Journal of Neonatal Nursing xxx (2017) 1–4

Contents lists available at ScienceDirect

Journal of Neonatal Nursing

journal homepage: www.elsevier.com/jneo

Original Article

Critical congenital heart disease screening does not predict car seat tolerance screen outcomes

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ARTICLE INFO

Article history:
Received 18 May 2017
Received in revised form
11 August 2017
Accepted 13 August 2017
Available online xxx

Keywords:
Car seat tolerance screen
Car seat test
Critical congenital heart disease screen
CCHD
Prematurity
Low birth weight

ABSTRACT

Background: Car Seat Tolerance Screening (CSTS) and Critical Congenital Heart Disease (CCHD) screens were both implemented to identify infants with cardiorespiratory distress. We hypothesized that the CCHD screen would be poorly sensitive to predict a failed CSTS for many reasons.
Methods: Retrospective record review of infants in 2013 who qualified for CSTS. Calculated sensitivity, specificity, predictive value (PV) of a failed CCHD screen to identify those infants who failed their CSTS.
Results: 270 subjects underwent both screens and 14 failed a CSTS (5.2%). Of these, 1 failed the CCHD and 1 had an equivocal result. None were diagnosed with CCHD. An abnormal CCHD (failed or equivocal) had a sensitivity = 14.3% and a PV = 40% for predicting CSTS failure.
Conclusions: CCHD screening is poorly sensitive and has poor PV for identifying those infants who are at risk of failing a CSTS. We therefore cannot recommend replacement of the CSTS with routine CCHD screening.

Introduction

Despite advances in neonatal care and improvement in survival and long term outcomes, discharge readiness remains one of the most difficult assessments in newborn medicine. Because of this, a number of screening tests have been implemented in order to determine cardiopulmonary maturity at the time of anticipated discharge. Two of the most commonly used in the United States are the Car Seat Tolerance Screen (CSTS) and the Critical Congenital Heart Disease (CCHD) screen.

As newborn medicine improves, neonates born smaller and more preterm are surviving and being discharged home at earlier postmenstrual ages and smaller weights. However, studies in the 1980s noted that these infants, despite being deemed otherwise ready for discharge home, were at risk for desaturation and bradycardia events when placed in their car seat (Willett et al., 1986, 1989). Therefore, since the early 1990s, the CSTS, or Car Seat Challenge, has been recommended by the American Academy of Pediatrics (AAP) (Safe transportation of premature, 1996; American Academy of Pediatrics, 1991; Bull et al., 2009). The Canadian Paediatric Society also began recommending performing CSTS in the early 2000s, but as of 2016 no longer recommends routine screening for preterm infants citing a lack of evidence on long term outcomes (Narvey, 2014). Minimal data exists on CSTS performance internationally.

This test involves a period of observation using pulse oximetry in the semi-upright car safety seat to monitor for periods of apnea, bradycardia, desaturations prior to discharge, and is recommended for all infants born preterm (<37 weeks gestational age, GA) and is also performed on numerous full term low birth weight (LBW, <2500 g) neonates. The recommended test duration is 90–120 min, or length of the car ride home, whichever is longer (Bull et al., 2009). Despite widespread implementation, little is known about the ability of the CSTS to identify infants at risk of cardiopulmonary events. Since this test is performed on premature infants, the majority of these tests are either performed or supervised by neonatal intensive care unit (NICU) or newborn nursery (NBN) nursing staff.

Abbreviations: AAP, American Academy of Pediatrics; CCHD, critical congenital heart disease; CI, confidence interval; CSTS, car seat tolerance screening; DOL, day of life; ECHO, echocardiogram; ED, emergency department; GA, Gestational age; LBW, low birth weight; LFNC, low flow nasal canula; NBN, newborn nursery; NICU, neonatal intensive care unit; PDA, patent ductus arteriosus; PFO, patent foramen ovale; PNC, prenatal care; UMMC, University of Maryland Medical Center.

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http://dx.doi.org/10.1016/j.jnn.2017.08.002
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A second common pre-discharge screening test for neonates in the US and internationally is the CCHD screen. The CCHD screen was implemented with the knowledge that earlier detection of critical congenital heart disease, or lesions that would require surgical intervention within the first year of life, leads to improved outcomes. Prenatal testing with fetal echocardiograms in every pregnancy would be expensive and time consuming. The CCHD screen involves performing pulse oximetry usually between 24 and 72 h of life (generally pre- and post-ductal) on all newborns in order to identify those affected. Though the incidence of CCHD diagnoses are rare, this test is thought to be an inexpensive and safe screening tool to identify those unknown at the time of birth. This test has been recommended since 2011 by the US Secretary of Health and Human Services, as well as the AAP and American Heart Association (Mahle et al., 2012). Additionally, countries including Norway, Switzerland, and the United Arab Emirates are close to universal screening in newborns, and pilot studies are occurring in the United Kingdom, Spain, Italy, Australia, China, and the Netherlands (Hom and Martin, 2014). Countries in Africa and South and Central America are also reported to be in the early stages of organization (Hom and Martin, 2014).

