt normal blood circulation in neonates. ASD and VSD involve abnormal openings in the septum, causing oxygen-rich and oxygen-poor blood to mix, leading to increased cardiac strain [5]. PDA, a failure of fetal circulatory adaptation, results in excessive pulmonary blood flow and potential respiratory distress. These conditions, if untreated, can contribute to complications like heart failure, growth retardation, and long-term neurodevelopmental impairments [6]. The etiology of CHD is multifactorial, involving genetic mutations, chromosomal abnormalities and various environmental risk factors such as maternal diabetes, TORCH infections, nutritional deficiencies and consanguinity [1-5]. Despite advancements in neonatal care improving survival rates, preterm infants undergoing early open-heart

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surgery face significantly higher risks of mortality and neurodevelopmental impairment, yet limited research exists on gestational predictors and longitudinal outcomes [7,8]. Malnutrition and failure to thrive are commonly observed in CHD infants, with prevalence rates ranging from 15% to 41% [9]. The increased metabolic demand due to heightened sympathetic activity, respiratory distress, and congestive heart failure contributes to inadequate nutrient intake and impaired growth. Additionally, gastrointestinal anomalies, gastro esophageal reflux, and food intolerance further exacerbate malnutrition, impacting both preoperative and postoperative outcomes. Poor nutritional status before surgery has been associated with increased mortality, prolonged hospitalization and delayed postoperative recovery. Given the limited research on CHD-related nutritional challenges in Bangladesh, this study aims to examine the common patterns of CHD, particularly ASD, VSD and PDA and their clinical outcomes in sick term and preterm neonates admitted to the Neonatal Intensive Care Unit (NICU) in Dhaka, Bangladesh. The findings will contribute to the existing literature and inform the development evidence-based strategies to improve survival rates and long-term health outcomes in CHD patients.

METHODS & MATERIALS

This prospective observational study was conducted in the Neonatal Intensive Care Unit (NICU) of Uttara Crescent Hospital, from January 1, 2023 to December 30, 2023, to assess the patterns of congenital heart disease (CHD) in neonates. A total of 61 neonates diagnosed with CHD were included using a consecutive sampling technique, based on clinical presentation and echocardiographic confirmation. Inclusion criteria encompassed neonates with atrial septal defect (ASD), ventricular septal defect (VSD), patent ductus arteriosus (PDA), and patent foramen ovale (PFO), while those with chromosomal abnormalities or severe congenital malformations incompatible with life were excluded. Data were collected retrospectively from medical records, focusing on demographics (gestational age, gender), CHD types, associated conditions (Infant of a diabetic mother, neonatal sepsis, perinatal aspiration syndrome, jaundice, preterm low weight, pneumonia, respiratory distress syndrome) and treatment modalities such as oxygen therapy and pharmacological management, including ibuprofen and paracetamol. Statistical analysis was performed using SPSS version 26, with descriptive statistics presented as frequencies and percentages.

RESULTS

The study cohort consisted of 61 individuals, with a mean age of 6.89 days ±4.597, ranging from 2 to 29 days. The gender distribution showed a slight male predominance (54.1% male, 45.9% female). These finding suggest a balanced representation across neonatal and early infant groups, critical for studying congenital heart disease. [Table I]

Table – I: Distribution of Neonates based on the basic characteristics (*n*=61)

	Statistics
Age (in days)	
Mean ± SD	6.89 ± 4.597
Minimum	2
Maximum	29
Gender	**(n, %)**
Male	33, 54.1
Female	28, 45.9

The distribution of these defects within the sample population is presented in the Table II, All patients in this study were clinically diagnosed with congenital heart disease (CHD), and each case was carefully categorized based on the specific type of CHD. Term and Preterm births were equally represented (45.9% each), with near-term births constituting 8.2%. Atrial Septal Defect (ASD) was the most prevalent (81.9%), followed by patent Ductus Arteriosus (PDA) at 60.6%. Ventricular Septal Defect (VSD) and Patent Foramen Ovale (PFO) accounted for 8.1% and 14.7% respectively. Moreover, study population also had one or more associated medical complications such as jaundice (n, %), intrauterine growth restriction - IUGR (3, 4.9%), low birth weight-LBW (29, 47.5%), pneumonia-PNA (29, 47.5%), transient tachypnea of the newborn-TTN (15, 24.6%), meconium aspiration syndrome-NNJ (13, 21.3%), IDM (13, 21.3%), VLBW (5.8.2%), AGA (25, 41.0%), congenital respiratory distress syndrome-RDS (12, 19.7%), and early-onset sepsis- EONS (21, 34.4%). [Table II]

Table – II: Distribution of Study Population Based on Gestational Age, CHD Type, and Associated Medical Conditions. (*n*=61)

