Objectives

• Provide information on newborn screening for critical congenital heart defects using pulse oximetry

• Cover Georgia’s procedures for critical congenital heart disease (CCHD) screening, follow-up for at risk infants and result reporting
Critical Congenital Heart Disease

CCHD is a group of heart defects that can be life threatening and require medical attention within the first few days or first year of life.

- Baby’s First Test, 2013

300 Infants sent home each year in the US with undiagnosed CCHD putting them at risk for serious complications.
Newborn Screening Goals

1. Education of providers and families
2. Early identification
3. Early intervention through timely follow-up
4. Reduced morbidity and mortality
Why Screen for CCHD?

Newborns with CCHD typically appear normal at birth

Screening identifies CCHD before symptoms are detected

Early identification can result in better outcomes

Factors Contributing to Missed Detection:
1. Absence of Murmurs
2. Palpable pulses from presence of PDA
3. Cyanosis (difficult to detect in many newborns) not noticeable when $O_2$ saturation between 80-89 percent.

We Protect Lives.
Early Detection of CCHD: Examination and Screening

- CCHD can be identified as a result of either prenatal ultrasound or postnatal physical exam but is missed in a small percentage of births

- Detection rates for CCHD:
  - Prenatal ultrasound: ~25-50%
  - Postnatal newborn physical exams: ~25-50%

- Approximately 30% of the remaining infants will be undetected in the immediate newborn period

- Some of these will present with life threatening symptoms shortly after discharge
Pulse Oximetry Screening

A pulse oximeter is used to measure the percentage of hemoglobin in the blood that is saturated with oxygen.

Strengths

- Inexpensive
- Non-invasive
- Painless
- Quick
- Simple
- Saves Lives

Weaknesses

- Possible false positives and negatives
- Not all types of CHD detectable
- Costly follow-up
- Requires change in work flows

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## Detectable CCHD Defects Through Screening

### Primary Targets
- Hypoplastic left heart syndrome
- Pulmonary Atresia (with intact septum)
- Tetralogy of Fallot
- Tricuspid Atresia
- Total anomalous pulmonary venous connection
- Truncus Arteriosus
- Transposition of the great vessels

### Secondary Targets
- Single Ventricle
- Coarctation
- Interrupted aortic arch
- Ebstein Anomaly
- Double-outlet right ventricle
- Aortic Atresia
- Hypoplasia of aortic arch
Hospitals’ Role in CCHD Screening

Georgia law requires hospitals to perform a pulse oximetry screen on all live births before discharge. Key implementation considerations include:

- Time of Initial Screening
- Early Discharge Screening
- Referral and Further Evaluation
- Completion of Delayed Reporting Form
Equipment

- Motion-tolerant and report functional oxygen saturation
- Validated in low-perfusion conditions
- Cleared by the FDA for use in newborns
- 2% root, mean-square accuracy
- Calibrated regularly based on manufacturer guidelines
- Used with Infant Disposable or Reusable Pulse oximeter probes
Why No Adult Oximeters?

Conventional Adult Oximeter

• Does not have heart rate (HR) display with normal correlation for newborns
• Does not have stable pleth wave with motion artifact

Adult Probe

• Clips too large for testing newborns
• Gives inaccurate readings
Factors Affecting Pulse Oximetry Interpretation

- Translucency and blood flow where the measurement is taken
- Extreme low body temperatures
- Blood volume deficiency
- Exposure to strong external light while taking measurement
Pulse Oximeter Probe Placement

Place the photo-detector portion of the probe on the fleshly portion of the outside of the infant’s right hand or foot.

1

Right Hand Application Site

Place the light emitter portion of the probe on the top of the hand or foot.

2

Place the photo-detector directly opposite of light emitter, on the bottom of the hand or foot.

3

Foot Application Site
Additional Screening Tips

- Clean reusable probes with recommended disinfectant, as dirty probes can decrease accuracy of the reading.
- Use disposable wraps to secure sensor to right hand or foot, with no gaps between probe and infant’s skin.
- Allow the pulse-ox to remain in place for at least 30 seconds before obtaining a reading.
- Ensure pleth wave on the oximeter (arterial pulse) is stable at the monitoring site and is without motion artifact.
Performing CCHD Screening

<table>
<thead>
<tr>
<th>Time of Screening (per AAP Guidelines)</th>
<th>Environment for testing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 24 hours of age</td>
<td>Quiet, comforting</td>
</tr>
<tr>
<td>If discharged before 24 hours old, screen as close to 24 hours as possible</td>
<td>Avoid noise and harsh lights</td>
</tr>
<tr>
<td></td>
<td>Babies should be warm, quiet, alert, not crying or moving</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Assess for</th>
<th>Other Screening Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothermia</td>
<td>Perform prior to painful heel-stick procedures</td>
</tr>
<tr>
<td>Presence/adequacy of pulses</td>
<td>Document results on NBS card</td>
</tr>
<tr>
<td>Phototherapy</td>
<td>For delayed reporting, complete delayed reporting form. Fax to NBS Program.</td>
</tr>
<tr>
<td>Presence of dried blood, footprint ink, betadine solution</td>
<td></td>
</tr>
</tbody>
</table>
AAP-endorsed CCHD Screening Algorithm

Child in well-baby nursery ≥ 24 hours of age or shortly before discharge if ≤ 24 hours of age

Screen

- <90% in right hand or foot
- 90% - <95% in right hand and foot or >3% difference between right hand and foot
- ≥95% in right hand or foot and ≤3% difference between right hand and foot

Repeat screen in 1 hour

- <90% in right hand or foot
- 90% - <95% in right hand and foot or >3% difference between right hand and foot
- ≥95% in right hand or foot and ≤3% difference between right hand and foot

Repeat screen in 1 hour

- <90% in right hand or foot
- 90% - <95% in right hand and foot or >3% difference between right hand and foot
- ≥95% in right hand or foot and ≤3% difference between right hand and foot

Positive Screen

Negative Screen
Using the Screening Tool

A positive screen = “fail”

1. Any oxygen saturation value <90% (right hand or either foot)
2. Oxygen saturation value <95% in both extremities on 3 different measurements, each separated by one hour or
3. A >3% difference in oxygen saturation between the right hand and foot on 3 measurements each separated by one hour.

