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RESEARCH

Timing of Newborn Pulse Oximetry Screenings for Critical Congenital Heart Defects Before Discharge

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ABSTRACT

Objective: To determine if there would be positive results from a second pulse oximetry screening (POS) completed for newborns at discharge at 28 to 48 hours of age in addition to the newborn POS completed at 24 to 25 hours of age.

Design: Prospective descriptive research study.

Setting: Rural, mid-Atlantic, 13-bed, level I hospital.

Participants: Newborns ($N = 1{,}002$) at 35 weeks' gestation or older discharged from the newborn nursery.

Methods: Registered nurses (RNs) performed POS at 24 to 25 hours of age (POS 1) and at discharge but less than 48 hours of age (POS 2). Data related to critical congenital heart defects were collected.

Results: There were no positive POS results (O_2 saturation $\leq 90\%$) at POS 1 or POS 2, and no additional diagnostic tests were ordered as a result of POS. Although one full-term newborn had negative results at POS 1 and POS 2, the RN identified a murmur, and a subsequent echocardiogram was used to detect tetralogy of Fallot and pulmonary atresia. The RNs detected concerning conditions in 14 newborns that resulted in 28 additional tests, including echocardiograms (9), chest x-ray imaging (8), laboratory testing (7), electrocardiograms (3), and ultrasound imaging (1).

Conclusions: The POS-positive result rate was 0 for newborns at POS 1 and POS 2. Therefore, our study findings supported Maryland's mandate of one POS completed within 24 to 48 hours of birth. Nurses must continue to be vigilant about assessing newborns, including screening for critical congenital heart defects and congenital heart defects.

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Critical congenital heart defects (CCHD) account for 6% to 10% of all infant deaths (de Wahl Granelli et al., 2009). The seven major CCHDs are hypoplastic left heart syndrome, pulmonary atresia, tetralogy of Fallot, total anomalous pulmonary venous return, transposition of the great vessels, tricuspid atresia, and truncus arteriosus (Centers for Disease Control and Prevention [CDC], 2015). These account for 17% to 31% of all congenital heart diseases (CHDs), and most infants with these conditions die within the first year of life (CDC, 2015). Worldwide, approximately 8 per 1,000 infants are born with CHD (Hoffman, 2011), and of those 2.5 to 3.0 per 1,000 infants have CCHDs (Cuzzi & Bradshaw, 2011). In addition, 1 to 2 newborns per 1,000 live births have ductal-dependent circulation and need a patent ductus arteriosus for survival (de Wahl Granelli et al., 2009). Because of the hemodynamic compromise after constriction of the ductus, severe hypoxemia and acidosis occur and can lead to shock, organ damage, and death (Mahle et al., 2009).

A prenatal midtrimester sonogram or initial provider physical examination of the newborn may not detect CCHD (Ewer et al., 2011). Because newborns with CCHD may display behavior thought to be normal, such as poor feeding and being sleepy or irritable, CCHDs are difficult to diagnose. For this reason, pediatricians and pediatric cardiologists who perform newborn physical examinations before discharge sometimes miss CCHD (Hoffman, 2011). Cyanosis of the newborn may not be visible to health care providers until the pulse oximetry level is at or below 80% (Altman, 2014). Newborns with undiagnosed CCHD may be discharged to home only to return to the emergency department in critical condition within a few days after discharge. Late diagnosis

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Pulse oximetry screening is noninvasive, painless, inexpensive, and cost effective; positive results indicate the need for further tests for critical congenital heart defects.

is associated with increased morbidity and mortality because of hypoxemia and organ damage (Mahle, Martin, Beekman, Morrow, & Section on Cardiology and Cardiac Surgery Executive Committee, 2012; Shah, 2012). Pulse oximetry screening (POS) is a noninvasive, painless, inexpensive, and cost-effective method to screen for CCHD (Cuzzi & Bradshaw, 2011). Health care resources used to screen and evaluate newborns for CCHD far outweigh cost of late detection and infant death (Mahle et al., 2009).

Based on findings from the Secretary's Advisory Committee on Heritable Disorders in Newborns and Children and with strong backing from the American Heart Association and American Academy of Pediatrics (Mahle et al., 2009; Mahle et al., 2012; Shah, 2012), in 2011 Secretary of Health and Human Services Kathleen Sebelius recommended that pulse oximetry be added to the recommended uniform screening panel along with the current metabolic and hearing screenings (Kemper et al., 2011; Mahle et al., 2012; Shah, 2012). In May 2011, legislation was enacted for Maryland hospitals to implement POS. The Maryland Department of Health and Mental Hygiene was tasked with providing each hospital with a POS algorithm for conducting, tracking, and reporting outcomes and with an education program for staff and parents (Badawi & Blitzer, 2012). Thereafter, all Maryland hospitals were required to complete POS for all newborns at 24 to 48 hours of age. Based on these recommendations and mandates, the study site established a policy to screen newborns 24 to 48 hours old.

We conducted a literature search in the PubMed/National Center for Biotechnology Information Bookshelf, MEDLINE, and Nurse Proquest databases using the search terms *newborn screening, infant, CCHD, CCHD screening,* and *pulse oximetry* for years 2002 through 2014. We found no articles in which the authors compared outcomes in newborns screened at 24 hours versus at discharge (up to 48 hours of age). Annually, there are approximately 1,000 births at the study site, and nurses noted that most newborns were not seen by a health care provider until 2 days after discharge. This was of concern because this is a crucial time when the ductus arteriosis is closing and newborns with undetected CCHDs are at risk. Therefore, conducting the POS closer to discharge but not after 48 hours may help to detect CCHD and additional postductal heart anomalies. A further concern was that in the previous year at this site, eight newborns with CHD were transferred to a level III NICU; four needed immediate surgery. At a rural community hospital, resources are not always available or timely even when relationships with pediatric cardiologists and echocardiogram readings are in place. Confirming best practices to improve newborn outcomes was warranted. From an evidence-based practice perspective, research was needed to identify the number of newborns in whom CCHD and CHD would remain undetected after the 24-hour POS and before discharge or up to 48 hours of age.

The study objective was to determine if there would be positive results from a second POS completed for newborns at discharge at 28 to 48 hours of age (POS 2), in addition to the newborn POS completed at 24 to 25 hours of age (POS 1). Secondary objectives were to determine the presence of CHDs and the need for follow-up testing based on results of POS.

Methods

Design and Participants

This prospective descriptive study received institutional review board approval from the study hospital. The study population consisted of newborns in a rural hospital located in the mid-Atlantic region of the United States. Although it has a level I, 13-bed nursery, mother–baby dyad care is used to promote family-centered care. Study inclusion criteria were as follows: gestational age older than 35 weeks, provision of informed consent for participation in this research study by biological parent of the newborn being tested, and parent able to communicate in English or through use of the hospital language line. The one exclusion criterion was a known diagnosis of pulmonary or cardiac complications or other comorbidity that would preclude completion of the 24-hour and 48-hour screenings.

Procedure

All unit registered nurses (RNs) attended an in-service session led by the nurse investigators in which the study's purpose, procedures (population inclusion criteria, algorithm to use, timing of POS, and need for accurate timely results), documentation requirements, and possible need of an additional probe were described. The probe used at POS 1 was saved and used again at POS

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