Study Population Distribution	(n, %)
Gestational Age	
Term	28, 45.9%
Pre-term	28, 45.9%
Near Term	5, 8.2%
Type of CHD	
ASD	50, 81.9%
VSD	5, 8.1%
PDA	37, 60.6%
PFO	9,14.7%
Associated Medical Conditions	
NNJ/Jaundice	13, 21.3%
IDM	13, 21.3%
LBW	29, 47.5%
PNA	10, 16.4%
TTN	15, 24.6%
VLBW	5.8.2%
Congenital pneumonia	4, 6.6%
RDS	12, 19.7%
EONS	21, 34.4%
AGA	25, 41.0%
IUGR	3, 4.9%

The distribution of congenital heart disease (CHD) patterns and associated treatment modalities in the study population

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revealed significant findings. The mean defect sizes were 1.747 ± 1.2485 mm for atrial septal defects (ASD), 3.233 ± 0.8684 mm for patent ductus arteriosus (PDA), and 3.125 ± 2.17466 mm for patent foramen ovale (PFO). Treatment approaches were dominated by oxygen inhalation, utilized by 54.3% patients, underscoring its pivotal role in CHD management. Pharmacological interventions included paracetamol drops (19.6%) and injections (8.7%), while specialized therapies like Syrup Ibuprofen and Tab Vigorex were applied sparingly (2.2% each). These findings highlight the variability in CHD defect sizes and the reliance on both supportive care and targeted pharmacological treatments to address the condition effectively. [Table III]

Table – III: Distribution of Congenital Heart Disease Patterns and Associated Treatment Modalities in the Study Population. (*n*=61)

Pattern of CHD	Mean ± SD
ASD	1.747 ± 1.2485
PDA	3.233 ± 0.8684
PFO	3.1250 ± 2.17466
Treatments	**(n, %)**
Oxygen Inhalation	38, 62.3%
Syrup Ibuprofen	2, 3.3%
Paracetamol Drop	4, 6.6%
Injection	15, 24.6%
Paracetamol Sildenafil	2, 3.3%

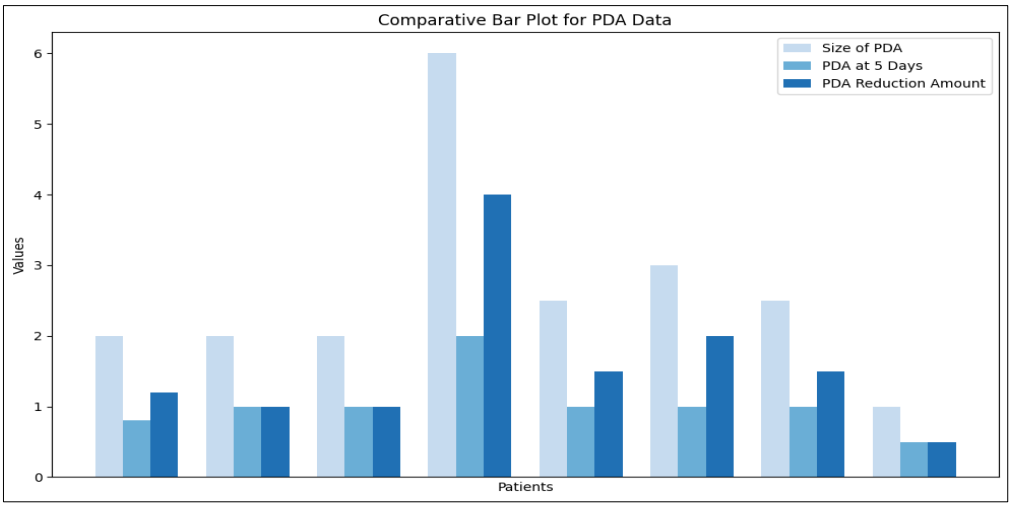

Figure – 1: Comparative Bar plot for PDA Data across Patients over 5 days

The comparative bar plot focusing on the size of Patent Ductus Arteriosus (PDA) across patients and its subsequent reduction over a 5-day period. The initial PDA sizes range from 1.0 to 6.0, with reductions observed varying from 0.5 to 4.0mm. Patient with higher initial PDA sizes (e.g., 6.0) show the largest reductions, up to 67%, reflecting the effectiveness of intervention in severe cases. Moderate PDA sizes (e.g., 2.5-3.0) exhibit reductions of 60-67%, indicating substantial improvement. Meanwhile, smaller initial sizes (e.g., 1.0-2.0) generally show reductions of 50-60%, suggesting less scope for improvement due to already lower baselines. Overall, the reduction trends highlight a strong response to treatment, with greater reductions observed in patients starting with higher PDA values.

