Journal of Cardiovascular Disease Research

ISSN:0975-3583,0976-2833 VOL10,ISSUE02,2019

Role of Pulse Oximetry as Screening Tool in detecting Cyanotic Congenital Heart Disease inSick Neonates at Tertiary Care Hospital Neonatal Intensive Care Unit in Jharkhand

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Abstract:

Objective: To evaluate pulse oximetry for detection of congenital cyanotic heart disease in sick neonates using echocardiography as gold standard. Methods: Pulse oximetry readings were taken at admission from 500 neonates from right upper limb and either foot with infant breathing room air. Pulse oximetry was considered abnormal if oxygen saturation at room air measured <90% or difference between right hand and foot was more than 3%. Persistent abnormality was considered positive result. Echocardiography was performed on all neonates with positive pulse oximetry (study group) as well as on neonates with negative pulse oximetry (controls).**Results:** Pulse oximetry was positive in 24 neonates. It detected 9 out of 10 (90 %) true positives. The sensitivity, specificity, positive predictive value, negative predictive value and odds ratio (95% CI) of pulse oximetry was 90 %, 55.58 %, 5.62 %, 99.47 and 11.3 respectively. **Conclusion:** Pulse oximetry screening is useful in detecting cyanotic heart disease.

Keyword: Pulse Oximetry, Cyanotic Heart Disease, Screening Tool

Introduction:

Congenital heart diseases (CHDs) account for 6 -10 % of all the infant deaths, and 20 - 40 % of all infant deaths from malformations [1]. About 25% of CHDs are life threatening and manifest before the first routine clinical examination [1,2]. The existing pulse oximetry monitoring protocol to detect critical congenital heart disease, is restricted to neonates in infant nursery [5]. Pulse oximetry as a screening test for congenital cyanotic heart disease has been evaluated among in sick neonates. The present study was designed to evaluate the utility of pulse oximetry screening in detecting congenital cyanotic heart disease among sick neonates in a referral neonatal unit catering to out born neonates.

Methods:

The study was conducted in the Referral Neonatal Unit of a teaching hospital between April 2018 and April 2019. The unit caters exclusively to out born sick neonates referred from community hospitals of Ranchi and surrounding states, or to those born at home and transported to the hospital directly by the parents. All neonates admitted to the unit during the study period were eligible for inclusion. Neonates in whom stable pulse oximeter signals could not be obtained were excluded. Informed written consent was obtained from the parents of all enrolled subjects. All neonates at admission were clinically evaluated by a resident doctor for temperature, heart rate, respiratory rate (RR), chest retractions, central cyanosis, femoral pulses, other peripheral pulses, capillary filling time, peripheries (cool or warm) and clubbing. Presence of either tachypnoea (RR >60/min), retractions, central cyanosis, poor femoral pulses,

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precordial pulsations, hepatomegaly or murmur was considered as positive clinical examination suggestive of congenital heart disease [11]. Pulse oximetry readings (Measupro digit pulse oximetry, model no 0.250) were taken at admission from right upper limb and either foot with infant breathing room air. The recordings were noted one minutes after stable signals were obtained. Pulse oximetry was considered abnormal if oxygen saturation at room air or on oxygen therapy measured <90% or there was more than 3% difference between right hand and foot [5]. All neonates with abnormal pulse oximetry were subjected to three observations each, separated by at least 60 minutes. Screen was considered positive only if the abnormality persisted till the last reading. Echocardiography (Philips iE33 xMATRIX echocardiography system) was performed by a paediatric cardiologist on all neonates with a positive pulse oximetry screen (study group) and on one subsequently enrolled neonate with negative screen per neonate with positive screen (controls). Sensitivity, specificity, positive and negative predictive value, positive likelihood ratio and negative likelihood ratio of pulse oximetry in detecting cyanotic heart diseasewere evaluated.

Results:

A total of 500 neonates admitted in referral neonatal unit during the study period were screened. Pulse oximetry was positive in 160 neonates, and in ten neonates, stable pulse oximeter signals could not be obtained.

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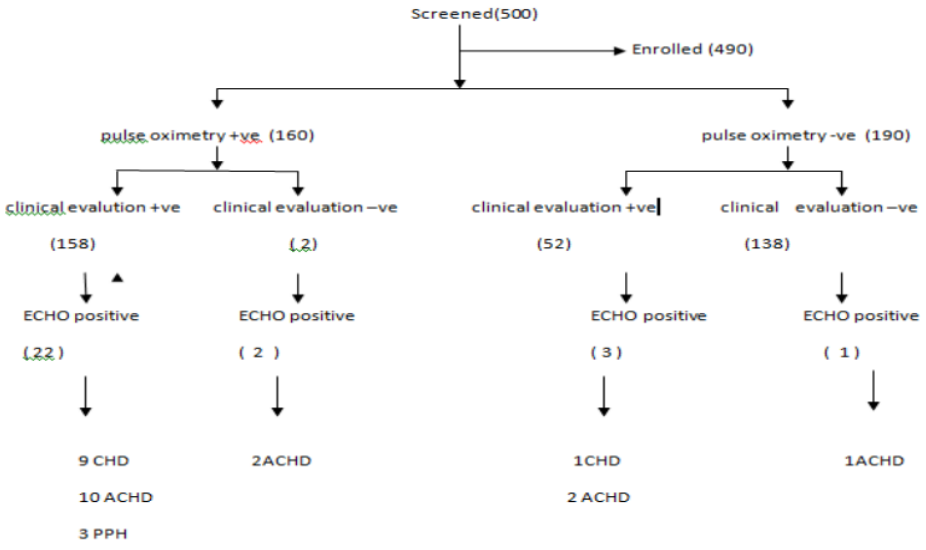
TABLE IComparison of Characteristics of Cases and Controls

