Implementation of Critical Congenital Heart Disease Screening in Minnesota

WHAT’S KNOWN ON THIS SUBJECT: Pulse oximetry screening at 24 hours of age improves detection of critical congenital heart disease in asymptomatic newborns.

WHAT THIS STUDY ADDS: This study describes an initial experience with pulse oximetry screening for critical congenital heart disease and provides a strategy for preparing for state implementation of recent federal newborn screening recommendations.

OBJECTIVE: To assess the level of preparedness and resources needed in Minnesota for the implementation of newborn screening for critical congenital heart diseases (CCHDs).

METHODS: A cross sectional survey of all birth centers in Minnesota was performed to assess the capacity to deliver care essential for the CCHD screening program. Compliance with the screening algorithm, nursing workload, and cost were assessed by using a pilot program implemented in 6 normal newborn nurseries.

RESULTS: Ninety-one of 99 eligible centers participated in the survey and 90 reported the ability to screen newborns in accordance with recommendations. Only 22 centers, with 63% of births, had access to echocardiography and routinely stocked prostaglandins for neonatal use. Our pilot study screened 7549 newborns with 6 failed screens and 1 CCHD diagnosis. Two of the failed screens were due to misinterpretation of the algorithm, 1 failed screen was not reported, and 4 failed screens were not recognized. Repeated screens were required for 115 newborns, with 29% of retesting due to misinterpretation of the algorithm. The mean nursing time required was 5.5 minutes, and the cost was $5.10 per screen.

CONCLUSIONS: In Minnesota, two-thirds of newborns are born in centers with resources for initial diagnosis and management of CCHD. Implementation of a pilot screening program demonstrated minimal increase in nursing workload, but identified problems with interpretation of the algorithm and data reporting. This pilot project suggests the need for simplification of the algorithm, additional training of health care providers, and development of a centralized reporting mechanism. Pediatrics 2013;132:e587–e594
Newborn pulse oximetry screening has emerged as an effective way to detect asymptomatic newborns with most forms of critical congenital heart disease (CCHD). In September 2011, the US Secretary of Health and Human Services approved inclusion of newborn screening for CCHD to the Recommended Uniform Screening Panel. The addition of this screening tool to the Recommended Uniform Screening Panel provides the opportunity to improve the outcomes of children born with CCHD. Meeting the objectives of this point-of-care screening recommendation presents unprecedented challenges for normal newborn nurseries (NBNs) and state public health systems. CCHD screening requires hospital involvement and a quick-response local action plan unique to this disease. These challenges include not only developing the infrastructure to perform and monitor the screening, but also implementing a follow-up plan that provides safe care for newborns who fail the screen. The level of readiness of each state and NBN to successfully implement this screening is unknown and likely varies widely from state to state and between hospitals within the same state.

The Minnesota Department of Health (MDH) adopted implementation of newborn screening for CCHD in August 2012. Since October 2009, MDH has partnered with medical professionals including faculty at the University of Minnesota, local hospitals, and patient advocates to develop this program. Major challenges for the Minnesota screening program include the following: (1) a large, thinly populated state with pediatric cardiology care localized in southeastern metropolitan regions; (2) diverse NBNs with varied technology and staffing; (3) variable availability of echocardiography and pediatric cardiology services; and (4) variable level of specialized care and availability of prostaglandins (PGE1) for stabilization of infants with CCHD.

To better understand the level of preparedness for the diagnosis and management of CCHD, we conducted a questionnaire survey of all NBNs in the state of Minnesota. The responses from this survey led to creation of a statewide inventory of NBN characteristics that is crucial to assess the state’s capacity to implement newborn screening for CCHD. In addition, we implemented a pilot project of newborn CCHD screening in 6 NBNs in Minnesota to evaluate compliance with the recommended protocol, nursing workload, and cost of screening, which all need to be considered before state-wide implementation.

**METHODS**

**Survey of Birth Centers in Minnesota**

An e-mail-based questionnaire survey (Table 1) was sent to all NBNs in the state of Minnesota based on MDH 2010 birth data. A total of 106 NBNs were surveyed and follow-up telephone interviews with the NBN nurse managers, physicians, and pharmacists were completed between January and April 2012. The facilities were classified according to their location in a metro or rural area and their association with a larger health care system. A total of 67,933 newborns were delivered in these facilities in 2010. The distribution of births among the different categories of NBN is displayed in Table 2. The survey included a brief questionnaire structured to obtain information regarding the NBN capacity to deliver essential services for the CCHD screening program (Table 1), including the availability of motion-tolerant pulse oximeters, access to diagnostic pediatric cardiology services (echocardiogram and/or consultations), ability to transfer echocardiographic images electronically to a pediatric cardiology specialist, level of newborn care available at the center, and availability of PGE1 in the hospital’s active drug inventory.

