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Research Article

Role of pulse oximetry in screening newborns for congenital heart disease at 1 hour and 24 hours after birth

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ABSTRACT

Background: The incidence of congenital heart disease is 8-10 /1000 live birth in different parts of the world. Early detection of major critical congenital heart defects might improve the outcome of new-born babies. Echocardiography is mainly used as diagnostic tool rather than screening tool due to cost effectiveness. Thus pulse oximetry, non-invasive easy to perform stays as main screening tool for diagnosis of critical congenital heart disease in newborn.
Methods: Prospective study conducted in Neonatal unit in Chennai Medical College Hospital & research centre over a period of one year. A total of 430 asymptomatic newborn delivered were screened with pulse oximetry at 1 hour and 24 hours after birth. All positive newborns were screened with echocardiography.
Results: Out of 430 newborns screened, 5 newborns had saturation <95% at 1 hour. Echocardiography was done in all 5 babies, out of which 3 revealed hypoplastic left heart syndrome, 1 had transposition of great arteries and 1 had truncus arteriosus. The sensitivity, specificity, positive predictive value and negative predictive value of the pulse oximetry in screening of heart disease in newborn was 55.55%,100%, 100% & 99.01% respectively.
Conclusions: Pulse oximetry will detect more infants in settings with a lower prenatal diagnosis rate. Pulse oximetry helps to diagnose critical congenital heart disease even at 1 hour of life which helps in early intervention and thereby improves outcome.

Keywords: Pulse oximetry, Saturation, Congenital heart disease

INTRODUCTION

Congenital heart disease (CHD) refers to structural or functional heart disease seen in neonates, infants and children. The incidence of congenital heart disease is 8-10 /1000 live birth in different parts of the world.[1] Approximately 1/3-1/4 of these congenital heart diseases are critical, which by definition require surgery or interventions in first year of life.[2] Delay in diagnosis of critical congenital heart disease increases morbidity & mortality. Critical congenital heart disease usually is asymptomatic in initial few days of life and present suddenly with clinical deterioration due to changes in pulmonary vascular resistance and closure of ductus arteriosus. Though clinical examination can be used to diagnosis congenital heart disease, critical heart disease can be missed till their presentation. Standard portable echocardiography, mainly used as diagnostic tool rather than screening tool due to cost effectiveness & need for skilled personnel.[3] Thus pulse oximetry, non-invasive and easy to perform stays as main screening tool for diagnosis of critical congenital heart disease in newborn.

Aim & objectives

1. To study the value of pulse oximetry at 1 hour & 24 hours after birth for predicting CHD in newborns.
2. To study the clinical profile of newborns detected with abnormal pulse oximetry screening.

3. To confirm the diagnosis by echocardiography in positively screened newborns.

METHODS

A prospective interventional study conducted in Chennai Medical College Hospital and Research centre, Irungalur, Trichy during the period of January 2015 to December 2015. All well term neonates were screened with pulse oximetry at 1 hour and 24 hours of birth in all 4 limbs. Detailed antenatal history including drugs, infections (TORCH), maternal diseases (GDM), family history of heart disease and physical examination of neonate were recorded. Neonates who were born preterm, who had any respiratory distress or any other features of congenital anomaly were excluded. Screening was considered positive if saturation was <95% in right hand & foot[4] or difference >3% between upper limb & lower limb.[5] Newborn with saturation < 95 % at 1 hour was monitored continuously and who had persistent low saturation were subjected to echocardiography. All neonates were screened again at 24 hours of life irrespective of their 1 hour readings.

RESULTS

A total of 430 well term neonates were included in the study. Saturation was recorded in all babies at one hour of life. A cut off value of 95% was set to consider positive. Out of 430 screened, 5 babies had saturation <95%.They were observed in NICU and saturation was periodically repeated. All 5 babies had persistently low saturation at 24 hours of life. Echocardiography was done for all 5 babies.

Table 1 shows the epidemiological characteristics of the study group. It is to be noted that antenatal ultrasound was normal in all screened newborns.

