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ROLE OF PLUSE OXOMETRY AS SCREENING TOOL IN DIAGNOSIS OF CONGENITAL HEART DISEASE IN NEWBORN

Pediatrics

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ABSTRACT

Introduction: Timely diagnosis of congenital heart disease (CHD) is challenging but critical. Children with such life-threatening defects may not initially have symptoms or the symptoms may be vague, and the condition is not detected on routine clinical examination in the majority of cases. In the UK alone, up to 100 otherwise healthy infants may be dying every year from undiagnosed CHD. Pulse oximetry is the first, appropriately simple method to have been used for universal screening of CHD, and the earliest reports (abstracts) on pulse oximetry screening were published in 1995.
Aims: To assess the importance of pluse oximetry as a screening tool in diagnosis of congenital heart disease in newborn.
Materials And Methods: The study was conducted in postnatal ward of BMCH from Preparatory phase-1st september2018 to 15th October 2018, Data collection-1st January 2019 to 31th December 2019 and Data analysis phase- 1st January 2020 to 30th April 2020. 500 babies who are randomly selected from total study material.
Result: Our study showed that 6(1.2%) patients were Abnormal, 475(95.0%) patients had ND and 19(3.8%) patient were Normal. 6(1.2%) patients were Abnormal, 475(95.0%) patients had ND and 19(3.8%) patient were Normal. 20(4.0%) patients were Abnormal and 480(96.0%) patient were Normal. 20(4.0%) patients were Abnormal and 4(0.8%) patients were Normal. 6(1.2%) patients had only pphn and 2(0.4%) patients had pphn. 2(0.4%) patients were Abnormal. 495(99.0%) patients had Acyanotic heart disease and 5(1.0%) patients had Cyanotic heart disease.
Conclusion: We found that 2(0.4%) patients were Abnormal ANC, 4(0.8%) patients were RR Abnormal and 5(1.0%) patients had cyanosis, it was found that 16(3.2%) patients had Murmur and 6(1.2%) patients were abnormal chest X-Ray and we found that 6(1.2%) patients were Abnormal ECG and 20(4.0%) patients were Abnormal ECHO.

KEYWORDS

CHD, pulse oximetry, CCHD and high altitude.

INTRODUCTION

Timely diagnosis of congenital heart disease (CHD) is challenging but critical. Children with such life-threatening defects may not initially have symptoms or the symptoms may be vague, and the condition is not detected on routine clinical examination in the majority of cases.[1] In the UK alone, up to 100 otherwise healthy infants may be dying every year from undiagnosed CHD.[2]

Strategies that have been suggested to improve early detection of CHD include prenatal ultrasound screening, prolonged hospital stay after delivery,[3] one or more postdischarge examinations during the first or the following two weeks of life, and training clinicians to detect "silent" CHD. However, all these strategies are cumbersome and costly and their value is doubtful. Prenatal ultrasound detects only 25% of CHD (16% without syndromes), and the effectiveness of all postnatal interventions remains questionable. Despite the apparent need, until recently, there were no other means for early detection of CHD.

Pulse oximetry is the first, appropriately simple method to have been used for universal screening of CHD, and the earliest reports (abstracts) on pulse oximetry screening were published in 1995. Currently, a wealth of experience based on screening of 45 000 newborns is available, making it timely to review the usefulness of the screen.[4]

Congenital heart disease (CHD) is one of the most common birth defects, with an incidence of nine out of every 1,000 live births. Critical CHD (CCHD) is defined as cardiac lesions that require surgery or cardiac catheterization within the first month (or within the first year by different definitions) of life to prevent death or severe end-organ damage. Although infant mortality has decreased over the past 3 decades for children with all forms of CHD, many children are still diagnosed too late to avoid significant morbidity or death. Delayed diagnosis of CCHD is unfortunately all too common, with up to 25% of infants with these defects being missed in newborns when identification is based on clinical symptoms or signs of heart disease even in settings with routine prenatal sonograms.[5] Approximately 40% of these infants with missed diagnoses at birth present in cardiogenic shock at a medical facility and 5% are diagnosed at autopsy. Studies in Europe and the US have suggested that newborn screening with pulse oximetry testing prior to discharge from the nursery can decrease the number of missed diagnoses by ~30%. In 2011, pulse oximetry screening for CCHD was added to the Recommended Uniform Screening Panel by the Health and Human Services Secretary. In the subsequent years, many states have implemented their own protocols to comply with this recommendation.[6]

Pulse oximetry has been the mainstay procedure for indirectly detecting hypoxemia in medically ill patients since the 1980s. The screening of CCHD by pulse oximetry involves taking advantage of its ability to detect clinical and more importantly subclinical levels of hypoxemia that should raise suspicion for a CCHD. However, pulse oximetry does not readily offer information about decreased stroke volume, which is another physiologic feature of several CCHDs that could be detectable during the neonatal transition. In this review, we highlight the relevant principles and limitations of pulse oximetry in the context of detecting CCHD.

