

**Role of Echocardiography
in Congenital Heart Diseases
in Neonatal Intensive Care Unit**

Dr. Nayera Ismail Attia
Professor of Pediatrics Institute of Post-
Graduate Childhood Studies
Medical Studies Department
Ain Shams University
Dr. Hebatalla Mohamed Attia
Assistant Professor Of Cardiology
Faculty of Medicine- Ain Shams University
Reem Mamdouh Soliman

Abstract:

Many infants die without the diagnosis of complex CHDs, especially in developing countries. Echocardiography is used postnatally in high-risk infants for the diagnosis or exclusion of congenital heart defects and for assessment of cardiovascular function. To detect the prevalence of simple and complex congenital heart diseases among neonates admitted to the neonatal intensive care unit of Obstetrics and Gynecology Hospital, Ain Shams University over five years and evaluate and assess the clinical indications of echocardiography and its nature in relation to echo findings in the neonatal intensive care unit.

Design of the study:

Cross sectional study on two phases. Phase I: Retrospective study over four and half years. Phase II: Prospective study over six months.

Methods:

Echocardiography assessment was performed according to symptoms and signs in a neonate suspected to have congenital heart disease. It comprised 446 neonates admitted to a neonatology unit over five years subdivided to three groups according to the results of echocardiography as regards absence of congenital heart disease (group 1) or presence of simple (group 2) or complex congenital heart disease (group 3).

Results:

On studying the Frequency distribution of Timing of Echocardiography in all neonates, there is high statistically significance for performing echocardiography in neonates in the three groups especially group 3 in the first week of life ($P < 0.01$). Also, the highest indication for doing echocardiography was the presence of a murmur (39.5%), the presence of non cardiac congenital anomalies (22.6%) or bad medical maternal history (17%) and cyanosis (7.8%) with high statistical difference in group three neonates who had complex congenital heart diseases ($P < 0.01$). As regards the most common echocardiographic finding in neonates with

simple CHD, there was increased cases had PFO+PDA (37.3%), atrial septal aneurysm+ PDA (15%), PFO alone (7.9%) and for complex CHD, there were increased cases of D-TGA (26.9%), Fallot's tetralogy (19%), and Hypoplastic left heart syndrome (14.3%).

Conclusion:

Cardiac echocardiogram in neonates suspected having congenital heart diseases shows that prevalence of CHD (simple and complex) was 90.3%.

Introduction:

Congenital heart diseases (CHD) are relatively common with a prevalence ranging from 3.7 to 17.5 per 1000 live births (Bolisetty, 2004).

It can be defined as a structural abnormality of the heart or intrathoracic great vessels which is actually or potentially of functional significance. It represents a spectrum of conditions, from those that may be fatal in the neonatal period, to those with which a normal lifespan would be expected (Clarke, 2005).

Most deaths from congenital heart defects occur in the first year of life and these are most likely to be related to extra-cardiac anomalies, cardiovascular collapse during the changes from fetal to newborn physiology, heart failure (Bache, 2002).

For these defects, timely recognition in the newborn period is vital to prevent death or cardiovascular collapse with its attendant morbidity (Hall, 2003).

Current guidance recommends a routine clinical examination for all newborns and again at 6-8 weeks of age (Hall, 2003).

In the neonatal period a diagnosis of CHD may be considered for two reasons:

1. A heart murmur or other cardiovascular abnormality identified in an asymptomatic infant
2. The development of symptoms and signs that could be attributable to congenital heart diseases

(Clarke, 2005).

Although many lesions are diagnosed antenatally by ultrasonography, serious and potentially lethal critical congenital heart defects (CCHDs) may not be apparent on prenatal ultrasound, on subsequent physical examination after birth, or on follow-up after discharge. When detected early, CCHDs are either cured or ameliorated by surgery in the vast majority of cases; therefore, a universal screening test for CCHD would be beneficial if it were demonstrated to have acceptable sensitivity and specificity and to offer information that could not be provided by routine examination and observation (Richmond, 1999).

