Clinical Examination and Pulse Oximetry to Detect Congenital Heart Defects

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Abstract

Background: Many studies have shown that arterial-pulse oximetry is an effective tool for screening congenital heart defects (CHD), and most of these studies have been carried out in developed countries.

Objective: Analyze primary data from the CHD screening performed through clinical examination and arterial-pulse oximetry in a maternity hospital, in the Brazilian Northeast.

Methods: Neonates born after 34 weeks of pregnancy and in good clinical conditions were screened for CHD through clinical examination (CE) and arterial-pulse oximetry (APO) after 24 hours of life and before hospital discharge.

Results: Screening techniques increased the detection of CHD at the maternity hospital. However, most cases were detected through clinical examination. Underperformance of arterial-pulse oximetry.

Conclusion: The combination of arterial-pulse oximetry and clinical examination is crucial in the detection of congenital heart defects. Arterial-pulse oximetry alone, although useful to detect critical cases, has underperformed against clinical examination.

Keywords: Mass screening; Heart defects, congenital; Oximetry

Introduction

Congenital heart defects (CHDs) affect 8-10 out of every 1,000 live births1-2. This incidence is a worldwide constant, and CHDs can be addressed as a public health issue3. This scenario is even worse in developing countries, where the lack of experts and mass screening programs usually leads to underdiagnosis.

Screening for critical congenital heart defects (CCHDs) with arterial-pulse oximetry (APO) has already been described in studies. Different protocols were used4-7, however the high levels of sensitivity and specificity reported led to its universal usage. On the other hand, most studies on APO screening was carried out in developed countries.

In this scenario, a Chinese study reported that combining clinical examination (CE) and APO increases the early diagnosis of CHD8. The authors concluded that adopting such combination is reasonable for CHD screening in different backgrounds.

The purpose hereof is to analyze primary data from the CHD screening performed through clinical examination and arterial-pulse oximetry in a maternity hospital, in the Brazilian Northeast.
Methods

The study comprised neonates born after 34 weeks of pregnancy, from January to October 2013, and in good health conditions, born in the maternity hospital of Instituto de Saúde Elpidio de Almeida, Campina Grande, state of Pernambuco, Brazil. Screening to detect CHD through clinical examination and arterial-pulse oximetry.

The study was approved by the Committee for Ethics in Research of Complexo Hospitalar Oswaldo Cruz, under No. 18024513.3.0000-5192.

The APO screening was performed with a pulse oximeter (PM 60, Mindray, Shenzhenm, China) placed on the newborn’s right hand and foot. Nurses responsible for the screening process underwent 1-week training taught by qualified professionals.

APO screening was positive when the difference between two APOs was >3% or when one of them was <95%. All measurements were performed on neonates after 24 hours of life.

For the clinical examination screening, neonatologists were trained to carry out a cardiovascular clinical examination focused on CHD detection, including observation of peripheral or central cyanosis, palpation of the precordium and peripheral pulses, besides the identification of heart murmurs by cardiac auscultation. Positive cases underwent screening echocardiography, whose protocol is already described. Abnormal or inconclusive cases were submitted to echocardiography performed by a pediatric cardiologist.

The cardiovascular clinical examination was carried out before hospital discharge.

Results

The screening comprised 4,027 neonates, 51.6% male with average weight at birth of 3.21 ±0.34 kg. Positive screening for 43 (1.07%) patients (27 by CE and 23 by APO). These patients underwent screening echocardiography. Newborns not included in the analysis: 1 neonate with hypertrophic cardiomyopathy, 2 with pericardial effusions, and 6 with patent ductus arteriosus.

Nine neonates presented CHD. Table 1 shows their respective diagnosis and their relation with altered APO or CE readings. No case of CHD was identified after hospital discharge.

Table 2 shows the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of all cases of CHD. Only 2 cases of CCHD (1 transposition of the great arteries and 1 total anomalous pulmonary venous drainage) were diagnosed. In these cases, APO presented a sensitivity of 100%, specificity of 99.53%, PPV of 9.52% and NPV of 100%. CE, in turn, presented a sensitivity of 100%, specificity of 99.38%, PPV of 7.41% and NPV of 100%.