AIMS AND OBJECTIVES

To assess the importance of pluse oximetry as a screening tool in diagnosis of congenital heart disease in newborn.

MATERIALS AND METHODS

Type Of Study: prospective observational study,

Study Timeline:
Preparatory phase-1st september2018 to 15th October 2018
Data collection-1st January 2019 to 31th December 2019
Data analysis phase- 1st January 2020 to 30th April 2020

Place Of Study: Postnatal ward of BMCH

SELECTION CRITERIA:
A) Inclusion Criteria-
Asymptomatic term newborns babies born in BMCH during study period have been considered for this study, however considering logistics of our institution. I have taken 500 babies who are randomly selected from total study material.

B) Exclusion Criteria

- Newborns with respiratory distress
- Newborns with congenital anomalies
- Newborn babies with birth asphyxia and neonatal encephalopathy
- Newborns with MAS
- Babies with uncooperative mothers

RESULT AND DISCUSSION

We found that 228(45.6%) patients were Female and 272(54.4%) patient were Male. 2(0.4%) patients were Abnormal and 498(99.6%) patient were Normal. 217(43.4%) patients had Pre term and 283(56.6%) patient had Term. 4(0.8%) patients were Abnormal and 496(99.2%) patient were Normal. 2(0.4%) patients were Abnormal and 498(99.6%) patient were Normal. 5(1.0%) patients had cyanosis. 16(3.2%) patients had Murmur. 4(0.8%) patients were <95% and 496(99.2%) patients were >95%. 7(1.4%) patients were <95% and 493(98.6%) patients were >95%.

Ewer AK et al [7](2012) found that fifty-three of the 20,055 babies screened had a major CHD (24 critical and 29 serious), a prevalence of 2.6 per 1000 live births. Pulse oximetry had a sensitivity of 75.0% [95% confidence interval (CI) 53.3% to 90.2%] for critical cases and 49.1% (95% CI 35.1% to 63.2%) for all major CHDs. When 23 cases were excluded, in which a CHD was already suspected following antenatal ultrasound, pulse oximetry had a sensitivity of 58.3% (95% CI 27.7% to 84.8%) for critical cases (12 babies) and 28.6% (95% CI 14.6% to 46.3%) for all major CHDs (35 babies). False-positive (FP) results occurred in 1 in 119 babies (0.84%) without major CHDs (specificity 99.2%, 95% CI 99.0% to 99.3%). However, of the 169 FPs, there were six cases of significant but not major CHDs and 40 cases of respiratory or infective illness requiring medical intervention. The prevalence of major CHDs in babies with normal pulse oximetry was 1.4 (95% CI 0.9 to 2.0) per 1000 live births, as 27 babies with major CHDs (6 critical and 21 serious) were missed. Parent and staff participants were predominantly satisfied with screening, perceiving it as an important test to detect ill babies.

Our study showed that 6(1.2%) patients were Abnormal, 475(95.0%) patients had **ND** and 19(3.8%) patient were Normal. 6(1.2%) patients were Abnormal, 475(95.0%) patients had **ND** and 19(3.8%) patient were Normal. 20(4.0%) patients were Abnormal and 480(96.0%) patient were Normal. 20(4.0%) patients were Abnormal and 4(0.8%) patients were Normal. 6(1.2%) patients had only pphn and 2(0.4%) patients had pphn. 2(0.4%) patients were Abnormal. 495(99.0%) patients had Acyanotic heart disease and 5(1.0%) patients had Cyanotic heart disease.

Engel MS et al [8](2016) found that the screening of CCHD by pulse oximetry involves taking advantage of its ability to detect clinical and more importantly subclinical levels of hypoxemia that should raise suspicion for a CCHD. However, pulse oximetry does not readily offer information about decreased stroke volume, which is another physiologic feature of several CCHDs that could be detectable during the neonatal transition. In this review, we highlight the relevant principles and limitations of pulse oximetry in the context of detecting CCHD.