Table 1: Epidemiological parameters of screened newborns.

Characteristics	Total screened newborns	Newborns with heart disease
Male	236	4
Female	194	5
Birth weight in grams (median)	2800	2600
Gestational age in weeks (mean)	38.3	38.5
NVD	202	5
LSCS	228	4
Maternal GDM	5	Nil
PIH	8	1
Abnormal antenatal ultrasound	Nil	Nil

Out of the 430 babies, 5 babies had tachypnoea and retractions. 3 babies developed cyanosis in the first day of life. Routine auscultation revealed a murmur in 4 babies. Echocardiography was also done in babies with negative screening and positive clinical symptoms.

Figure 1 depicts the clinical profile of neonates with suspected congenital heart disease at 24 hours of life. Figure 2 and Figure 3 shows the pre-ductal and post ductal saturation at 1 hour and 24 hours of life in the study population.

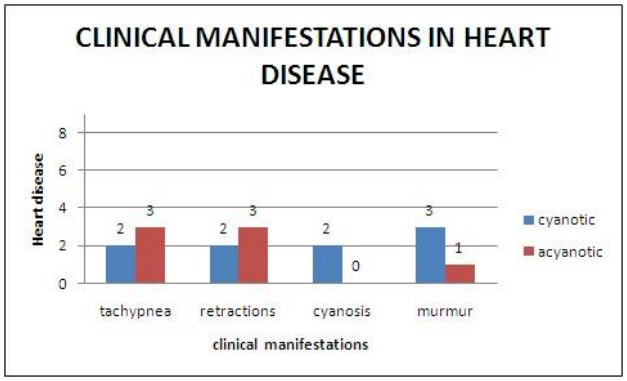

Figure 1: Clinical profile of the screened newborns within 24 hours of life.

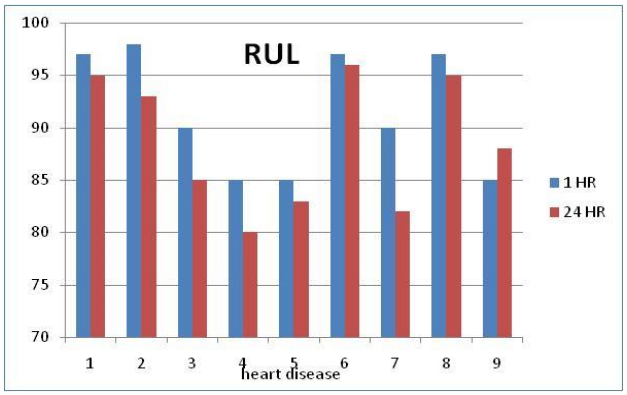

Figure 2: Preductal saturation trends at 1hr and 24 hrs of birth.

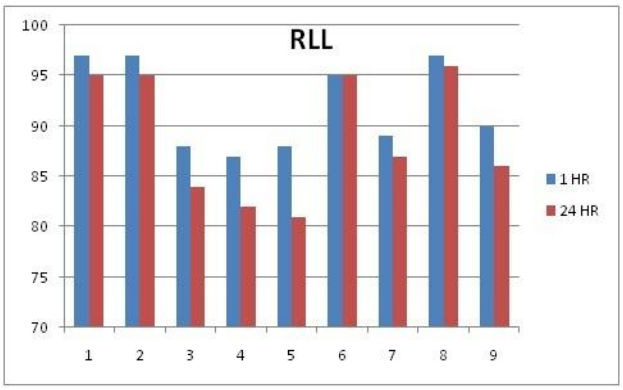

Figure 3: Postductal saturation trends at 24 hours of birth.

Echocardiography done in all 5 babies with saturation <95% revealed hypoplastic left heart syndrome in 3 babies, 1 had transposition of great arteries and 1 had truncus arteriosus (Table 2). The sensitivity, specificity, positive predictive value and negative predictive value of the pulse oximetry in screening of heart disease in newborn was 55.55%, 100%, 100%, 99.01% (Table 3).

