Newborn Respiratory Disease

M2 – Respiratory Sequence
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Newborn respiratory distress syndrome is characterized by low lung volumes. Contributing factors to the low FRC in such patients include:”

a. decreased lung compliance
b. surfactant deficiency
c. increased chest wall compliance
d. hey, babies are small
e. All of the above*
Review M1

- 2 Dead French Guys
- 1 Dead Swiss Guy
Laplace Relationship

- $\Delta P = 2\gamma/r$
- Trans-surface pressure = $2\text{(surface tension)} / \text{radius of curvature}$
Von Neergard

• Swiss physicist who demonstrated surface tension forces at work in excised cat lungs. (Air filled v saline filled cat lungs) Laplace relationship holds for alveoli.
If this surface film is compressed the phospholipids will be packed more tightly and more water excluded from the surface. This is ideal: the smaller the radius of curvature the more important surface tension forces become (LaPlace), the smaller the radius of curvature the tighter the surfactant molecular pack and the greater the reduction in surface tension forces.
Jean L. Poiseuille

Poiseuille, Jean Léonard Marie (1799-1869) was a French physiologist who made a key contribution to our knowledge of the circulation of blood in the arteries.

Poiseuille's Law of the Flow of Liquids Through a Tube:

Where:
- \( l \) = the length of the tube in cm
- \( r \) = the radius of the tube in cm
- \( p \) = the difference in pressure of the two ends of the tube in dynes per cm\(^2\)
- \( c \) = the coefficient of Viscosity in poises (dyne-seconds per cm\(^2\))
- \( v \) = volume in cm\(^3\) per second

Then:

\[
v = r^4 \frac{p}{8cl}
\]
• Arteriogram:
  – Newborn lacks intra-acinar arteries
  – Lacks background “haze” seen in the adult lung
  – So resistance is high
THE FIRST BREATH:
Goal #1: Fluid out, Air in.
Fig. 1. Diagram of the complete measuring system. Air was circulated through the mask via a 10-liter reservoir and volume fluctuations were measured by the angular displacements of the wedge spirometer.
• Starling forces at work to clear lung fluid
• Functional Residual Capacity is established
Goal #2. Blood In

- Fetal circulation:
  - “right-to-left shunting” at the level of the atria and the ductus arteriosus.
PULMONARY ARTERIAL—LEFT ATRIAL PRESSURE

The Postnatal Decline of Pulmonary Vascular Resistance

Figure 4-14. Compare to Figures 3-17, 3-29, and 3-34, and see text. Adapted from Cassin et al. /Physiol, 171:61, 1964.
Fig. 3. Correlation of mean pulmonary arterial pressure with age in 85 normal term infants studied during the first three days of life.
Case: #1

• Because “it’s the Holidays” and her mother-in-law will be in town to “help out”, a scheduled repeat elective cesarean section is performed on a woman at 37 weeks gestational age. When this baby is born he is tachypneic.

• List as many reasons as you can for the lack of clearance of lung fluid.

• How would you treat this problem?
Transient Tachypnea of the Newborn: (TTNB)

- Also known as “Wet Lung, Retained Fetal Lung Fluid”.
- Occurs as a consequence of delayed or incomplete clearance of fetal lung fluid.
- Predisposing/causative factors:
  - No labor, c-section, hypoventilation, low colloid oncotic pressure, low pulmonary blood flow
Transient Tachypnea of the Newborn

- Lung water content (and weight) is high and an increased respiratory rate is energy efficient.
- Signs in infant
  - tachypnea
- ABGs:
  - usually normal
- Clinical course:
  - usually benign / self limiting.
- Treatment (usual):
  - none or O2.
Transient Tachypnea of the Newborn

No labor
During labor
30 minutes of life
6 hours of life

Source Undetermined
Transient Tachypnea of the Newborn

Source Undetermined (All Images)
Case: #2

- A woman delivers premature twins at 25 weeks gestational age. The twins develop respiratory distress.
  - Why is lung volume low in these infants?
    - Small baby
    - Compliant chest wall
    - Non-Compliant lungs (surfactant deficiency)
Hyaline membranes
Atelectasis

Source Undetermined (Both Images)
Image of alveoli without surfactant in abnormal respiration
Newborn Respiratory Distress Syndrome (RDS)

• Why does this infant have the following signs:
  • Tachypnea?
    – Minute ventilation is RR x TV. With a compliant chest wall increasing RR is more efficient than taking deeper breaths (increasing TV).
  • Grunting?
    – Exhaling against a partially closed glottis provides positive end expiratory pressure -maintains lung volume (FRC).
Newborn Respiratory Distress Syndrome (RDS)

• Nasal flaring:
  – On inspiration alae diameter increases to lower airway resistance.

