Physical Examination and Pulse Oximetry in Newborn Infants: Out with the Old, in with the New?

Physical examination serves as the foundation for medical diagnosis and continues to be the primary means of managing critically ill children and of identifying potentially lethal congenital or acquired conditions.[1] In this issue of *The Journal*, 2 studies address some of the limitations of the physical examination and explore how commercially available technology—in this case, pulse oximetry—can complement routine physical examination to treat newborn infants with conditions such as congenital heart disease and respiratory depression.

Newborn infants with congenital heart disease (CHD) may be diagnosed in the nursery on the basis of physical examination findings such as a heart murmur or tachypnea, although the presence of these findings is inconsistent. One study suggests that the routine newborn physical examination failed to detect critical CHD in 69% of cases.[2]

A common feature of many forms of congenital heart disease is hypoxemia. Hypoxemia may result in obvious cyanosis. Generally, however, 4 g of deoxygenated hemoglobin is needed to produce visible cyanosis, and those children with mild hypoxemia (arterial oxygen saturation of 80% to 95%) may not be overtly cyanotic. Moreover, the identification of cyanosis is problematic in African-American and Hispanic neonates because of skin pigmentation.

Beginning in the 1990s, investigators began to explore the possible role of neonatal pulse oximetry in identifying CHD.[3,4] The published studies have all reported that pulse oximetry is able to identify some newborn infants with critical CHD who are otherwise asymptomatic and hence would presumably elude clinical detection before discharge from the newborn nursery. However, owing to the relatively small number of screened newborn infants in these published series, it has been challenging to determine whether oximetry screening should be incorporated into routine newborn care.[5]

Against this backdrop, Meberg et al[6] report the outcomes of a screening strategy to detect CHD using pulse oximetry at 14 centers in Norway—accounting for approximately 50% of all deliveries in the nation. Using this screening strategy, the investigators identified 40 asymptomatic newborn infants with congenital heart defects out of a birth cohort of over 50,000 children. Importantly, the majority of infants with CHD (94%) were identified by methods other than screening pulse oximetry such as prenatal diagnosis, newborn nursery physical examination, or identification after discharge from the newborn nursery. Hence, the detection rate of newborn oximetry for all forms of CHD must be considered quite poor. However, if one considers only those subjects with critical CHD—those lesions that require intervention and can result hemodynamic compromise—screening oximetry fared much better. Only 8 newborn infants with critical CHD were not detected by the oximetry screening program.

The false-positive rate of screening oximetry was relatively high (0.6%) in this series. One of the reasons that the false-positive rate is high is that the authors chose to screen soon after birth. It is known that the Spo_2 of newborn infants is lower in the first several hours after birth.[4] On the other hand, the median Spo_2 at 20 to 24 hours of life (97.8%) is similar to the results for healthy term infants between 2 and 7 days of age (97.6%).[7] Although the early screening strategy proposed by Meberg et al[6] provides an opportunity to identify critical CHD promptly and hence prevent hemodynamic compromise, it results in a false-positive rate that may not be practical and could incur higher costs. As such, screening after 24 hours but before hospital discharge may be a more reasonable strategy. Studies have suggested that the false-positive rate when testing is done after 24 hours is less than 0.1%.[8]

Another limitation of newborn oximetry screening is that some critical CHD lesions may produce little or no cyanosis. Newborn infants with coarctation of the aorta and to a much lesser extent hypoplastic left heart syndrome may have an Spo_2 of 95% in the lower extremities in the first days of life. In the present study, screening oximetry did identify several newborn infants with coarctation of the aorta. This would be in keeping with several smaller series that screening oximetry can detect just over 50% of newborn infants with coarctation.[4,9]

Interestingly, 3 of the subjects had a low Spo_2 at screening but were not identified with critical CHD before newborn nursery discharge. The reason for this paradox is that the investigators did

CHD Congenital heart disease

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not perform echocardiographic studies in all of the newborn infants with positive screens. Rather, further testing was performed at the discretion of the care providers. Given the known limitations of physical examination, a more prudent strategy might be to perform an echocardiogram on all newborn infants with a positive screen regardless of the physical examination findings. The latter approach undoubtedly adds costs and may be problematic at delivery centers without ready access to specialists trained in pediatric echocardiography, but it should allow much better detection of critical CHD.

Many caregivers and health policy experts may be uncomfortable endorsing a screening strategy that has the potential to miss almost one-half of newborn infants with the disease of interest. However, any strategy that can improve detection of critical CHD deserves consideration. Delayed or missed diagnosis of critical CHD can result in end-organ injury and death. Recent preliminary studies from United States suggest that for every 100,000 live births in the United States, there are approximately 1 to 3 deaths directly attributable to the delayed diagnosis of critical CHD.[10,11]

Hence, although the search for additional methods to identify critical CHD should be explored, screening pulse oximetry may be the best off-the-shelf technique available. Additional analysis of the optimal time of newborn screening (first day of life or later), the appropriate screening Spo_2 cutoff, and the economic implications of this strategy is warranted.

In a separate article, Kamlin et al[12] evaluated the utility of second-generation pulse oximetry to assess the heart rate of newborn infants in the delivery suite. Accurate assessment of heart is important as resuscitation algorithms are guided in part by the heart rate.[1] Heart rate is typically assessed either by auscultation or palpation of the pulses. Several studies have suggested that in the newborn infant, the determination of heart rate by physical examination is imprecise and may lead to inappropriate therapy.[13,14] Given the increasing availability of pulse oximetry, these investigators examined whether pulse oximetry may be a more appropriate method for determining heart rate of the newborn infant after delivery.

This pilot study suggested that pulse oximetry may indeed have a role in the assessment of the newborn infant at the time of delivery. Technical problems from the pulse oximeter remain a concern, however, and 12% of subjects needed to be excluded for this reason. In addition, even when the oximeters function properly, signal quality may be poor as the result of motion artifact or poor perfusion. Even though second-generation pulse oximeters provide better analysis of the signal quality, delivery room caregivers would need to make a rapid assessment of signal quality and determine whether the readings are sufficient to guide immediate therapy. Lastly, in the present study, there were only 2 infants who had a heart rate low enough to require cardiac compressions. Additional studies will be required to determine what role pulse oximetry should play in the newborn nursery.

Together, these 2 studies underscore the need to critically appraise time-honored physical examination findings. Although evolving technologies should not be adopted simply for their novelty, these strategies may provide an important complement to physical examination findings. Clearly, the current approaches to the diagnosis of CHD and assessment of the depressed newborn infant can be improved. It would seem very likely that pulse oximetry can play some role in that process.

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