Table 2: Saturation trends and Echocardiography findings.

SPO2		Final diagnosis
Preductal	**Post ductal**	
85	80	Hypoplastic left heart syndrome
89	82	Hypoplastic left heart syndrome
88	85	Hypoplastic left heart syndrome
84	80	Truncus arteriosus
85	88	Transposition of great arteries
96	97	Patent ductus arteriosus/Ventricular septal defect
98	97	Ventricular septal defect
97	96	Patent ductus arteriosus/atrial septal defect
98	97	Patent ductus arteriosus

Table 3: Statistical parameters of the study.

Parameters	Percentage
Sensitivity	55.55%
Specificity	100%
Positive predictive value	100%
Negative predictive value	99.01%

DISCUSSION

Critical congenital heart disease **(**CCHD) is not detected in some newborns until after their hospital discharge, which results in significant morbidity and occasional mortality. Most newborn with CCHD can be diagnosed by Echocardiography. Cost- effectiveness and need of trained personnel limits its usage in all newborn and thereby fails to diagnose newborn with CCHD.[6]

Routine pulse oximetry performed on asymptomatic newborns after 1 hour and 24 hours of life, but before hospital discharge, may detect CCHD. Routine pulse oximetry performed after 24 hours in hospitals that have on-site pediatric cardiovascular services incurs very low cost and risk of harm.[7] They are accurate and well established test for objective quantification of hypoxemia.

Out of 430 newborns screened, 5 newborns had saturation <95% at 1 hour. These newborns were observed in NICU for periodic saturation monitoring and clinical symptoms. Out of the 5 newborns 2 developed respiratory distress and cyanosis. Other 3 babies remained clinically normal. Repeat saturation at 24 hours of life was persistently low in all 5 babies. So echocardiography was done in all 5 babies, out of which 3 revealed hypoplastic left heart syndrome, 1 revealed transposition of great arteries, and 1 more revealed truncus arteriosus.

Out of the 430 babies, 5 babies had tachypnoea and retractions. 2 babies developed cyanosis in the first day of life. Routine auscultation revealed a murmur in 4 babies. Echocardiography was also done in babies with negative screening and positive clinical symptoms.

Echocardiography done in babies with persistently low saturation (5 babies) revealed critical cyanotic heart disease, whereas the same done in babies with negative screening and showing clinical signs of heart disease revealed non-threatening shunt lesions (Table 2).

In the present study, pulse oximetry had a detection rate of 2% (5 out of 430) which was followed by clinical examination and echocardiography compared to Shah et al[8] which showed a detection rate of 0.57%.

In our study the sensitivity, specificity positive predictive value, negative predictive value was 55.55%, 100%, 100%, and 99.01% respectively. This is comparable to the study done by Granelli, et al in which the sensitivity was 62.07% and specificity was 99.82%.[5]

American academy of pediatrics recommends that, pulse oximetry testing at 24 hours after birth would appear to be the most reasonable strategy.[7] But in our study screening at 1 hour of birth picked up all critical congenital heart disease. This would aid in early interventions like prostaglandin infusion to maintain patency of the ductus arteriosus.

In our study, we did not address the issue of costs which has been extensively examined by Griebsch, et al who came to the conclusion that pulse oximetry, clinical examination and echocardiography combined can make a cost effective and timely diagnosis of critical congenital heart disease.[6]

The limitations of the present study include a smaller sample size. Also, echocardiography was done only on selected cases rendering the statistical values imprecise.

CONCLUSION

A common feature of critical congenital heart disease is hypoxemia. Pulse Oximetry Screening can be an important primary screening tool in routine neonatal care for early detection and effective management of critical

congenital heart diseases. Pulse oximetry will detect more infants in settings with a lower prenatal diagnosis rate. Pulse oximetry helps to diagnose critical congenital heart disease even at 1 hour of life which helps in early intervention and thereby improves outcome.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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