Echocardiography has become the most important non-invasive tool in the diagnosis and management of cardiac diseases. Two dimensional echocardiography provides a full anatomical evaluation in most congenital heart defects. Physiologic data on the direction of blood flow can be obtained with the use of pulsed wave, and color flow Doppler (Daniel, 2006).

Prenatal or fetal echocardiography can diagnose congenital heart diseases by 18 weeks of gestation and this prenatal diagnosis allows for delivery in a well equipped place for such conditions where many congenital heart defects are surgically repaired based on the echocardiogram with no need for cardiac catheterization (Daniel, 2006).

It must be noted also that initial evaluation of a neonate with suspected congenital heart disease includes four-extremity blood pressure, chest X-ray, electrocardiogram and hyperoxia test (which is perhaps the most sensitive and specific tool in the initial evaluation) (Stephanie,2008).

The ability to identify affected newborn infants, when totally asymptomatic, and institute programs and treatments that prevent serious morbidity and mortality is a great privilege for the pediatrician

(Wren, 2000).

Methodology:

This cross sectional study (prospective and retrospective) was conducted on 446 neonates had echocardiographic assessment and was admitted in NICU of Obstetrics and Gynecology Hospital, Ain Shams University, in the period from July 2004 to June 2009.

Each of the newly born infants included in this study was subjected to the following:

1. Full Clinical History.
2. Assessment of gestational age using Ballard score.
3. Thorough Clinical examination laying stress on cardiovascular system.
4. Chest radiograph and Electrocardiogram was done if needed.
5. Neonatal Echocardiographic examination of each suspected neonate with congenital heart diseases was done.

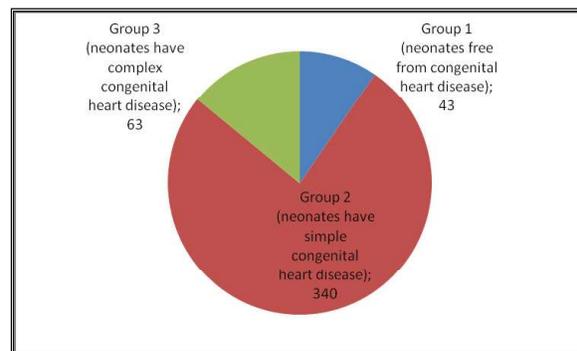
The neonates under study were subdivided according to the results of echocardiography as regards absence of congenital heart disease or presence of simple or complex congenital heart disease.

- ✧ Group 1 (neonates free from congenital heart disease): It comprised 43 neonates (9.7%) with gestational age ranged between 26- 42 weeks, with mean of 36.2±4 weeks, and birth weight ranged between 0.9- 5.1kg with mean of 2.4±0.9 kg. They were 23 males (53.5%) and 20 females (46.5%). Thirteen of them delivered vaginally (30.2%) and 30 by cesarean section (69.8%).
- ✧ Group 2 (neonates have simple heart disease): It comprised 340 neonates (76.2%) with gestational age ranged between 26- 42 weeks, with mean of 36.2±4 weeks, and birth weight ranged between 0.9- 5.1kg with mean of 2.4±0.9 kg. They were 174 males (51.2%) and 166

females (48.8%). One hundred and thirteen of them delivered vaginally (33.2%) and 227 by cesarean section (66.8%)

- ✧ Group 3 (neonates have complex heart disease): It comprised 63 neonates (14.1%) with gestational age ranged between 27- 40 weeks, with mean gestational age of 37.7±3.4 weeks, and birth weight ranged between 1- 4.5 kg with mean of 2.6+0.7 kg. They were 32 males (50.8%) and 31 females (49.2%). Twenty six of them delivered vaginally (41.3%) and 37 by cesarean section (58.7%).