**Pilot Program**

The pilot newborn screening program was started in August 2011. Data were collected and analyzed at 6 hospitals starting at implementation and ending in August 2012. Hospital 1 is a quaternary care center in the Twin Cities metropolitan area; hospitals 2 to 5 are large community hospitals within the Twin Cities metropolitan area with level II or III newborn care units. Hospital 6 is a rural hospital within a large health care system that has a level I NBN. All 6 hospitals had the ability to perform echocardiography, although the rural hospital used echocardiographers without specific pediatric training. Pulse oximetry screening was performed only in newborns admitted to the NBN by using a screening algorithm, which was ultimately adopted by the Secretary’s Advisory Committee on Heritable Disorders in Newborns and Children, the Health Resources Service Administration, the US Department of Health and Human Services, the American Academy of Pediatrics, and the American Heart Association (Fig 1) . All screens were performed with motion-tolerant pulse oximeters and reusable probes to minimize the cost of screening. Newborns clinically suspected to have heart disease were excluded from the screening. Training programs including informational materials about the purpose of the
screen and the technique of pulse oximetry, the recommended protocol, and a multiple choice knowledge test with answer key for assessment after the training were provided for the screening staff and primary care providers preceding the implementation of the screen in each center. Educational materials about CCHD and pulse oximetry screening were prepared for mothers and families and translated into Spanish, Somali, and Hmong, the most commonly spoken languages among minorities in Minnesota. The educational materials were distributed in the obstetrical practices affiliated with the NBNs along with an opt-out form for parents or guardians who wished to decline screening or data reporting. The algorithm recommends screening after 24 hours of age; however, provisions were made for NBN workflow and screening at less than 24 hours of age if necessary due to early discharge.

A data collection form was used to track age at time of screen, number of screens performed, time needed for screening, screen results, actions taken for newborns who failed the screen, and problems encountered during screening. Nursing staff completed the form and forwarded it to the coordinating center at the University of Minnesota. The institutional review boards at the University of Minnesota and participating hospitals approved this study.

**RESULTS**

**Survey of Birth Centers in Minnesota**

Of the 106 hospitals surveyed, 99 delivered newborns in 2012 and 91 NBNs replied to the survey. Ninety NBNs had pulse oximetry equipment meeting requirements for newborn screening.

The units responding to the survey deliver 94% of the newborns in Minnesota. Survey results are displayed in Table 3. Among the 90 NBNs with appropriate equipment for pulse oximetry, only 16 had access to in-house pediatric cardiology consultants, covering 43% of all births in the state. Most of these NBNs were in metropolitan areas or affiliated with a well-developed health care network. Twenty additional units had the ability to perform a same-day complete neonatal echocardiogram, covering 61% of the state's births. There were 44 more units that had intermittent coverage by an echocardiographer without specific pediatric training. Thus, at least 88% of newborns were covered by basic in-situ cardiac evaluation in the state of Minnesota; however, for 11% of them the echocardiograms could not be digitally transmitted to a pediatric cardiologist for interpretation. The effect of this delay was not assessed in this study.

Thirty-three units covering 65% of the state's annual births reported availability of PGE1 in the pediatric dosing form, but 7 of them provided only level I newborn care, suggesting that they might have limited ability to stabilize a decompensating child with PGE1 infusion. Overall, the availability of pediatric cardiology services was skewed toward less coverage in nonmetropolitan area hospitals, particularly those operating outside of a larger health care system (Fig 2).

**Pilot Newborn Pulse Oximetry Screening**

A total of 9634 newborns were born in the 6 hospitals during data collection, accounting for ~15% of the state's total annual births. Of them, 887 were admitted directly to the NICU, 22 had a clinical indication for a cardiology evaluation, and 272 families opted out...
of screening \((n = 41)\) or reporting \((n = 231)\), leaving 8453 newborns admitted to NBNs eligible for the study (Fig 3). Of these, 7549 newborns were screened by pulse oximetry, and 904 newborns were neither screened, nor reported \((10.7\%)\). Data from Hospital 1 suggest that \(~8\%\) of newborns admitted to the NBN at this site were discharged from the NICU or a medical-surgical floor, suggesting that some of these infants were not discharged from NBNs and were exempt from screening.