Danworapong S et al [9](2019) found that a total of 7137 asymptomatic term newborns were enrolled. POS had a sensitivity of 42.86% (95% CI 9.90–81.59) and a specificity of 99.96% (95% CI 99.88–99.99). Nearly 57.14% (4 out of 7 cases of CCHD) constituted secondary target group. All the late diagnoses (3 cases) were of coarctation of the aorta (COA). The mortality rate of late detected CCHD was 33.3%. POS displayed low detection rate in secondary target group, particularly those with COA. POS decreased late detection of CCHD by 57.1%. The mortality rate of COA was high in late detection. It was found that the appropriate time span for POS follow-up should be up to 4 months.

We observed that in Acyanotic heart disease, 226(45.7%) patients were Female and 269(54.3%) patients were male. In Cyanotic heart disease, 2(40.0%) patients were Female and 3(60.0%) patients were male. Association of Sex vs AC/C was not statistically significant (p=0.8005). In Acyanotic heart disease, 2(0.4%) patients were Abnormal and 493(99.6%) patients were Normal. In Cyanotic heart disease, 5(100.0%) patients were Normal. Association of ANC Detection vs AC/C was not statistically significant (p=0.8867). In Acyanotic heart disease, 2(0.4%) patients had Pre term Guest complication and 493(99.6%) patients had Term Guest complication. In Cyanotic heart disease, 2(0.4%) patients had Pre term Guest complication and 493(99.6%) patients had Term Guest complication. Association of Guest complication vs AC/C was statistically significant (p=0.0490).

It was found that in Acyanotic heart disease, 4(0.8%) patients were Abnormal and 491(99.2%) patients were Normal. In Cyanotic heart disease, 5(100.0%) patients were Normal. Association of RR vs AC/C was not statistically significant (p=0.8400). In Acyanotic heart disease, 2(0.4%) patients were Abnormal and 493(99.6%) patients were Normal. In Cyanotic heart disease, 5(100.0%) patients were Normal. Association of PR-pp vs AC/C was not statistically significant (p=0.8867). In Acyanotic heart disease, 5(1.0%) patients had cyanosis. Association of cyanosis vs AC/C was not statistically significant (p=0.8213). In Acyanotic heart disease, 16(3.2%) patients had Murmur. Association of Murmur vs AC/C was not statistically significant (p=0.6828).

Tekleab AM et al [10](2019) found that of those 56 cases, subsequent echocardiography examination detected persistent pulmonary hypertension of the newborn (PPHN) in ten (17.9%) cases (subsequently two of them were found to have sepsis), patent ductus arteriosus in eleven (19.6%) cases, and atrial septal defect in two (3.6%) cases. No case of CCHD was detected among the screened newborns. SpO2 screening detected non-cardiac causes of hypoxemic illnesses (sepsis and PPHN) which otherwise would have been missed. However, we recommend a larger sample size study to assess the efficacy of SpO2 screening in detecting CCHD in our setting.

Plana MN et al [11](2018) found that the pulse oximeter measures this by passing light through peripheral blood vessels (eg, a fingertip in an adult, in a hand or foot in a baby). Oxyhemoglobin and de-oxyhemoglobin absorb this light in different ways, and the proportion of light absorbed can be analyzed by software within the oximeter, which then calculates the percentage of hemoglobin saturated with oxygen.

We found that in Acyanotic heart disease, 4(0.8%) patients were <95% and 491(99.2%) patients were >95%. In Cyanotic heart disease, 5(100.0%) patients were >95%. Association of Spo2<4 vs AC/C was not statistically significant (p=0.8400). In Acyanotic heart disease, 7(1.4%) patients were <95% and 488(98.6%) patients were >95%. In Cyanotic heart disease, 5(100.0%) patients were >95%. Association of spo2>48 vs AC/C was not statistically significant (p=0.7888). In Acyanotic heart disease, 6(1.2%) patients were Abnormal, 474(94.9%) patients had ND and 19(3.8%) patient were Normal. In Cyanotic heart disease, 5(100.0%) patients had ND. Association of CXR vs AC/C was not statistically significant (p=0.8755).

Our study showed that in Acyanotic heart disease, 6(1.2%) patients were Abnormal, 474(94.9%) patients had ND and 19(3.8%) patient were Normal. In Cyanotic heart disease, 5(100.0%) patients had ND. Association of ECG vs AC/C was not statistically significant (p=0.8755). In Acyanotic heart disease, 20(4.0%) patients were Abnormal and 475(96.0%) patient were Normal. In Cyanotic heart disease, 5(100.0%) patients had ND. Association of ECHO vs AC/C was not statistically significant (p=0.6464).