Figure (1): Frequency distribution of echocardiographic findings among all neonates:



This figure shows that echocardiographic finding of 43 neonates (9.7%) is free from congenital heart disease while 340 neonates (76.2%) have simple congenital heart disease and 63 neonates (14.1%) have complex congenital heart disease.

Results:

The results of the current study are:

- ✧ There is statistically significant higher mean gestational age in neonates who had complex congenital heart (37.7±3.4 weeks) compared to the other groups (36.2± 4 weeks) and significantly mean postnatal age for performing echocardiography in neonates having complex CHD than the other groups (P <0.05).
- ✧ Echocardiography was frequently done in the first week of life (73.8% of cases). There is high statistically significance for performing echocardiography in neonates having complex CHD

than the other groups especially in the first week of life.

Table (1) Frequency distribution of Timing of Echocardiography in all groups

Age (days)	All Neonates		Group 1		Group 2		Group 3		X ²	P-Value
	No.	%	No.	%	No.	%	No.	%		
1-7	329	73.8	25	5.6	247	55.4	57	12.8	37.9	0.00**
8-30	104	23.3	10	2.2	88	19.7	6	1.3		
>31	13	2.9	8	1.8	5	1.1	0	0		
Total	446	100.0	43	9.7	340	76.2	63	14.1		

** P<0.01 highly significant

This table shows that there is high statistically significance (P< 0.01) for performing echocardiography in neonates in the three groups especially group 3 in the first week of life.

- ✧ LBW& AGA neonates were much encountered among all neonates being 31.2% and 47.1% respectively (Group 2 versus group 1& 3).
- ✧ The most clinical finding presented on admission of the neonate to the NICU was respiratory distress (53.1%), low birth weight (47.7%), murmur (39.5%), jaundice (21.9%), weak suckling (12.7%).
- ✧ There is statistical difference between the three groups in indication of admission of the neonate to the NICU as RDS, prematurity, presence of other congenital anomalies, PROM and antenatal diagnosed CHD especially for neonates who have congenital heart disease (simple or complex) in group 2& 3 respectively.
- ✧ Eighty three percent of all neonates have irrelevant maternal history, 17% have bad medical & obstetric history as PROM, history of maternal medications and diabetes mellitus.
- ✧ There is statistical difference between the three groups in associated maternal& obstetrical conditions among all neonates as maternal medications, diabetes mellitus, hypertension and past neonatal deaths from CHD especially for neonates who have congenital heart disease

(simple or complex) in group 2 & 3 respectively.

- ✧ The highest indication for doing echocardiography was the presence of a murmur (39.5%), the presence of non cardiac congenital anomalies (22.6%) or bad medical maternal history (17%) and cyanosis (7.8%).

Table (2) clinical indications of echocardiography among all cases

Indication	No	%
Murmur	176	39.5
Non Cardiac Congenital Anomalies	105	23.5
Bad Medical Maternal History	76	17
Cyanosis	35	7.8
Abnormal chest x-ray or ECG findings	34	7.6
Neonatal Problems Other Than RDS	29	6.5
Associated Chromosomal Abnormality	13	2.9
Antenatal Diagnosis Of CHD	5	1.0
Total	446	100.0

ECG: Electrocardiogram, RDS: Respiratory distress syndrome, CHD: Congenital heart diseases.

This table shows that the highest indication for doing echocardiography was the presence of a murmur (39.5%), the presence of non cardiac congenital anomalies (22.6%) or bad medical maternal history (17%) and cyanosis (7.8%).

- ✧ There is statistical difference between the three groups in clinical indications for echocardiography (P<0.01) with high percentage of cyanosis in group three neonates who had complex congenital heart diseases (5.1% versus 0.2% in group one and 2.5% in group two) and high frequencies of most indications in group two neonates who had simple congenital heart diseases as hearing murmur, presence of non cardiac congenital anomaly or bad medical maternal history, abnormal chest x-ray or ECG findings, associated chromosomal abnormality, antenatal diagnosis of CHD.
- ✧ Murmur (as an indication for echocardiography) is significantly increased in preterm neonates compared to term neonates (113

neonates versus 63 neonates) (P<0.05) but the presence of other indications are significant statistically encountered among term neonates compared to preterm neonates (P<0.05).