The mean age at first screen was 30 hours, with a range from 10 to 102 hours, and wide variation between NBNs (Table 4). Only 6 newborns were reported as failing the screening \((0.08\%)\), and the only 1 diagnosed with CCHD (Tetralogy of Fallot with pulmonary atresia) failed with the first measurement \((\text{oxygen saturation} < 90\%)\). The other 5 were reported as failed after the third test, although 1 “failure” was due to misinterpretation of the algorithm. Four of the newborns who failed screening had an echocardiogram within 4 hours. Three of them were diagnosed with neonatal pulmonary hypertension; and the fourth, whose screen was misinterpreted as failed, was normal. The remaining failed neonate passed a fourth screening outside of the protocol. Another neonate failed the screen for \(O_2\) saturation \(< 90\%\); however, the neonate was symptomatic and not eligible for the study. A subsequent cardiac evaluation was normal. None of the newborns who failed the screen were tested before 24 hours of age.

Twenty additional newborns were reported as “passes” on the data form, when in fact they failed based on a difference of \(>3\) points between right arm and foot \((\text{criterion B})\). Seventeen of these newborns failed the first test and should have been retested according to the protocol. The remaining 3 failed after the third test and should have had further evaluation. Follow-up data for 15 of the 17 infants from the first group and all 3 from the second group revealed no diagnoses of CCHD after discharge. There was 1 additional unreported newborn that failed criterion C \((\text{oxygen saturation} < 90\%)\). This newborn was correctly identified as failing at the point of care and underwent echocardiography before discharge, which was normal. Altogether, the screen generated 6 echocardiograms, whereas at least 22 echocardiograms were performed for clinical indications in the same time period. None of the echocardiograms for clinical indications revealed CCHD.

A small number of newborns were retested for a second \((n = 95)\) or third \((n = 20)\) time, with 29% of retesting due to inappropriate interpretation of the algorithm (Table 5). In 4 patients, screening failure due to an \(O_2\) saturation \(< 90\%\) was followed by rescreening instead of triggering immediate evaluation as recommended in the protocol. All of these patients failed repeat screening and underwent echocardiography with no

### Table 3 Survey Results From the 99 Active Minnesota NBNs in 2012

<table>
<thead>
<tr>
<th>Total Births, 67,693</th>
<th>Number of Centers (% of Births Covered)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Pulse oximetry availability</td>
<td>90 (94)</td>
</tr>
<tr>
<td>Echocardiography availability</td>
<td>80 (86)</td>
</tr>
<tr>
<td>Pediatric echocardiography availability</td>
<td>36 (61)</td>
</tr>
<tr>
<td>Pediatric cardiology consultation availability</td>
<td>16 (43)</td>
</tr>
<tr>
<td>Digital transmission of echocardiograms</td>
<td>57 (75)</td>
</tr>
<tr>
<td>Digital transmission of other data</td>
<td>88 (84)</td>
</tr>
<tr>
<td>Availability of PGE1</td>
<td>29 (65)</td>
</tr>
<tr>
<td>Level I nursery</td>
<td>33 (75)</td>
</tr>
<tr>
<td>Level I with PGE1</td>
<td>22 (85)</td>
</tr>
</tbody>
</table>

### Figure 2
Percentage (%) of births with access to the service available in NBN by location of NBN and affiliation with a health care system.
CCHD diagnoses. The most common indication for rescreening with appropriate interpretation of the algorithm was the presence of more than 3 points difference in the oxygen saturation between the right arm and foot (criterion B) (42%) with the remaining cases rescreened due to oxygen saturations of 90% to 94% (criterion A) (29%).

Mean nursing time reported for screening was 5.5 min (range 1–40 minutes) and this remained constant throughout the study and between NBNs (Table 4). Equipment related reasons were the most frequently noted cause \((n = 90)\) for prolonging the time required to screen, whereas patient-related reasons were noted in only 6 cases. The failed screens were not associated with longer time needed for a reading (mean time 5.1 minutes versus 5.5 minutes for all screens). The times reported did not include additional time spent explaining the screening to families or reporting the results. The nursing time spent for CCHD screening corresponded to 4.75% of a nursing full-time equivalent for 1000 screens. Based on a nursing salary of $70 000 dollars annually, the nursing cost of CCHD screening was calculated to be $3324 per 1000 newborns. Additional expenses included the cost of a reusable probe ($300) that could be used for up to 1000 screens and the cost of straps ($0.60 per strap \(\times 2\) per patient). Nursing time and supplies cost $5.10 per infant screened in Minnesota.10 The cost of each neonatal echocardiogram in our system is $1300, which raises the cost of screening to $46 300 per patient diagnosed with CCHD. This cost favorably compares to the newborn screening for metabolic diseases with an estimated cost of $68 750 per case detected.10