Table 1
Congenital heart defects identified through clinical examination, arterial-pulse oximetry and through both methods

<table>
<thead>
<tr>
<th>CHD</th>
<th>Total n (%)</th>
<th>CE n (%)</th>
<th>APO n (%)</th>
<th>CE + APO n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VSD</td>
<td>6 (66.66)</td>
<td>5 (62.50)</td>
<td>2 (50.0)</td>
<td>6 (66.66)</td>
</tr>
<tr>
<td>TAPVD</td>
<td>1 (11.11)</td>
<td>1 (12.50)</td>
<td>1 (25.0)</td>
<td>1 (11.11)</td>
</tr>
<tr>
<td>PS</td>
<td>1 (11.11)</td>
<td>1 (12.50)</td>
<td>0 (0.0)</td>
<td>1 (11.11)</td>
</tr>
<tr>
<td>TGA</td>
<td>1 (11.11)</td>
<td>1 (12.50)</td>
<td>1 (25.0)</td>
<td>1 (11.11)</td>
</tr>
<tr>
<td>Total</td>
<td>9 (100.0)</td>
<td>8 (100.0)</td>
<td>4 (100.0)</td>
<td>9 (100.0)</td>
</tr>
</tbody>
</table>

CHD – congenital heart defect; CE – clinical examination; APO – arterial-pulse oximetry; VSD – ventricular septal defect; TAPVD – total anomalous pulmonary venous drainage; PS – pulmonary stenosis; TGA – transposition of the great arteries.
### Table 2
Sensitivity, specificity, positive predictive value and negative predictive value of APO and CE

<table>
<thead>
<tr>
<th></th>
<th>CE (%)</th>
<th>APO (%)</th>
<th>CE + APO (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>88.89</td>
<td>44.44</td>
<td>100.0</td>
</tr>
<tr>
<td>Specificity</td>
<td>99.55</td>
<td>99.53</td>
<td>99.55</td>
</tr>
<tr>
<td>Positive predictive value</td>
<td>30.77</td>
<td>17.39</td>
<td>33.33</td>
</tr>
<tr>
<td>Negative predictive value</td>
<td>99.98</td>
<td>99.88</td>
<td>100.0</td>
</tr>
</tbody>
</table>

CE – clinical examination; APO – arterial-pulse oximetry

### Discussion

This study highlights some restrictions of APO in developing countries. No prior study applying such methodology has been carried out in the Brazilian Northeast. The incidence of CHD was of 4.46 out of every 1,000 live births, when the diagnosis of persistent arterial ductus was included. Such incidence is lower than the numbers described in international literature, however, it can be explained by the exclusion of very preterm infants and newborns readmitted to ICUs (populations with higher incidence of CHD)\(^1,\)\(^2\).

Another fact that might have affected the results was that not all newborns had undergone echocardiography to confirm or deny the diagnosis of CHD. This study, however, has been carried out in the context of a pediatric cardiology network that promotes the continuous search of CHD cases after hospital discharge, minimizing the chance of false-negative diagnoses. Such approach has already been applied in other studies\(^1,\)\(^3\).

APO’s sensitivity was low to identify CHD. Many studies show high sensitivity and specificity values for APO, however, many others refute such findings. One in particular, carried out in India\(^12\), reported low sensitivity of APO and CE to detect CHD and CCHD. In backgrounds of work overload, which is typically observed in developing countries, human or technical factors might be responsible for such finding. However, the altered APO reading alone is deemed crucial in the diagnosis of certain CCHD\(^11\). This could not be analyzed in this study as the incidence of CCHD was not significant; besides, there were no isolated cases of altered APO readings. On the other hand, APO has shown high sensitivity and specificity for CCHD detection.

Several studies reported unsatisfactory results of CE to detect CHD\(^12\). However, it is worth noting that CE is a professional-dependent method. Therefore, upon appropriate training, the sensitivity and specificity of CE might increase. In this study, the CE reported high sensitivity and specificity, however, it is worth noting that virtually all cases showed obvious clinical signs, particularly murmurs. Therefore, it is difficult to determine whether the lack of prior CHD diagnosis was due to inefficient screening or lack of appropriate structure for evaluation of suspected cases. The combination of CE and APO delivered the best results.

The continuous training of health professionals in the performance of CE and APO, ideally associated with reduced work overload, is definitely the best approach to promote the detection of CHD in newborns from developing countries. Besides, the implementation of mass screening programs for CHD is paramount regardless of such changes, because even if we do not achieve ideal results, it will still promote an increase in the early detection of CHD.

### Conclusion

The combination of arterial-pulse oximetry (APO) and clinical examination (CE) is crucial in the detection of congenital heart defects (CHD). Despite lower results in CHD detection, the APO is essential in the diagnosis of CCHD.

### Potential Conflicts of Interest

No relevant potential conflicts of interest.

### Sources of Funding

This study had no external funding sources.

### Academic Association

This study is not associated to any graduate programs.
References


