RESEARCH LETTER

Extended Pulse Oximetry Screening in Healthy Neonates

Supreet Khurana,[1] Suksham Jain,[1] Deepak Chawla,[1] Jeet Ram Kashyap[2]

Department of [1]Neonatology, [2]Cardiology, Government Medical College and Hospital, Chandigarh, India

Corresponding author: Dr. Supreet Khurana, Department of Neonatology, Government Medical College and Hospital, Chandigarh, India. *supreetkhurana85@gmail.com*

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ABSTRACT

Pre discharge pulse oximetry screening (POS) is recommended to pick up critical congenital heart diseases in apparently well neonates. However, it is possible that cases may be missed during the early POS in the presence of delayed closure of the ductus arteriosus. Repeat POS in the second week of life was found to be helpful and feasible for early detection of pathological states causing hypoxemia in seemingly well neonates. Studies with larger sample size are recommended to establish the role of an additional POS in the second week for enhanced CCHD detection.

***Keywords*:** Congenital heart disease, Cyanosis, Newborn, Saturation

Critical congenital heart diseases (CCHD) contribute towards up to 10% neonatal mortality and long-term morbidity [1]. Antenatal ultrasonography in the second trimester, alone has the potential to pick about 50% CCHD while neonatal physical examination alone has a highly variable sensitivity of 11-77% [2,3]. Pulse oximetry has emerged as an essential component of pre-discharge screening of the neonate to aid detection of CHD in apparently healthy neonates, especially in high income countries. It is recommended that all the neonates should undergo pulse oximetry screening (POS) preferably around 24 hours of life, or as close to discharge as possible, whichever is earlier, to pick up CCHD [4]. However, these recommendations are difficult to implement in resource-poor set-ups. Although, pre-discharge POS improves the detection rate of CCHD when combined with antenatal ultrasound and physical examination, however, chances of missing a CCHD still remain high [5]. POS has been shown to have only a moderate sensitivity of 73-79% primarily due to persistence of a patent ductus arteriosus (PDA) beyond first 48 hours of life in CCHDs with ductus dependent systemic circulation [6]. We hypothesized that an additional POS in the second week of life can increase the chances of picking up CCHD in the neonate.

A prospective observational diagnostic study was conducted at tertiary care teaching institute from January, 2020 to March, 2022. To improve upon the sensitivity of POS from a baseline of 75% (conducted once pre-discharge) to 84% (repeated after 7-14 days), with a power of 80% and type 1 error of 1% and considering a loss to follow up of 20%, a minimum sample size of 1030 was required.

All the inborn asymptomatic neonates ≥ 34 weeks of gestation at birth with minimum stay of 24 hours in the hospital and whose parents were willing for a follow-up between day 7-14 of life were enrolled consecutively in the study. Those with antenatal ultrasound suggestive of CHD or any other major malformation were excluded a priori.

A smart phone-based application with an attachable pulse oximeter cable were used to perform pulse oximetry (Masimo professional health with reusable iSpO2) at the bedside of the enrolled neonates after obtaining written informed consent from either of the parents. The pulse oximeter was connected sequentially to right-hand followed by one foot. POS along with neonatal physical examination were performed at 24-36 hours of age or at the time of discharge whichever was earlier. The probe was applied till the plethysmograph was stable and a consistent reading on the smart phone appeared (duration: 30 - 180 s at each site). Neonates with a saturation of ≤ 94% in right hand or foot, or a difference of ≥ 4 % between the right hand and foot

were considered as failed POS, and underwent an echocardiography on the same day by an expert cardiologist (JRK). The second POS was carried on between day 7 and day 14 of life using the same devise for all enrolled neonates who were available for follow-up. The study was approved by the institutional ethics committee.