A negative screen = “pass”

Any oxygen saturation value that is ≥ 95% in either extremity and ≤ 3% difference in oxygen saturation between the upper and lower extremity.

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Calculating Pulse Oximetry Values

• Use of calculator

• CCHD Smartphone App:  http://pulseoxtool.com/index.php

• Use of Pulse Oximetry Grid
  1. The combined values from the right hand and either foot must be used in order to identify a pass, fail or requires re-screening:
  2. The pulse oximeter values for the right hand are located in the column on the left side of the grid.
  3. The rest of the grid contains the pulse oximeter values for either foot.
  4. Obtain values for right hand and either foot
  5. If value falls in “green” section, no action is needed.
  6. If value falls in “yellow” or “red” section, Action is needed. Refer to the AAP – endorsed CCHD screening algorithm to determine the action required.
The screening should occur in the **right hand** and **either foot**. If using only one pulse oximeter, test one right after the other.
Factors that can lead to false positive results:
- Lung disease
- Sepsis
- Screened too early

Factors that can lead to false negative results:
Not all CHD defects detected through pulse oximetry screening
Documenting Results on NBS Card

All pulse oximetry screening results must be entered on the card for all screens done.

**CCHD screening section:**

<table>
<thead>
<tr>
<th>CCHD Results</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial:</td>
<td></td>
</tr>
<tr>
<td>Repeat #1</td>
<td></td>
</tr>
<tr>
<td>Repeat #2</td>
<td></td>
</tr>
<tr>
<td>Final Outcome</td>
<td></td>
</tr>
</tbody>
</table>

- Enter results for right hand, foot and time of screening in the correct spaces.
- Check the box for final outcome (pass or fail).
- Enter either hospital or cardiologist name in the referred to box for follow-up.
Delayed Reporting

If CCHD screening results are not available and the bloodspot is ready to be shipped.

What to Do?

• Complete the “Delayed Screening Report”
• Fax a copy of the delayed screening report form to: Newborn Screening Program @ 404-657-2773
• Place original copy in medical record
Delayed Screening Report Form

Delayed Screening Report

When an infant is screened for hearing loss and CHD, and the results were not documented on the NBS card, the hospital or birthing facility must complete this form and fax to the NBS program.

Complete a separate form for each screening report.

Date ______________________ / ______________ / ______________

Submitting Facility (print)

Place Hospital Label Here

Hearing Screening Results

Hearing Screen Date: ______________ / ______________ / ______________

<table>
<thead>
<tr>
<th>Right Ear</th>
<th>Left Ear</th>
<th>Screen Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Pass</td>
<td>☐ Pass</td>
<td>☐ aABR</td>
</tr>
<tr>
<td>☐ Refer</td>
<td>☐ Refer</td>
<td>☐ aOAE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>☐ aABR and aOAE</td>
</tr>
</tbody>
</table>

CHD Screening Results

Initial Screening: (If rescree is required proceed to second screening):

<table>
<thead>
<tr>
<th>Time and Date:</th>
<th>Pulse Ox Saturation of Foot:</th>
<th>Pulse Ox Saturation of Right Hand:</th>
<th>Difference (right hand – foot):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>☐ Fail ☐ Pass ☐ Rescreen</td>
</tr>
</tbody>
</table>

Second Screening: (1 hour following initial screening if rescree is required):

<table>
<thead>
<tr>
<th>Time and Date:</th>
<th>Pulse Ox Saturation of Foot:</th>
<th>Pulse Ox Saturation of Right Hand:</th>
<th>Difference (right hand – foot):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>☐ Fail ☐ Pass ☐ Rescreen</td>
</tr>
</tbody>
</table>

Third Screening: (1 hour following second screening if rescree is required):

<table>
<thead>
<tr>
<th>Time and Date:</th>
<th>Pulse Ox Saturation of Foot:</th>
<th>Pulse Ox Saturation of Right Hand:</th>
<th>Difference (right hand – foot):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>☐ Fail ☐ Pass ☐ Rescreen</td>
</tr>
</tbody>
</table>

Referred To (Physician or Hospital):

CCHD Screener’s First Initial/Last Name:

Please fax this form to the Georgia Newborn Screening Program at 404-657-2773.

MOH CH 1208
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Pediatric Echocardiology and Referral Resources

Children’s Healthcare of Atlanta, Sibley Heart Center, 404-256-2593

Georgia Pediatric Cardiology, 678-289-1988

Pediatric Cardiology Services, 770-995-6684

Savannah Children’s Heart Center, 912-988-5050

GRU Pediatric Cardiology Services, 706-721-8522
Resources

Baby’s First Test

Heart Smart Videos

Centers of Disease Control and Prevention

Children’s National Medical Center

Mended Little Hearts
References

- Hokanson, J.S. Pulse Oximetry Screening for Unrecognized Congenital Heart Disease in Neonates. *Congenital Cardiology Today*. 2011; 9(1).
Acknowledgements

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• Georgia Hospital Association
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• Minnesota Department of Public Health
• Sibley Heart Center