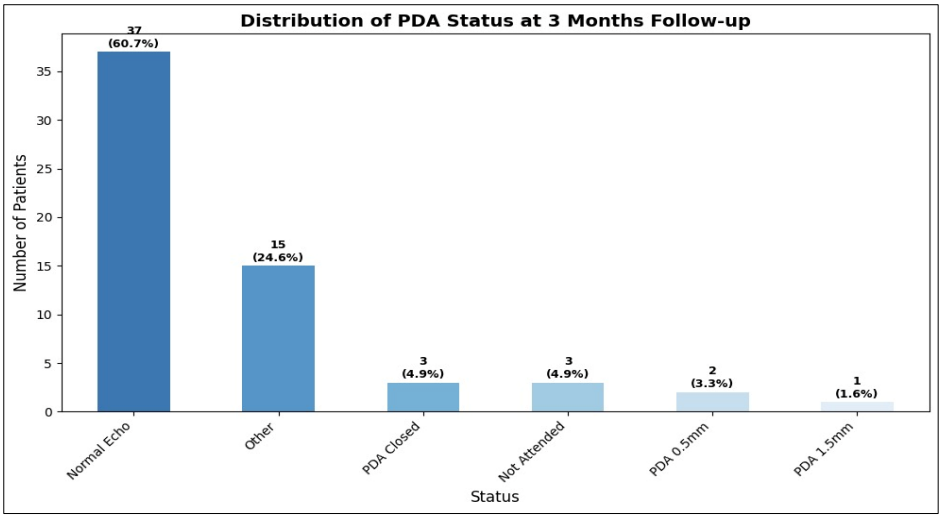

Figure – 2: Distribution of PDA Status at 3-Month Follow-Up

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The majority of patients (37, 60.7%) had normal echocardiographic findings at the 3-month follow-up, indicating resolution of PDA or absence of any residual defect. A significant proportion (15, 24.6%) fell into the "Other" category, representing mixed outcomes such as borderline PDA or additional cardiac findings. Among the cohort, 3 patients (4.9%) had a definitively closed PDA categorized separately from the broader 'Normal Echo' group to delineate complete anatomical resolution. Small residual PDA defects were observed in 2 patients (0.5mm, 3.3%) and 1 patient (1.5 mm, 1.6%), indicating limited cases of incomplete closure at 3 months. A small subset (3 patients, 4.9%) did not attend the follow-up. Table IV showing statistically significant association between maternal Gestational Diabetes Mellitus (GDM) and the occurrence of Patent Ductus Arteriosus (PDA) in neonates. Among the 15 neonates born to GDM mothers, 86.7% were diagnosed with PDA, whereas only 52.2% of neonates born to non-GDM mothers had PDA. The Pearson correlation coefficient (r=0.304) indicates a moderate positive relationship, suggesting that maternal GDM increases the likelihood of PDA in neonates. Furthermore, the p-value (0.017) confirms statistical significance ($p < 0.05$), meaning the observed association is unlikely to be due to chance. These findings suggest that maternal GDM may be a contributing factor in the development of PDA, emphasizing the need for careful monitoring and management of neonates born to GDM mothers. [Table IV]

Table – IV: Association between GDM and PDA in Neonates with Pearson Correlation Analysis

Maternal GDM Status	Neonates with PDA (%)	Neonates without PDA (%)	Pearson Correlation (r)	p-value
GDM Mothers (n=15)	13 (86.7%)	2 (13.3%)	0.304	0.017
Non-GDM Mothers (n=46)	24 (52.2%)	22 (47.8%)		

