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Use of early pulse oximetry in the detection of cardiac lesions among asymptomatic term newborns

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KEYWORDS

Cardiac lesions;
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Abstract *Background and objectives:* Cardiovascular malformations are the commonest form of congenital defects and could result in significant morbidity. Antenatal and early postnatal detection is still unreliable, especially in developing countries and low-income communities. The aim of the study was to assess the value of early pulse oximetry in the detection of cardiac lesions among asymptomatic term newborns with subnormal oxygen saturation.

Patients and methods: A cross-sectional study was conducted at the well-baby nursery of a community hospital, between March and August 2013. A total of 120 asymptomatic, apparently healthy term newborns who had persistent postductal SpO_2 < 95% in the initial and repeat tests within the first 24 h after birth were consecutively enrolled. Pulse oximetry testing was performed after the age of 2 h and confirmed 2 h later. Cases with persistent saturation below 95% underwent echocardiography.

Results: 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.

Conclusion: 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.

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Introduction

Apparently healthy newborn babies may be admitted to the nursery with hidden malformations or an unrecognized disease. Despite looking pink to health workers observing them, the baby might have low arterial oxygen saturation; a sign of a disease.[1,2]

Cardiovascular malformations are the commonest type of congenital malformations.[3–5] The term congenital heart defects (CHDs) encompasses a variety of lesions with a wide spectrum of clinical significance, ranging from hemodynamically-insignificant to potentially significant lesions,[4] and hypoxemia is a common feature of many forms of CHD.[6]

Screening strategies to detect CHDs rely on antenatal ultrasound and postnatal clinical examination; however, both techniques have a fairly low detection rate for isolated defects and many babies are discharged from hospital without diagnosis.[7] Significant progress in the care of CHD patients has been observed, mostly due to improvements in diagnostic, medical, interventional and surgical management. However, no remarkable change in the detection of CHD in newborns has been noted.[8] Therefore the progress of screening strategies to enhance early detection is of great importance,[6,7] especially with the current tendency toward early postpartum discharge.[8]

Pulse oximetry (POx) is a noninvasive, quick, simple, safe and painless test that measures oxygen saturation (SpO_2), and adds value to the existing screening.[7,9–11] It does not require calibration and is able to provide instantaneous data that correlate well with blood gas measurements.[6] Thus, it may allow the early detection of hypoxemia that would not necessarily produce clinical cyanosis in initially asymptomatic lesions.[5]

The first hour of life is not suitable for POx testing owing to the large number of false findings.[12,13] Thereafter, infants can be examined at any time, but somewhat more reliably after 2 h.[12,14] Concurrently, it is challenging to set the cut-off value for a positive test. Based on several studies,[5,8,12,14] it has been recommended to use a SpO_2 value $<95\%$ in the lower limb.[15]

Pure left-to-right shunts such as ventricular septal defect (VSD), atrial septal defect (ASD), or patent ductus arteriosus (PDA) do not produce arterial desaturation, but some of these defects proved to be test-positive. This happened almost at all times within the first 24 h of life, probably due to bidirectional or right-to-left shunting during early postnatal transition.[5,12,16] Occasionally, shunting may occur at more than one level.[12]

In developing countries, many challenges oppose the management of CHDs, including early diagnosis, team approach, referral systems, medical insurance, limited resources, and availability of state-of-the-art pediatric cardiac centers.

Research to date in low-income countries has mainly prioritized the role of pulse oximetry in sick newborns and not in apparently healthy newborns. Meanwhile, there is no primary data on the prevalence of hypoxemia in asymptomatic newborns.[17] Currently in Egypt, pulse oximetry is not routinely applied in all maternity units especially in low-income communities.

The aim of the present study was to assess the value of early pulse oximetry in the detection of cardiac lesions among asymptomatic term newborns with subnormal oxygen saturation.

Patients and methods

Study design

This was a cross-sectional study conducted at Bab-El-Shaeria Hospital, Al-Azhar University, Cairo, Egypt, over a period of 6 months from March to August 2013. The study was approved by the local Ethics Committee. Informed parental consent was obtained prior to enrollment in the study.

Study population

The study included all consecutive candidates born and admitted to the well-baby nursery fulfilling the eligibility criteria. Asymptomatic, apparently-well babies delivered at term (37–40 completed weeks of gestation) who had persistent postductal $SpO_2 < 95\%$ in the initial and repeat tests within the first 24 h after birth, irrespective of the mode of delivery were included. Exclusion criteria included: preterm newborns, symptomatic newborns with cardiovascular instability or cyanosis, newborns with a cardiac murmur, respiratory distress or any other condition necessitating monitoring or admission to NICU or might cause desaturation, dysmorphic features or suspected to have clinical syndromes, a positive antenatal history, and an antenatal diagnosis of CHD or maternal history of PROM.

Methods

Pulse oximetry measurement was performed when the babies were awake, calm, fed and with normal temperature at the nursery between 2nd and 24th hours, using portable pulse oximetry (Huntleigh, smart signs, mini pulse, MP1 standard, Huntleigh Healthcare Ltd, UK) which displays fractional oxygen saturation and pulse rate. The probe was placed on the right foot for at least 2 min until a stable recording was obtained. After each measurement, the multiple-use sensor was disinfected.

If the initial $SpO_2 < 95\%$, POx test was repeated 2 h later. Newborns with persistent $SpO_2 < 95\%$ in the repeat test were subjected to thorough history taking and complete clinical evaluation by trained personnel; and underwent echocardiography.

Echocardiographic examination was performed by a single operator using GE Vivid 7 Dimension echocardiography machine (GE Medical System, N-3190, Horten, Norway), in standardized views (subcostal, apical, left parasternal and suprasternal), utilizing the two dimensional (2-D), color flow Doppler, continuous wave (CW), pulsed wave (PW) and motion-mode (M-mode).

Congenital heart disease was defined as "the presence of a gross structural abnormality of the heart or intrathoracic great vessels that is actually or potentially of functional significance".[18] Thus, isolated abnormalities of no functional consequence (such as persistent left superior vena cava), congenital arrhythmias and abnormalities of the transitional circulation and physiologic pulmonary branch stenosis, were not considered to be indicative of CHD.[5]

Based on the significance of echocardiographic findings, studied cases were categorized into 3 groups: significant