- ✧ The most common echocardiographic finding in neonates with simple CHD was PFO+PDA (37.3%), atrial septal aneurysm+ PDA (15%), PFO alone (7.9%).

Table (3) Echocardiographic findings among group 2 (simple congenital heart defects)

Lesion	No	%
Pda+ Pfo	126	37
PDA+ Atrial Septal Aneurysm	52	15.3
PFO	27	7.9
PDA	19	5.6
PDA+ PFO+ septal hypertrophy	17	5
Pda+ Asd	12	3.3
Atrial Septal Aneurysm	11	3.2
Atrial septal aneurysm+PDA+septal hypertrophy	10	2.9
Atrial septal aneurysm+PDA+ PFO	9	2.6
ASD	8	2.4
Pda+ Pfo+Vsd	7	2
PDA+ PFO+ Mitral regurge	5	1.5
Aortic Coarctation	4	1.2
Pfo+Vsd	4	1.2
septal hypertrophy+PDA+ ASD	3	0.9
Septal Hypertrophy+ PFO	3	0.9
Mitral regurge+PDA+ Atrial septal aneurysm	2	0.6
Mitral regurge+ PDA+Atrial septal aneurysm+VSD	1	0.3
Mitral regurge+PDA+Atrial septal aneurysm+ septal hypertrophy	1	0.3
Mitral regurge+ PFO+ Atrial septal aneurysm+ septal hypertrophy	1	0.3
Mitral regurge+ PDA+ septal hypertrophy	1	0.3
Mitral Regurge+ PDA	1	0.3
Mitral regurge+PDA+ ASD+VSD	1	0.3
Mitral regurge+PDA+ PFO+VSD	1	0.3
Mitral regurge+PDA+PFO+ pericardial effusion	1	0.3
PDA+PFO+ pericardial effusion	1	0.3
PDA+ Pericardial Effusion	1	0.3
ASD+ Pericardial Effusion	1	0.3
Asd+Hocm	1	0.3

Lesion	No	%
Pda+Hocm	1	0.3
Pda+ Vsd	1	0.3
PDA+ Septal Hypertrophy	1	0.3
Atrial Septal Aneurysm+PFO	1	0.3
Atrial septal aneurysm+ PFO+ PDA+ septal hypertrophy	1	0.3
Atrial septal aneurysm+ PFO+PDA+VSD	1	0.3
Atrial septal aneurysm+PFO+ASD+VSD	1	0.3
Atrial Septal Aneurysm+VSD	1	0.3
Atrial septal aneurysm+PDA+ ASD	1	0.3
Total	340	100

PDA: Patent ductus arteriosus, PFO: Patent foramen ovale, ASD: Atrial septal defect, VSD: Ventricular septal defect, HOCM: Hypertrophic obstructive cardiomyopathy.

This table shows that the most common echocardiographic finding in neonates with simple CHD was PFO+PDA (37.3%), Atrial septal aneurysm+ PDA (15%), PFO alone (7.9%).

The most common echocardiographic findings in neonates with complex CHD were D-TGA (26.9%), Fallot's tetralogy (19%), and Hypoplastic left heart syndrome (14.3%).

Table (4) Echocardiographic findings among group 3 (complex congenital heart defects)

Defect	No. 63	%
D-Tga	17	26.9
F4	12	19
Hypoplastic Left Heart Syndrome	9	14.3
Simple defects associated with Cor triatriatum sinistrum	7	11.1
DORV	6	9.5
Tricuspid Atresia	3	4.8
Ebstein's Anomaly	3	4.8
Aberrant Subclavian Artery	2	3.2
Incomplete AV canal with D-TGA & pulmonary stenosis	1	1.6
Pulmonary Atresia With IVS	1	1.6
AV canal with double aortic arch	1	1.6
Single Heart In Twins	1	1.6
Total	63	100

D-TGA: Dextro-Transposition of Great Arteries, F4: Fallot's tetralogy, DORV: Double Outlet Right Ventricle, AV: Atrioventricular IVS: intact ventricular septum.

