Cyanosis in the Newborn

NUHS-Evanston
General Care Nursery Rotation
Objectives

1. What is the Definition of Cyanosis?

2. What Physiologically Causes Cyanosis?

3. What Affects your Ability to Detect Cyanosis?

4. What is your DDx for Cyanosis in a Newborn?

5. What is your Initial Management of Cyanosis?
Case 1

- You are paged by the Nursery RN Term infant was just delivered and now is starting to look “blue”
- As you are running over you ask the medical student who is trying to keep up with you…”
  - what is the definition of cyanosis
  - and it’s two main classifications?”
- Your astute well read medical student replies…
CYANOSIS

• “Bluish discoloration of the tissues when the absolute level of reduced (deoxygenated) hemoglobin in the capillary bed exceeds 3 g/dL.”

Two Categories of Cyanosis

Peripheral

Physiology: *Increased O2 extraction by the tissues*

Exam: distal extremities and +/- circumoral or periorbital areas cyanotic (but have pink Mucous Membranes)

Causes: vasomotor instability, vasoconstriction

Example: Acrocyanosis

Central

Physiology: *Systemic Arterial Oxygen Desaturation*

Exam: globally cyanotic including mucous membranes

4 Likely Causes:
1. Hypoventilation
2. Pulmonary Disease
3. Right to Left Shunts
4. Hemoglobin Disorder

Examples: Hypoplastic Left Heart, Central Hypoventilation Syndrome
One more question

• So proud of the medical student you ask her one last question before rounding the corner into the nursery…

• What are 3 factors that affect your ability to Detect Cyanosis?

(hint: 2 of the 3 have to do with the fact that cyanosis has to do with reduced/deoxygenated Hemoglobin)
Factors Affecting Cyanosis Detection

Hemoglobin Concentration
- Cyanosis is dependent upon the total amount of reduced hemoglobin NOT the ratio of reduced to oxygenated hemoglobin
  - Infant Hgb of 20 → cyanosis will be visible at SaO2 of 86%
  - Infant Hgb of 9 → cyanosis not visible until SaO2 is 67%

Factors Affecting the Oxygen Dissociation Curve
- **Shifts to the Left** (↑Fetal Hgb, Low Temp, Low CO2, Low 2,3,DPG)
  - Higher O2 affinity to Hgb → cyanosis seen at LOWER PaO2 levels
- **Shifts to the Right** (↑Adult Hbg, Fever, Acidosis, High 2,3 DPG)
  - Less O2 affinity, more reduced Hgb → cyanosis seen at HIGHER PaO2

Skin Pigmentation
- check mucous membranes and nail beds when evaluating for cyanosis
Back to the Case...

• You arrive in the nursery to find the infant looking like this...

• What is your diagnosis?
Case 1 Diagnosis: Acrocyanosis

- **Acrocyanosis**
  - Peripheral cyanosis around the mouth and the extremities (hands and feet).
  - Often seen in healthy newborns, may persist 24-48 hours, usually benign

- **Less likely causes for peripheral cyanosis:**
  - polycythemia, low cardiac output, sepsis
  - An infant with risk factors for these scenarios should have further evaluation
Case 2

• You to assist with delivery of an infant to a women with no prenatal care who arrived in active labor

• You walk in to see the infant being delivered
  – The infant is crying but completely cyanotic including mucous membranes

• What is your differential for Central Cyanosis?
  (Hint: Use the 4 main causes discussed earlier)
DDx Central Cyanosis

**Pulmonary Disease (Lungs)**
- RDS, TTN, MAS, Pneumonia, Air Leak Syndrome
- Congenital Abnormalities:
  - Congenital Diaphragmatic Hernia, CCAM
- Impaired alveolar-arterial diffusion
  - Pulmonary Edema
  - Non Pulmonary Causes: SEPSIS, SEPSIS SEPSIS, Heart Failure,

**Right to Left Shunts (Heart)**
- Congenital Cardiac Lesions
- Persistent Pulmonary Hypertension (PPHN)

**Hypoventilation (Brain)**
- Airway Malformation:
- Neurologic
  - Hypoxic Ischemic Encephalopathy (HIE), Intracranial Hemorrhage (ICH), Seizure
- Metabolic:
  - hypoglycemia → apnea

**Hemoglobin Abnormality:**
- Methemoglobinemia
The then fellow asks you what cardiac lesions this could represent?
Cyanotic Congenital Cardiac Lesions

• 5+ T’s:

1. Tetrology of Fallot
2. Transposition of the Great Ateries
3. Tricuspid Atresia
4. Total Anomalous Pulm. Venous Return
5. Truncus Ateriousus
6. "T" "tons" of others: Double outlet right ventricle, Pulmonary atresia, Single ventricle, Hypoplastic left heart syndrome etc.
You send the Med Student to get more history on mom… any specifics you want to know?
Maternal History

• Pregnancy Complications:
  – Maternal Medical Problems/Medications
    » Eg. SLE, Lithium
  – Infections/GBS Status
  – Gestational Diabetes

• Family History:
  – Any history of congenital cardiac, lung or neurologic diseases, hemoglobinopathies

• Prenatal US
  – Poly or Oligohydranmios?
  – Any Concerns on Heart or Lung Development

• Perinatal Complications:
  – Gestational Age (Premature/Late Preterm)
  – Maternal Fever
  – Rupture of Membranes (duration/color)
  – Infant with prolonged down time after delivery?
Match the Maternal History with The Associated Newborn Condition

- Gestational Diabetes
- Polyhydramnios
- Oligohydramnios
- Meconium Stained Amniotic Fluid
- Prolonged Rupture Membranes

- Renal defects and pulmonary hypoplasia
- Cyanotic heart disease, neonatal polycythemia
- Neonatal Sepsis
- Fetal airway, esophageal, and neurological conditions
- Persistent Pulmonary Hypertension
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Back to the case...