Those neonates who fail their CCHD screen generally undergo echocardiography and receive a cardiology consultation. Unlike the CSTS, the CCHD screen has been increasingly mandated by state laws and national recommendations (Glidewell et al., 2015; Kemper et al., 2011). And like the CSTS, this test is performed by NICU and NBN nurses for every neonate.

One question brought up in the CSTS literature is whether semi-upright positioning of the car seat significantly impacts cardiorespiratory status or if the CSTS is important simply as a period of continuous monitoring that may identify undiagnosed persistent respiratory immaturity (Davis et al., 2013). If the latter is the case, perhaps CCHD screening could replace CSTS as the sole discharge oximetry screen. Since the CCHD screen is mandatory, preterm and LBW infants will undergo both oximetry screening tests prior to discharge. The CSTS poses significant burden on nursing staff and resources since it lasts a minimum of 90–120 min while the CCHD screen, on the other hand, has been shown to take an average of <10 min to perform and poses minimal burden to the staff (Peterson et al., 2014). If the CCHD screen using fewer resources is already mandated, one question is whether this screen alone could also identify infants with cardiorespiratory immaturity while in the car seat, meaning we could safely discontinue CSTS testing in this population. Previous studies of the CSTS (Davis, 2015) have suggested that research should be performed to compare results of the CCHD and CSTS tests to identify which infants have predisposing conditions unrelated to car seat positioning and to assess the effect of car seat positioning on desaturation events.

In this study, our objective was to evaluate the sensitivity, specificity, and predictive value of routine CCHD screening to identify infants who fail an initial CSTS. We also sought to identify our compliance with CCHD and CSTS screening protocols. We hypothesized that CCHD screens would be poorly sensitive for detecting CSTS failure given the short duration of pulse oximetry monitoring.

Methods

This was a retrospective medical record review of infants born in 2013 and admitted to the University of Maryland Children's Hospital in Baltimore, MD. This study was approved by our Institutional Review Board. Inclusion criteria included subjects who qualified for CSTS due to preterm birth (<37 weeks birth GA) or LBW, and survival to discharge. Exclusion criteria included those discharged or transferred on positive pressure ventilation, or parents declined CSTS. Mandatory CCHD screening became state law in 2012 and therefore all infants qualified for CCHD screening in 2013. We collected data on clinical and demographic characteristics such as sex, race, GA, birth weight, amount of prenatal care (PNC) received, delivery mode, time spent in the NICU vs. NBN, respiratory support requirements, date/location/result of both the CSTS and CCHD screens. We reviewed all subsequent primary care appointments, emergency department (ED) visits, and admissions in order to determine if any CCHD diagnoses occurred outside of the newborn period.

Car seat tolerance screening

CSTS is performed in the unit of discharge, either the NBN or the NICU in each subjects' personal car seat. Car seat fit assessment is standardized per AAP recommendations (Bull et al., 2009) and performed by trained staff prior to testing. In 2013, failure criteria included: 1) Apnea, cessation of respirations for >20 s; 2) Bradycardia, any heart rate <80 bpm; 3) Desaturation, any drop in saturation <88%. Per our protocol, when an infant fails the CSTS, the provider is notified and proper restraint in the car seat is verified. Appropriate interventions are performed to ensure immediate safety (removal from car seat, oxygen administration, etc., as indicated). Location of the pulse oximetry probe is not specified nor recorded, so may be pre- or post-ductal.

CCHD screening

Our institution follows the AAP guidelines with recommended screening at >24 hrs–48 hrs after birth, prior to discharge.[10] Pre- and post-ductal oximetry are performed. A passed or "negative" CCHD screen occurs when saturations are both >94% and there is <4% difference between pre- and post-ductal saturations, and no further action is needed. A failed or "positive" screen occurs if any saturation <90%, and an ECHO is recommended. An equivocal screen involves any saturation 90–94% or >3% difference between pre- and post-ductal saturations. An equivocal screen may be repeated up to a total of 3 times until the screen is passed or negative. If the screen remains equivocal, this is considered a failed screen and an ECHO is recommended. Infants who have undergone an ECHO do not require CCHD screen prior to discharge.

Statistical analysis

We constructed a 2 × 2 table comparing CSTS results vs. CCHD results. We calculated sensitivity, specificity, and predictive value of a failed CCHD screen to identify those infants who failed their CSTS. We compared demographic and clinical risk factors using nonparametric Wilcoxon Rank-Sum Testing. Statistical analyses were performed using SAS 9.3 (SAS Institute, Carey, NC).

Results

We identified 428 subjects who qualified for CSTS due to being born LBW or preterm. Of these, 1 subject had parents decline testing, 22 died prior to CSTS, and 5 were on positive pressure ventilation at the time of transfer or discharge. Of the 400 who met all inclusion and exclusion criteria, 12 had no documented CSTS at the time of discharge from University of Maryland Medical Center (UMMC) and 22 were transferred to other facilities prior to CSTS, leaving 366 subjects with complete CSTS data (91.5%).

Of those without data on CSTS (n = 34, 8.5%), 3 had a prenatal diagnosis of double outlet right ventricle which was confirmed on postnatal echo, 28 had either a negative CCHD screen or an ECHO