This table showed that the most common echocardiographic findings in neonates with complex CHD were D-TGA (26.9%), Fallot's tetralogy (19%), and Hypoplastic left heart syndrome (14.3%).

- ✧ Preterm neonates showed significant results of Patent ductus arteriosus (152 neonates, 34.1% versus 125 neonates, 28% in fullterm) ($P < 0.01$) and atrial septal aneurysm (53 neonates, 12% versus 40 neonates, 8.9% in fullterm) ($P < 0.05$) with increased number in neonates had atrial septal defect and HOCM while fullterm neonates results had statistically significance for complex CHD (42 neonates, 9.4% versus 21 neonates, 4.7% in preterm) ($P < 0.01$) and increased number of most simple lesions as Patent foramen ovale, Septal hypertrophy, Ventricular septal defect, Mitral regurge.
- ✧ In neonates with absent bad maternal medical history, there was statistically significant percentage of Patent ductus arteriosus (238 neonates, 50.7% versus 39 neonates, 8.7% in neonates had bad maternal history) and patent foramen ovale (164 neonates, 36.9% versus 41 neonates, 9.2% in neonates had bad maternal history) ($P < 0.05$) while in neonates with bad maternal or obstetric history, there was highly statistically significant percentage of complex CHD (46 neonates, 10.3% versus 17 neonates, 3.8% in neonates had no bad maternal history), septal hypertrophy (30 neonates, 6.7% versus 8 neonates, 1.8% in neonates had no bad maternal history) ($P < 0.01$).

Conclusion:

From the previous study it is concluded that:

- ✧ The prevalence of CHD (simple and complex) among this study was 90.3%.
- ✧ Congenital heart defects are often predominantly in male neonates with symptoms

highly indicative for performing echocardiography in the first week of life in neonates had complex congenital heart diseases as cyanosis or in neonates had simple congenital heart diseases as hearing murmur, the presence of non cardiac congenital anomalies or bad medical maternal history, abnormal chest x-ray or ECG findings, Neonatal problems other than RDS, associated chromosomal abnormality, antenatal diagnosis of CHD.

- ✧ The most common echocardiographic finding in neonates with simple CHD was PFO+PDA, atrial septal aneurysm+ PDA, PFO alone. While neonates with complex CHD were D-TGA, Fallot's tetralogy, Hypoplastic left heart syndrome, Simple defects associated with Cor triatriatum sinistrum, DORV.

Recommendations:

1. Early diagnosis and prompt screening of congenital heart defects especially during pregnancy carries the possibility of a better outcome and favorable prognosis.
2. Fetal well being should be assured during pregnancy using ultrasonography survey and fetal echocardiography for structural anomalies.
3. Routine neonatal echocardiography for all neonates is mandatory for early diagnosis and adequate management of cardiac lesions.
4. Clinical examination and administration of pulse oximeter test before discharge from NICU is offering free diagnostic care for neonates of poor population.

References:

1. Bache A and Garne E.: Congenital heart defects in the county of Fyn. Epidemiology and mortality 1986- 1995. Ugeskr Laeger 2002; 164:4169-72.
2. Ballard JI Khoury, J.C., Wedig K., Wang L., Eilers-Walsman B.L. and Lipo R.: New