Ewer AK et al [12](2011) found that in 35 cases, congenital heart defects were already suspected after antenatal ultrasonography, and exclusion of these reduced the sensitivity to 58·33% (27·67–84·83) for critical cases and 28·57% (14·64–46·30) for all cases of major congenital heart defects. False-positive results were noted for 169 (0·8%) babies (specificity 99·16%, 99·02–99·28), of which six cases were significant, but not major, congenital heart defects, and 40 were other illnesses that required urgent medical intervention. Pulse oximetry is a safe, feasible test that adds value to existing screening. It identifies cases of critical congenital heart defects that go undetected with antenatal ultrasonography. The early detection of other diseases is an additional advantage.

Klausner RE et al [13](2018) found that of 10,316 infants with negative POx screens, 52.1% remained in the Yale New Haven Health system at 1 year of age and no CCHD lesions were listed in their charts. Although a CCHD screening program was effectively implemented, perhaps due to high antenatal detection rates (85%), POxS did not lead to a substantial increase in the early identification of CCHDs in our hospital system.

It was found that in Acyanotic heart disease, 20(4.0%) patients were Abnormal and 4(0.8%) patient were Normal Association of Murmur at >2wks vs AC/C was not statistically significant (p=0.8804). In Acyanotic heart disease, 6(1.2%) patients had only pphn and 2(0.4%) patients had pphn. Association of pphn vs AC/C was not statistically significant (p=0.9598). In Acyanotic heart disease, 2(0.4%) patients were Abnormal. Association of echo follow-up vs AC/C was not statistically significant (p=0.8867).

Riede FT et al [14](2010) found that oxygen saturation (SpO(2)) of <or=95% was measured on lower extremities and confirmed after 1 h, complete clinical examination and echocardiography were performed. POS was defined as false-negative when a diagnosis of cCHD was made after POS in the participating hospitals/at our centre. From July 2006-June 2008, 42,240 newborns from 34 institutions have been included. Seventy-two children were excluded due to prenatal diagnosis (n = 54) or clinical signs of cCHD (n = 18) before POS. Seven hundred ninety-five newborns did not receive POS, mainly due to early discharge after birth (n = 727; 91%). In 41,445 newborns, POS was performed. POS was true positive in 14, false positive in 40, true negative in 41,384 and false negative in four children (three had been excluded for violation of study protocol).

Donia AE et al [15](2016) found that significant cardiac lesions were detected in 38 newborns (31.6%); they had significantly lower oxygen saturation compared to those with insignificant lesions (n = 41, 34.2%) and normal hearts (n = 41, 34.2%). Repeat testing after 2 h was more reliable. Using cut-offs lower than 95% missed a significant number of lesions. Pulse oximetry can be used as a tool in apparently healthy term newborns for the early detection of cardiac lesions that might necessitate specialized follow-up and care. An initial test after the age of 2 h followed by a confirmatory test 2 h later, with a cut-off value of <95% is proposed. A comprehensive study is necessary to validate the results of this study. This might be of significant importance in low-income communities.

CONCLUSION

We found that 2(0.4%) patients were Abnormal ANC, 4(0.8%) patients were RR Abnormal and 5(1.0%) patients had cyanosis.

It was found that 16(3.2%) patients had Murmur and 6(1.2%) patients were abnormal chest X-Ray.

We found that 6(1.2%) patients were Abnormal ECG and 20(4.0%) patients were Abnormal ECHO.

		Acyanotic heart disease	Cyanotic heart disease	TOTAL	Chi-square value	p-value
CXR	Abnormal	6	0	6	.2658	0.8755
	Row %	100.0	0.0	100.0		
	Col %	1.2	0.0	1.2		
	ND	470	5	475		
	Row %	98.9	1.1	100.0		
	Col %	94.9	100.0	95.0		
	Normal	19	0	19		
	Row %	100.0	0.0	100.0		
	Col %	3.8	0.0	3.8		
	TOTAL	495	5	500		
	Row %	99.0	1.0	100.0		
	Col %	100.0	100.0	100.0		
ECG	Abnormal	6	0	6	.2658	0.8755
	Row %	100.0	0.0	100.0		
	Col %	1.2	0.0	1.2		
	ND	470	5	475		
	Row %	98.9	1.1	100.0		
	Col %	94.9	100.0	95.0		
	Normal	19	0	19		
	Row %	100.0	0.0	100.0		
	Col %	3.8	0.0	3.8		
	TOTAL	495	5	500		
	Row %	99.0	1.0	100.0		
	Col %	100.0	100.0	100.0		

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