1

Neonatal/Pediatric
Cardiopulmonary Care

Disease

2

Bronchopulmonary Dysplasia

3

Baby Jane

- Baby Jane is a 33-day-old prematurely born girl who weighs 1420 g. At birth, her estimated gestational age was 28 weeks. Her initial diagnosis was RDS and PDA. She received mechanical ventilation for 3 weeks with peak inspiratory pressure recorded as high as 38 cmH2O with an FiO2 between 0.60 and 0.80 for more than 1 week. Initial radiographic findings were low lung volumes, ground-glass appearance, and air bronchograms. The patient received indomethacin (Indocin) therapy to close his PDA at 1 week of age.

4

Baby Jane

- She was extubated and put in a 35% oxyhood. An examination revealed an alert but agitated, pink infant; RR of 78/min., T 36.3°C, HR 166/min, BP 64/48; moderate substernal, subcostal, and chest wall intercostal retractions; inspiratory crackles and expiratory wheezing bilaterally. CBG findings show pH 7.28, PcCO2 62 mmHg, PcO2 40 mmHg, BE +4, HCO3 30 mEq/L.
  - What are the indications of respiratory distress and what additional information should be gathered?

5

Baby Jane

- What is your interpretation of the CBG and what is the most likely cause of the decreased PcO2?
- What is the differential diagnosis of this patient's problem and what is the most likely diagnosis?

6

BPD

- 1st described in 1967
- 2° to lung injuries following prolonged exposure to O_2 & mechanical ventilatory support
- Most incidences of BPD occur following Rx of RDS
- Symptoms of BPD w/o BPD radiological signs = NCLD (neonatal chronic lung disease)

7

Pathophysiology

- Linked to several factors
  - Prematurity
  - Oxygen
  - Mechanical ventilation
  - Infection
  - Patent Ductus Arteriosus
  - Genetics
  - Malnutrition & vitamin A deficiency

8

Prematurity

- Incidence of BPD is $1/\propto$ to gestational age (lung maturity)
- BPD represents the response of immature lungs to lung injury
  - Antioxidant systems
    -
    -
    -
  - Also, regulation of repair systems is impaired

9

Oxygen

- Oxygen-induced lung injury occurs due to the production of toxic radicals (superoxide, H_2O_2, free radicals)
  - Results in
    -
    -
  - As exposure is prolonged
    -
    -
    -
- Lung tissue protected by antioxidants (catalase, superoxide dismutase, vitamins A, C, E)

10

Mechanical Ventilation

- Mechanical ventilation-induced injury due to
  - Alveolar instability (atelectasis)
    -
    -
  - Hyperdistension (barotrauma/volutrauma)
    - Caused by
      -
      -
      -
- Injury → vascular permeability → edema & inflammation

11

Infection

- Infections cause release of inflammatory mediators leading to increased need for oxygen and mechanical ventilation

12

PDA

- L→R shunt leads to
  -
  -
  - Result:
    -
    -

13

Genetics

- May be a genetic disposition to development of BPD
- Possibly related to
  -
  -
  -
- Probably - stimulation of the gene responsible for development of fibrosis

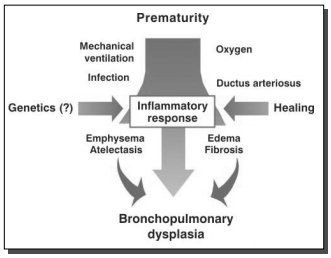
14

Malnutrition & Vitamin A Deficiency

- Vitamin A and good nutrition contribute to the regeneration and re-epithelization of lung tissue

15

Pathophysiology



- End-product of lung injury is -
- Result is -

16

Baby Jane

- Does the absence of fever indicate no infectious process is occurring?
- Does the fact that the infant's color is pink ensure adequate oxygenation?
- What is tracheal tugging and why does it occur?

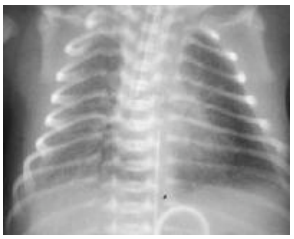
17

Baby Jane

- What is the cause of the expiratory wheezing?
- What is the significance of the presence of crackles?