- Ballard Score, expanded to include extremely premature infants,1991. **J. Pediatr** 119 (3):417-423.
3. Bolisetty S, Daftary A, Ewald D, Knight B and Wheaton G.: Congenital heart defects in Central Australia. **Med. J. Aust.** 2004; 180: 614-617.
 4. Bricker L, Garcia J, Henderson J, Mugford M, Neilson J, Roberts T, and et al.: Ultrasound screening in pregnancy: a systematic review of the clinical effectiveness, cost-effectiveness and women's views. **Health Technol Assess** 2000; 4(16).
 5. Clarke E., Kumar M.R.: Evaluation of suspected congenital heart disease in the neonatal period. **Current Paediatrics** (2005) 15, 523-531.
 6. Daniel S.: The Cardiovascular System. In: Kleigman R., Marcante K. Jensen H.B, Behrman R.E. (Eds). **Nelson Essentials of Pediatrics**, 5th edition,2006. Elsevier Inc.p656-687.
 7. Gilger, M; Jensen, C; Kessler, B; Nanjundiah, P; Klish, WJ.: Nutrition, growth, and gastrointestinal system: basic knowledge for pediatric cardiologist. In: Garson A, Bricker JT, McNamara PG., editors. **The Science and Practice of Pediatric Cardiology**. Philadelphia, Pa, USA: Lea & Febiger; 1990. pp. 2354-2370.
 8. Hall DMB, Elliman D.: **Health for all children**. 4th ed. Oxford: Oxford University Press; 2003.
 9. Richmond S., Wren C. and Donaldson L.: Presentation of congenital heart disease in infancy: implications for routine examination. **Arch Dis Child Fetal Neonatal Ed.** 1999; 80 (1): F49-F53.
 10. Sands A., Craig B., Mulholland C., Patterson C., Dornan J. and Casey F.: Echocardiographic screening for congenital heart disease: A randomized study. **J. Perinat. Med.** 2002.
 11. Stephanie Burns Wechsler and Gil Wernosvsky: Cardiac Disorders. In: John P. Cloherty, Eric C. Eichenwald, Ann R. Stark (Eds). **Manual of Neonatal Care**, 6th edition, 2008. P394-400.
 12. Wren C, Richmond S and Donaldson L.: Temporal Variability in birth prevalence of cardiovascular Malformations. **Heart** 2000; 83:414-19.
 13. Wren C, Richmond S and Donaldson L.: Presentation of congenital heart disease in infancy: implications for routine examination. **Arch. Dis. Child Fetal Neonatal Ed** 1999; 80:F49- 53.

- ١٥,٩% اخذت الام الأيوبية اثناء الحمل و١٥,٤% وكان لديهم مرض البول السكري.
٥. يمثل أعلى مؤشر لعمل الموجات فوق الصوتية لحدیثی الولادة وجود لغط بالقلب ووجود عيوب خلقية اخرى ليست في القلب أو وجود تاريخ مرضی سيء للأم أو زرقان بالجسم.
٦. يوجد في حدیثی الولادة الذي ثبت انهم لديهم عيوب خلقية بالقلب معقدة ارتفاع مؤشرات مثل زرقة أما باقى المؤشرات مثل وجود لغط بالقلب ووجود عيوب خلقية اخرى ليست في القلب أو وجود تاريخ مرضی سيء للأم فقد وجد ارتفاعها بحدیثی الولادة الذين ثبت لديهم عيوب خلقية بسيطة بالقلب.
٧. النتيجة الأكثر شيوعا في الموجات فوق الصوتية لحدیثی الولادة من العيوب الخلقية البسيطة بالقلب هم PFO+ PDA (37.3%), Atrial Septal Aneurysm+ PDA (15%), PFO alone (7.9%)
٨. النتيجة الأكثر شيوعا في الموجات فوق الصوتية لحدیثی الولادة من العيوب الخلقية المعقدة بالقلب هم D-TGA (26.9%), Fallot's tetralogy (19%), and Hypoplastic left heart syndrome (14.3%)
٩. يتزايد في الاطفال المولودين قبل ميعادهم وجود قناة شريانية سالكة وتمدد الأوعية الدموية داخل الشرايين اما بالنسبة للمولودين في ميعادهم يتزايد وجود عيوب خلقية معقدة بالقلب.
١٠. يتزايد نسبة PFO وقناة شريانية سالكة في الاطفال الذين لا يوجد لديهم تاريخ مرضی سابق للأم اما تضخم الحاجز وعيوب القلب الخلقية المعقدة يتزايد في الاطفال ذو تاريخ مرضی سابق للأم.
- التوصيات:**
١. التشخيص المبكر والفحص الفوري لعيوب القلب الخلقية وخاصة خلال فترة الحمل.
٢. الجنين الرفاه ولا بد من التأکید أثناء الحمل باستخدام الموجات فوق الصوتية وتخطيط صدى القلب المسح الجنين عن التشوهات الهيكلية.
٣. روتين ضربات القلب لجميع المواليد حدیثی الولادة إلزامی للتشخيص المبكر والإدارة الكافية للآفات القلب.
٤. الفحص السريرى وإدارة اختبار مقياس التأكسج نبض قبل خروجه من العناية المركزة تقدم التشخيص مجانا لحدیثی الولادة من السكان الفقراء.