**DISCUSSION**

In this report, we present the needs assessment for newborn CCHD screening in the state of Minnesota obtained by survey of the state’s NBNs. The state’s current infrastructure for CCHD screening and pediatric cardiology support covers ~85% of the state’s hospital births, which is comparable to data from Wisconsin.11 Disparities between resources for CCHD screening and follow-up in metropolitan centers, centers affiliated with a large health care system, and rural independent centers exist, but overall, the survey suggests that the state is adequately prepared and equipped for implementation of CCHD screening. However, only two-thirds of newborns are born in an NBN that is adequately prepared to manage an infant with CCHD. In addition, data from interviews with hospital employees suggest that the availability of an echocardiographer able to acquire basic views to diagnose CCHD and/or of PGE1 to stabilize an infant with CCHD varies at times in small rural hospitals. The instability of resources critical for the management of CCHD supports the need for a centralized system to assess hospital readiness to recognize and treat newborns with CCHD. The most critical aspects of early care for infants with suspected ductal dependent CCHD is correct identification and prompt initiation of PGE1 to maintain patency of the ductus arteriosus, preventing the morbidity and mortality associated with severe hypoxemia and hypoperfusion.12 In support of this strategy, recent data from Washington, a state with geographic challenges similar to Minnesota, demonstrate that birth hospital location and need for transport does not affect outcomes for CCHD if initial stabilization is initiated in a timely manner.13 The state of Minnesota currently uses a secure database-driven, password-protected Web application called MNTrac for its emergency preparedness efforts. This application has been designed to track hospital information and could be used to triage patients with possible CCHD to an appropriate location for acute care. This pilot program offered useful information before statewide implementation.
TABLE 4 Results of Pilot Screening Program in Minnesota

<table>
<thead>
<tr>
<th>Hospital</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total births</td>
<td>1778</td>
<td>2689</td>
<td>2561</td>
<td>1645</td>
<td>493</td>
<td>468</td>
</tr>
<tr>
<td>Admissions to NBN</td>
<td>1503</td>
<td>2508</td>
<td>2379</td>
<td>1518</td>
<td>404</td>
<td>426</td>
</tr>
<tr>
<td>Opt-out screening</td>
<td>3</td>
<td>28</td>
<td>7</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Opt-out reporting</td>
<td>14</td>
<td>2</td>
<td>99</td>
<td>113</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Expected to screen and report</td>
<td>1192</td>
<td>2125</td>
<td>2150</td>
<td>1403</td>
<td>353</td>
<td>410</td>
</tr>
<tr>
<td>Newborns with available data</td>
<td>31 ± 15 (10–102)</td>
<td>31 ± 16 (10–98)</td>
<td>26 ± 15 (11–93)</td>
<td>27 ± 8 (12–98)</td>
<td>27 ± 6 (17–75)</td>
<td>27 ± 7 (10–75)</td>
</tr>
<tr>
<td>Number of newborns with:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 tests</td>
<td>4</td>
<td>16</td>
<td>22</td>
<td>38</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>3 tests</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>RA O₂ saturation for passes, mean ± SD (range)</td>
<td>98 ± 1% (90–100)</td>
<td>98 ± 1% (85–100)</td>
<td>98 ± 1% (80–100)</td>
<td>98 ± 2% (81–100)</td>
<td>98 ± 1% (85–100)</td>
<td>98 ± 1% (91–100)</td>
</tr>
<tr>
<td>Ft O₂ saturation for passes, mean ± SD (range)</td>
<td>99 ± 1% (92–100)</td>
<td>99 ± 2% (77–100)</td>
<td>99 ± 1% (81–100)</td>
<td>99 ± 3% (74–100)</td>
<td>99 ± 1% (85–100)</td>
<td>99 ± 1% (91–100)</td>
</tr>
<tr>
<td>RA-Ft O₂ saturation for passes, mean ± SD (range)</td>
<td>1 ± 1 (0–7)</td>
<td>1 ± 1 (0–9)</td>
<td>1 ± 1 (0–7)</td>
<td>1 ± 1 (0–8)</td>
<td>1 ± 1 (0–6)</td>
<td>1 ± 1 (0–8)</td>
</tr>
<tr>
<td>Needed second test for O₂ saturation 90%–94%</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Needed second test for O₂ saturation</td>
<td>1</td>
<td>0</td>
<td>5</td>
<td>8</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Misinterpretation of protocol</td>
<td>2</td>
<td>6</td>
<td>10</td>
<td>15</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Misinterpretation of protocol</td>
<td>2</td>
<td>6</td>
<td>10</td>
<td>15</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Failed screen for O₂ saturation 90%–94%</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failed screen for O₂ saturation 90%–94%</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failed screen for RA-Ft O₂ saturation &gt;3%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failed screen and RA-Ft O₂ saturation &gt;3%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Failed screen and RA-Ft O₂ saturation</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Missed/Misreported</td>
<td>2/0</td>
<td>7/1</td>
<td>8/0</td>
<td>0/2</td>
<td>1/0</td>
<td>2/0</td>
</tr>
</tbody>
</table>