A total of 1032 neonates underwent the initial POS before discharge from the hospital at a median age of 1.4 (1,1.9) days. Around 50% of these neonates were born by cesarean section with the median, one- and five-minute APGAR scores being 9 (9, 9). 867 (84%) neonates completed the second POS at a median postnatal age of 11 (9, 12.5) days. Most of the neonates missed the second screen due to traditional practice followed by mothers of going back to their parental house after discharge for better post-partum care. A significantly higher mean pre-ductal heart rate (HR), pre-post ductal SpO2 (peripheral capillary oxygen saturation) and post-ductal perfusion index (PI) were noted during the second POS (**Table I**), which could be explained by closure of ductus and gradual stabilization of the elevated pulmonary arterial pressures observed in neonates [7]. A total of 19 neonates failing the initial POS, underwent 2D- echocardiography and were hence not a part of second follow up. On comparing the POS parameters of the 11 neonates who failed second POS, the mean pre-ductal HR, pre-ductal PI and pre and post ductal SpO2 were found to be significantly lower during the second POS as compared to the first screen. The initial screen picked up two cases of CCHD namely VSD with pulmonary atresia and TGA with ASD and VSD while an additional case detected from repeat screen was of coarctation of aorta with moderate AS (CCHD) and another case of ASD, hence the pick rate of initial screen being 4.6/1000 neonates screened which increased by three additional cases detected (for all congenital heart diseases). Also, a good number of pathological states (pneumonia 5 and sepsis 2) were picked up by a repeat screen, which mandated admission prior to occurrence of overt clinical deterioration. The sensitivity and specificity increased from 66.67% (95% CI 9.43, 99.16) and 98.35% (95% CI 97.37, 99.04) amongst neonates who underwent first POS alone to 100% (95% CI 2.5, 100) and 98.85% (95% CI 97.89, 99.43) in those with repeat POS.

The incidence rate of CCHD occurrence is possibly lower in our study due to it being conducted at a tertiary care referral centre in comparison to literature representative of community screening rate [8]. Hence, a repeat screen has been shown to be not only feasible but also effective in timely pickup of conditions predisposing to adverse neonatal outcomes, particularly sepsis (7 out of 11 neonates who failed second POS had sepsis/pneumonia) amongst apparently healthy term and late preterm neonates. Study findings also urge towards need to conduct larger community-based trials to estimate the frequency of missed CCHD cases due to single pre-discharge pulse oximetry screening.

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Table I Comparison of Pulse Oximetry Screening Parameters

Parameters	*First POS screen* (*n* = 1032)	*Second POS screen (n=867)*	*P value*
Gestational age at birth (wks)	37.6 (2.07)	37.6 (1.74)	0.37
Birth weight (g)	2657.4 (475.9)	2622.7 (472.2)	0.10
Preductal heart rate (beats/min) [a]	130 (120, 140)	126 (118, 140)	0.001
Postductal heart rate (beats/min) [a]	130 (120, 139)	127 (120, 138)	0.32
Preductal SpO_2 (%)	97.04 (1.89)	97.40 (1.25)	< 0.001
Postductal SpO_2 (%)	97.41 (1.84)	97.83 (1.21)	< 0.001
Preductal perfusion index (PI)	2.2 (1.07)	2.24 (1.26)	0.45
Postductal perfusion index (PI)	1.95 (0.86)	2.17 (1.26)	< 0.001
POS screen passed neonates, n (%)	1013 (98.1)	856 (98.7)	0.3
POS screen failed neonates, n (%) CCHD CHD Pneumonia Sepsis Polycythemia PAH Cold stress	19 (1.8) 02 02 07 05 01 01 01	11 (1.2) 01 01 05 02 0 01 01	0.28
POS parameters of 2nd pos failed neonates (*n* = 11) Preductal heart rate (beats/min) [a] Postductal heart rate (beats/min) [a] Preductal SpO2 (%) Postductal SpO2 (%) Preductal PI Postductal PI	 130 (122, 150) 131 (122, 148) 96.63 (1.29) 97.36 (1.22) 2.48 (0.51) 2.76 (1.81)	 119 (112, 148) 120 (110, 132) 93.81 (1.19) 95.09 (2.99) 1.85 (0.58) 1.78 (0.69)	 0.036 0.070 <0.001 0.030 0.013 0.109

Data is presented as mean (SD) or [a]median (IQR)

CHD Congenital heart disease, PAH Pulmonary artery hypertension, PI Perfusion index, POS Pulse oximtery screening, SpO_2 Peripheral capillary oxygen saturation,