الملخص

دور الموجات فوق الصوتية للقلب في أمراض القلب الخلقية في وحدة الرعاية المركزة لحدیثی الولادة

تعتبر أمراض القلب الخلقية شائعة نسبيا بمعدل أنتشار يتراوح من ٣,٧ إلى ١٧,٥ لكل ١٠٠٠ ولید، ويمكن أن لا يتم تشخيص نصف الحالات عن طريق الفحص الروتینی لذلك يمكن للموجات فوق الصوتية للقلب ما قبل الولادة أن تشخص عيوب القلب الخلقية قبل الأسبوع ال ١٨ من الحمل وهذا يسمح بالاستعداد لتجهيز مكانا جيدا للولادة حيث أن كثيرا من عيوب القلب الخلقية يتم إصلاحها جراحيا.

هدف الدراسة:

تهدف هذه الدراسة إلى:

١. معرفة مدى أنتشار عيوب القلب الخلقية البسيطة والمعقدة بين حدیثی الولادة بوحدة الرعاية المركزة لحدیثی الولادة على مدى خمس سنوات.
٢. تقييم المؤشرات الأكلينيكية للموجات فوق الصوتية على القلب ومدى علاقتها بنتائج الموجات فوق الصوتية في وحدة الرعاية المركزة لحدیثی الولادة.

تصميم الدراسة:

تم إجراء دراسة مقطعية في وحدة الرعاية المركزة لحدیثی الولادة في مستشفى أمراض النساء والتوليد- جامعة عين شمس وضمت جميع المواليد المشتبه بإصابتهم بعيوب خلقية في القلب على مدى السنوات الأربع ونصف السنة والذين سوف يتم دخولهم بالوحدة للأشهر الستة المقبلة.

النتائج:

١. وجد ارتفاع متوسط عمر حدیثی الولادة الذين لديهم عيوب القلب الخلقية المعقدة مقارنة مع المجموعة الأخرى وارتفاع ايضا متوسط عمرهم في ميعاد عمل الموجات فوق الصوتية لديهم.
٢. الاعراض المتزايدة بين الاطفال حدیثی الولادة والى تسبب دخولهم للرعاية المركزة للطفل المريض هي ضيق في التنفس، وانخفاض الوزن عند الولادة، سمع لغط بالقلب، صفراء شديدة، ضعف في الرضاعة.
٣. بالنسبة للتشخيص لحدیثی الولادة، وجد ازدياد النسبة في متلازمة الضيق التنفسي، ولادة قبل الميعاد، وجود التشوهات الخلقية الأخرى، تمزق غشاء الولادة قبل اوانه، تشخيص العيوب الخلقية للقلب قبل الولادة.
٤. أظهرت ٨٣% من جميع الحالات عدم وجود تاريخ مرضی للأم، ١٦,٣% تمزق غشاء الولادة قبل اوانه،