Ra, fort, RA, right arm; RA-Ft, absolute difference between right arm and foot oxygen saturations.

*Missed group includes patients who failed the oxygen test by 1 or more of the criteria but were not identified as “failed” and did not complete the testing process.

*Misreported group includes patients who were not reported as failures despite meeting failing criteria.

There were some differences in the age and sex of newborns that passed and identified with correct interpretation of the algorithm had either anatomic or physiologic explanations for the observed oxygen saturations. Participation from 2 additional congenital heart centers from Minnesota and several centers in border states will be required to complete follow-up of this cohort and identify newborns that passed and identified screening positive (false-negatives). There was little difference between study sites in the predominant mode of delivery at NBIs (vaginal versus caesarean) when infants had their first screen. There were some differences in the age and sex of newborns that passed and identified screening positive (false-negatives). There was little difference between study sites in the predominant mode of delivery at NBIs (vaginal versus caesarean) when infants had their first screen. There were some differences in the age and sex of newborns that passed and identified screening positive (false-negatives). There was little difference between study sites in the predominant mode of delivery at NBIs (vaginal versus caesarean).
delivery) or emphasis on early discharge. Although the mean time required for screening was 5.5 minutes and did not change significantly during the study period, there was a wide range of time required. Some of the screening outliers may have included time spent discussing the screen with parents, despite instructions not to include this in the reported time.

The study identified significant compliance problems with the recommended algorithm, leading to unnecessary re-testing or echocardiography and to newborns being discharged without completing evaluation for failed screens. These compliance failures demonstrate the need for rigorous initial training and frequent training updates for screening staff. In addition, we would recommend coupling data collection to electronic medical record systems with an automatic notification feature triggered by values outside the protocol’s cutoff thresholds. Real-time monitoring will ensure that appropriate screening and interpretation is occurring. The MDH is currently evaluating a system that will allow transmission of pulse oximetry screening results directly from specially modified pulse oximetry devices to the MDH’s newborn screening program for analysis and feedback. This secure, centralized program would improve CCHD detection and follow-up. Finally, simplification of the protocol to highlight “trigger” values (ie, “less than or equal to 89%” and “less than or equal to 4 points” versus “less than 90%–94%” or “less than 3 points”) would likely improve interpretation rates, as might single site (foot) screening.

Limitations of this study include a lack of follow-up data to determine the incidence of false-negative screens, which is important to assess the efficacy of screening efforts. In addition, the experience in the selected hospitals does not necessarily reflect the population and level of care provided in the larger, more rural areas of the state. Finally, the calculation of cost for the state of Minnesota may not apply to other states and does not include cost related to transport or delayed discharge.

Overall, this report describes a model for assessing a state’s needs for implementation of newborn screening for CCHD and describes our initial experience with this program. Our data suggest the need for simplification of the screening algorithm, additional training of health care providers, and development of standards for data collection, electronic results reporting, and a centralized reporting and review mechanism. This experience will be used for refinement of the screening program and resource allocation in Minnesota as screening is implemented statewide. We hope that this experience will provide a framework for implementation in other states facing similar challenges.

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REFERENCES


6. Cuzzi S, Bradshaw E. The road to universal pulse-oximetry screening: are we there yet? *Pediatrics*. 2011;128(5). Available at: www.pediatrics.org/cgi/content/full/128/5/e1271


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