DISCUSSION

In this study (n=61), the mean age was 6.89 ± 4.60 days (range: 2-29), with 54.1% males and 45.9% females. ASD (36.1%) was the most common defect, followed by VSD (24.6%) and PDA (19.7%), differing from differing from Sehar et al. and Crump et al., who reported VSD and PDA as predominant [7,9]. PDA with ASD (37.7%) was the most frequent combined defect, aligning with prior studies but with a higher ASD prevalence. To begin with, the study from Sehar et al. portrayed that ventricular septal defect (VSD) was the most common congenital heart disease (18%, 210 cases), with 3.5% (41) having patent ductus arteriosus (PDA) and 1.2% (51) having pulmonary stenosis; PDA ranked second (13.4%, 554 cases) with a female predominance (F:M = 57:43), while atrial septal defect (ASD) constituted 12.2% (504 cases), highlighting the prevalence of left-to-right shunt lesions [9]. In addition, the study of Mannan et al. showed that PDA was observed in 36.7% (n=36) of cases, VSD in 8.2%(n=8) and ASD in 4% (n=4) [10]. The most common combined defect was PDA with ASD, accounting for 37.7% (n=37) of cases, followed by VSD with ASD at 8% (n=8) and PDA with VSD at 5% (n=5). The present study, our research found atrial septal defect (ASD) to be the most prevalent congenital heart disease (81.9%), followed by patent ductus arteriosus (PDA) at 60.6%, contrasting with previous studies where PDA was more predominant. Additionally, the most common combined defect in this cohort was PDA with ASD (37.7%), aligning with prior findings but with a higher overall ASD prevalence. Fatema et al. Provided the treatment included Oxygen Inhalation (100%), Syrup Ibuprofen and paracetamol (4.85%), Tab Vigorex, Pulmonary Vasodilators (59.51%), Anti-failure (73.27%) to close PDA and reduce inflammation for general recovery and immune support [10, 11]. In contrast, the study of Cheung et al. used perioperative treatment include inotropes (91.2%) for cardiac support, diuretics (88.4%) for fluid management, anticoagulants (72.1%) to prevent thrombosis, and analgesics (95.3%) for pain relief, ensuring hemodynamic stability and recovery [12]. Our current study prioritized oxygen inhalation (62.3%) and minimal pharmacological intervention (paracetamol drop 6.6%, injection 24.6%, Ibuprofen 3.3%), unlike prior studies with 100% oxygen use, pulmonary vasodilators and anti-failure drugs. Unlike the perioperative approach (inotropic 91.2%, diuretics 88.4%, anticoagulants 72.1%), management here focuses on closing the gap and reducing symptoms. Ran et al. showed that among 155 patients (mean age 22.8±14.7 days), median weight 850g [IQR 720-1,030g], 98.7% achieved PDA closure with a adverse event rate (84.6% minor, 15.4% major) and no deaths [13]. In another study of Faultersack et al., among 95 infants diagnosed with PDA, ASD or VSD, 39 (41.1%) had multiple intracardiac shunts, and 42 (44.2%) required ongoing follow-up, 37(38.9%) had spontaneous closure (PDA: 22, ASD: 9, VSD: 6), and none needed intervention over 2-6 years [14, 15]. In our current study, we observed that a spontaneous PDA resolution rate of 60.7% at the 3-month follow up, which is higher than the 38.9% reported in previous studies over a 2–6-year period. Additionally, while 24.6% of patients exhibited borderline or mixed outcomes requiring further monitoring, this aligns with prior findings where 44.2% required ongoing follow-up, highlighting the variability in PDA progression and resolution timeline. Moreover, Infants of diabetic mothers (IDMs) had significantly higher rates of echocardiographic abnormalities, including increased IVSd, IVSs, LVPW, LVDd, LVDs, and RVDd measures ($p<0.001$), and a positive correlation between birth weight and echocardiographic findings (r=0.768-0.859, p=0.001), supporting the association of maternal diabetes with neonatal heart complications [16]. Even, our study demonstrates a statistically significant association between Gestational Diabetes Mellitus (GDM) and neonatal Patent Ductus Arteriosus (PDA) (p=0.017). Among neonates born to GDM mothers (n=15), 86.7% had PDA, compared to 52.2% in non-GDM neonates, with a moderate positive correlation (r=0.304), suggesting increased PDA risk in this subgroup.

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Limitations of The Study

This study was conducted in a single NICU, limiting its generalizability to broader populations. The small sample size may not fully capture the diverse spectrum of CHD in Bangladesh. Additionally, follow-up data were limited to three months, restricting insights into long-term outcomes. Variability in diagnostic accuracy due to reliance on echocardiographic assessment could also affect findings. Future studies should incorporate larger, multicenter datasets with extended follow-up periods to enhance reliability and generalizability.

CONCLUSION

This study examines common congenital heart disease (CHD) patterns in NICU-admitted neonates in Dhaka, Bangladesh, with ASD, PDA, and VSD being most prevalent. CHD was significantly linked to preterm birth, perinatal asphyxia, IDM, respiratory distress, and sepsis. Early interventions, including oxygen therapy and pharmacological treatment, improved outcomes, with most PDA cases regressing within five days. The findings emphasize the need for early diagnosis and multimodal management, urging future research on long-term neurodevelopmental outcomes and genetic factors.

RECOMMENDATION

Given the high reliance on oxygen therapy and pharmacological management in case of PDA, early echocardiographic screening and timely interventions are crucial for improving neonatal outcomes. Future research should focus on long-term follow-up of CHD infants, exploring nutritional interventions and surgical advancements to enhance survival rates. Strengthening color doppler echocardiogram and neonatal cardiac care facilities in Bangladesh are imperative to mitigate CHD-related morbidity and mortality, ensuring better health outcomes for affected neonates.

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