Characteristics. Clinical signs.No.(%)	CasesN =160	ControlN=190
Tachycardia > 160/min	26(16.25)	7(3.68)
Tachypnea> 60/min	108(67.5%)	23(12.1%)
Chestretractions	86(56.25%)	58(30.5%)
Central cyanosis	21(13.12%)	0
Murmur	23(14.37%)	8(4.7 %)
Hepatomegaly	30(18.75%)	12(6.31%)
Feeble femoralpulses	26(16.25%)	9(4.3)
DISEASE CATEGORIES		
Cyanoticheart disease	9(5.62%)	1(0.52%)
Acyanotic heart disease	12(7.5%)	1(1.57%)
Persistent pulmonary hypertension	3(1.87%)	0
Respiratory diseases	95(59.3%)	7(3.15 %)
Shock	31(14.8)	7(3.68%)
Others	0	110(57.8%)



Flow of participants in the study

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Table II shows pulse oximetry findings in study population.

	SpO_2 <90%	Pre-Post Ductal Diff >3%	SpO_2 ≤95%	SpO_2 ≥95%
Cyanotic heart disease (10)	10(90%)	2(20%)	1(10%)	0
Acyanotic heart disease (15)	12(80)	2(13.3)	2(13.3)	1(6.6)
Persistent pulmonary hypertension (3)	3(100)	1(33.3)	0	0
Respiratory diseases (20)	95(79.1)	0	2(13.3)	(8.3)
Shock (30)	22(73.3)	0	6(20)	(6.6)
Others (110)	0	0	66(60)	44(40)

Table I & II compares the baseline demographic and clinical characteristics of cases and controls. Pulse oximetry was positive in 9 out of 10 (90 %) neonates with echocardiography proven cyanotic heart disease (d transposition of great arteries, n=2), (tetralogy of Fallot, n=3), (hypoplastic left heart n=1) , (tricuspid atresia n=2), (Total anomalous pulmonary venous connection n = 2). Pulse oximetry was negative in neonate with tetralogy of Fallot with mild pulmonary stenosis and large left to right shunt.

The sensitivity, specificity, positive predictive value, negative predictive value and odds ratio of pulse oximetry to detect cyanotic congenital heart disease was 90%, 55.58%, 5.62%, 99.47% and 11.3 respectively.

Discussion:

Since publication of several large studies that used pulse oximetry to screen for congenital heart defects in the newborn, pulse oximetry screening has generated considerableinterest among patients care providers and parents'group. [13,14]. These studies suggested pulse oximetry screening is feasible, cost-effective, and useful in detection of cardiac lesions. In this study, we found that neonates with CCHD were have been detected clinically within several hours of birth. Total of 500 neonates were screened for study, among them 350 neonates were screened for pulse oximetry screening test, in that 160 neonates were found to be positive and 190 were negative. All 350 neonates were undergone ECHO testing, in that we have seen only 10 neonates were found to have congenital heart disease, among them 9 CCHD neonates were detected in pulse oximetry positive group, and 1 neonate was detected from pulse oximetry negative group. In our study, only one case of cyanotic heart disease (tetralogy of Fallot) had a saturation persisting between 90% and 95%, because of this reading we have added this neonate under pulse oximetry negative group. The sensitivity and negative predictive values of pulse oximetry screening to detect cyanotic heart disease and critical congenital heart disease were high. Majority of the studies done in well infant nurseries had used the saturation cut-off of less than 95% for abnormal pulse oximetry [7,9,10]. The working group [5] recommended any saturation below 90% as abnormal for pulse oximetry screening in infant nursery, and recommended three repeated saturations taken 60 minutes, if the saturation is between 90% and 95%. Specificity of pulse oximetry was low because it was also positive in cases of respiratory diseases, acyanotic heart diseases with congestive heart failure, shock and persistent pulmonary hypertension which are common in neonatal intensive care settings.

To conclude, pulse oximetry screening is useful in detecting cyanotic heart diseases in a setting catering to sick out born neonates. Negative predictive value of pulse oximetry is high, making it useful to reliably rule out critical congenital heart disease or PPHN among sick neonates, thus avoiding need for an urgent echocardiography.

What This Study Adds? • Pulse oximetry screening is useful in detecting cyanotic heart diseases, critical duct-dependent systemic lesions and persistent pulmonary hypertension in sick neonates.

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