• Paradoxical breathing: (On inspiration the abdomen pops-up, the chest wall sinks)
  – Use of diaphragm with compliant chest wall produces negative intra-thoracic pressure, positive abdominal pressure, a costly way to breathe.

• Retractions:
  – increased use of muscles of respiration = very costly, and hence a “late” sign
Newborn Respiratory Distress Syndrome (RDS)

- Low lung volume
- Air Bronchograms
- “Ground glass”, “Salt and pepper”
  “reticulogranular lungs

Source Undetermined
Newborn Respiratory Distress Syndrome (RDS)

How would you treat this infant?

Simple things:
  - Oxygen

Maintain FRC:
  - Positive end expiratory pressure
  - Positive pressure ventilation,

Treat the Cause:
  - Artificial surfactant
• On day 7 one twin deteriorates. You hear a murmur.
  – What is this twin’s problem?
Patent Ductus arteriosus

Source Undetermined (Both Images)
Respiratory Distress Syndrome

• Occurs as a consequence of a structural and functional/biochemical immaturity of an infant's lung including:
  – a relative lack of surfactant production.
  – a compliant chest wall
  – a variable degree of L to R shunting through a patent ductus arteriosus.
Case #3:

- As a baby shower gift a pregnant woman’s friends present her with some crack cocaine. Tired of being pregnant the woman tries to induce labor by using the crack. Subsequent severe abdominal pain prompts her to seek medical attention. An emergency c-section is planned. At rupture of membranes there is blood and thick chunky pea-soup like material seen. The infant is born floppy, pale with no spontaneous respirations.
- Think about why and when this baby may have problems........
Case 3# Meconium Aspiration Syndrome.

Source Undetermined

Cornell University Medical College, 1995
Meconium Aspiration Syndrome.

Source Undetermined
Case #3

• After effective resuscitation, the infant is placed on a ventilator. Shortly thereafter you note decreased breath sounds, a shift of the PMI, hypotension and profound cyanosis.

• What has happened? What should you do?
Pneumothorax from meconium plug
• Having fixed this problem you note persistent cyanosis. You note curiously that the transcutaneous O2 saturation monitor gives different readings on the hands vs feet.

• What is happening? What can you do?
FLOW PATTERNS
MYOCARDIAL ISCHEMIA OF THE NEWBORN

MYOCARDIAL ISCHEMIA OF THE NEWBORN
Tricuspid Regurgitation with R → L Atrial Shunting

Source Undetermined (Both Images)
Persistant Pulmonary Hypertension (PPHN)
Persistant fetal circulation (PFC)

Persistent pulmonary hypertension of the newborn (PPHN) is the result of elevated pulmonary vascular resistance to the point that venous blood is diverted to some degree through fetal channels (i.e. the ductus arteriosus and foramen ovale) into the systemic circulation and bypassing the lungs, resulting in systemic arterial hypoxemia.
Persistant Pulmonary Hypertension (PPHN)  
Persistant fetal circulation (PFC)

Treatment:

• Fix that which is broken.
  – Correct the cause of hypoxia, hypercarbia, acidosis.

• If it hurts when you go like that, then don’t go like that.
  – Avoid over distention of lungs,
  – Barotrauma
Persistant Pulmonary Hypertension (PPHN)
Persistant fetal circulation (PFC)

- **Attempt to lower PVR.**
  - O2, Ventilation, Buffer
  - Inhaled Nitric Oxide

- **Attempt to raise SVR (and output)**
  - Volume expansion for preload
  - Vasoconstrictors?
  - Inotropic support
Additional Source Information

for more information see: http://open.umich.edu/wiki/CitationPolicy

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