Exam

- VS: HR 160 RR 56 BP: 90/50
- Gen: infant alert, moving all extremities
- SaO2: 82% (Pre and Post Ductal)
- Gen: alert, active, crying
- Resp: CTA B, no signs of distress
- CV: RRR, no murmurs, heaves/thrills
- Abdomen: soft, non-scaphoid
- Skin: globally cyanotic, no other lesions
- Remainder of exam unremarkable

What do you think is a more likely cause of the cyanosis in this infant cardiac or respiratory disease?

How long can it be considered normal for an newborn infant to appear cyanotic?
Back to the case...

• **Cause of the cyanosis in this infant...**
  - Cyanotic Infants with **no signs of respiratory distress/failure** are more likely to have a **congenital cardiac lesion**

• **How long can it be considered normal for an newborn infant to appear cyanotic?**
  - Newborns may have central cyanosis for up to 5 to 10 minutes after birth
  - The oxygen saturation rises to 85 to 95 percent by 10 minutes

• **For this infant what are your next initial steps in management?**

<table>
<thead>
<tr>
<th>Targeted Pre-Ductal SpO2 After Birth</th>
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<tbody>
<tr>
<td>1 Min 60-65%</td>
</tr>
<tr>
<td>2 Min 65-70%</td>
</tr>
<tr>
<td>3 Min 70-75%</td>
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<tr>
<td>4 Min 75-80%</td>
</tr>
<tr>
<td>5 Min 80-85%</td>
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<tr>
<td>10 Min 85-95%</td>
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Initial Management

• **Resuscitate** as per NRP Algorithm:
  – A: Secure Airway if Necessary
  – B: Assess breathing quality and ventilate if necessary
  – C: assess pulses/perfusion, give fluids/pressors if needed

• Place on Monitors

• Obtain Access: Place UV and UA

• Check Blood glucose: >45

• What Labs and further Evaluation would you do?

• What medications will you ask for?
Initial Labs/Evaluation

- **ABG with lactate**
- **Glucose**
- **Infectious**: Blood Culture, CBC/diff
- **Cardiology Consult**
- **Imaging:**
  - CXR: Heart Shape/Size, Pulmonary Vascularity
  - Obtain ECHO if:
    » Persistently cyanosis despite O2/ventilation
    » Abnormal Cardiac Exam
    » Abnormal perfusion/shock
- **Hyperoxia test***
  - May help determine between Cardiac lesion vs. Pulmonary cause of cyanosis based on PaO2 response to 100% O2
    » some limitations and ECHO to evaluate for a cardiac lesion is most accurate/reliable
**Medications**

- **Prostoglandin E1 (Alprostadil)**
  - started to maintain Ductus Ateriosus
    » Start if concern for cardiac lesion, until definitive diagnosis
  - Initial Dose: 0.01-0.05 mcg/kg/min (titrate up)
  - What is one side effect you should be prepared for?
    » Apnea → have intubation supplies ready
    » Can also see hypotension and tachycardia

- **Antibiotics:**
  - Ampicillin and Cefotaxime
    » until sepsis ruled out
Back to the Case

• **Echo:**
  – Demonstrates D-Transposition of the Great Arteries
  – This heart defect most likely to present with early cyanosis

• **Hospital Course:**
  – The infant is maintained on PGE-1
  – The Cardiologist performs a Balloon Atrial Septostomy to allow for further mixing
  – Infant is scheduled to go to the OR for Arterial Switch Operation at one week of life

• The Cardiologist commends you and the fellow for starting the PGE-1 immediately
Review of Newborn Cyanosis

• What is the physiological difference between peripheral and central cyanosis?

• What three factors affect your ability to detect cyanosis?

• What are the 4 likely causes of central cyanosis?

• What medication should you start immediately if you are worried about Cyanotic Heart Lesion? And what side effect should you be prepared for?
Recap of Newborn Cyanosis

• What is the physiological difference between peripheral and central cyanosis?
  – Peripheral: Increased O2 extraction by the tissues
  – Central: Systemic Arterial Oxygen Desaturation

• What three factors affect your ability to detect cyanosis?
  – Hemoglobin Concentration, Factors Oxygen Curve, Pigmentation

• What are the 4 likely causes of central cyanosis
  – Hypoventilation, Pulmonary Disease, Right to Left Shunts, Hemoglobin d/o
  – But...you should also always think of sepsis

• What medication should you start immediately if you are worried about Cyanotic Heart Lesion? And what side effect should you be prepared for?
  – Prostaglandin E-1
  – Apnea, may require intubation
References

- Altman, Carolyn A., MD. "Congenital Heart Disease (CHD) in the Newborn: Presentation and Screening for Critical CHD." *Congenital Heart Disease (CHD) in the Newborn: Presentation and Screening for Critical CHD*. UptoDate, 15 Nov. 2012. Web. 2 Feb. 2013


- Geggel, Robert MD. “Diagnosis and initial management of cyanotic heart disease in the newborn”. UptoDate, 29 Nov. 2012. Web. 2 Feb. 2013