18

Baby Jane



- What abnormalities are present on the chest radiograph?
  -
  -
- What pathophysiology is causing the CXR results?

19

Chest Radiography

- Stage I
  - 1st 3 days of life
  - Looks like RDS
- Stage II
  - 3-10 days
  - Lungs opaque with granular infiltrates that obscure cardiac markings

20

Chest Radiography

- Stage III
  - 10-20 days
  - Multiple small cyst formation with a visible cardiac silhouette
- Stage IV
  - After 28 days
  - Increased lung density
  - Formation of larger, irregular cysts

21

Baby Jane

CBG pH 7.33, PCO2 65, PO2 46, HCO3 35, FiO2 by oxyhood at 0.60

CBC WBC 11,000/mm^3, RBC 3.7 million/mm^3, segs 58%, bands 1%, lymphocytes 37%, monocytes 3%, eosinophils 1%, Hgb 12.9 g/dl, Hct 38%

22

Baby Jane

- How do you interpret the CBG?
- What is significant about the CBC results?
- In which stage of BPD is this patient?

23

Lab Studies

- What would you expect to be the ABG interpretation to be for a patient with BPD?
  - pH
  - PCO_2
  - PO_2
  - Bicarb
- Interp?

24

Lab Studies

- What would you expect to be the ECG interpretation to be for a patient with BPD?
  -
  -

25

Lab Studies

- What would you expect to be the PFT interpretation to be for a patient with BPD?
  - RR
  - V_T, V_E
  - R_{AW}

26

Diagnosis

- Chronic need for oxygen & mechanical ventilatory support
- Verified by
  -
  -

27

Baby Jane

- What is your suggestion for therapy for this patient?

28

Treatment

- Prevention
  - Avoid or reduce factors that lead to its development
    -
  - Pressures, FiO2, rates to maintain
    - PaO_2 mmHg
    - $PaCO_2$ mmHg

29

Treatment

- Mechanical ventilation
  - ETT small enough to allow leak to reduce chance of subglottic stenosis in long-term patient
  - Longer than 1-2 months → trach
  - Extubate ASAP but wean slowly with nasal CPAP
  - HFO has been shown to help with PIE
  - Adeq humidification to avoid mucus plugging

30

Treatment

- Respiratory care procedures
  -
  -
  -
  -

31

Treatment

- Fluid therapy
  - To maintain adeq hydration & urination
  - Furosemide (Lasix) usually needed
  - Fluid restriction to ↓ pulm edema & maintain balance
  - Warning: with diuretic therapy may lose H_2O rapidly → ↑ C_L quickly →
  - Observe U.O., BS, chest excursion to identify ↑ C_L
  - If diuretic therapy long-term - need to replace Ca^{++} & phosphorus to avoid weakening of bone

32

Treatment

- If right heart failure
  - Treat with
  - Close L→R PDA somehow

33

Treatment

- Nutrition
  - Patients have increased metabolic rate
  - Usually require 120-150 cal/kg/day to achieve growth & lung tissue repair
  - If nutrition inadequate
    -
    -
    -

34

Treatment

- Nutrition (con't)
  - 2 precautions
    - Oxygen consumption increases as calorie intake increases --
    - Metabolism of glucose increases CO_2 production -- can lead to

35

Treatment

- Vitamin E administration
  - Decreased levels of Vitamin E →
- Future outlook for BPD
  - Few studies done about long-term effects
  - Possibly
    -
    -

36

Baby Jane

- Baby Jane continued to have evidence of respiratory distress with retractions and tachypnea. Aerosolized medication treatments were started with terbutaline 0.25 ml in 2.75 ml NS. The patient's wheezing decreased after the treatments. Oxygen requirement fluctuated but was successfully reduced to 0.35. Four days later it was noted that a weight gain in excess of 60 g/day had been measured for 2 consecutive days. Crackles continued to be heard bilaterally and a repeat CXR revealed pulmonary edema superimposed on changes consistent with BPD.

37

Baby Jane

- She was treated with diuretics and F_IO_2 was titrated to maintain acceptable oxygenation status.
- The hospital course of this patient included another 3 months in the newborn intensive care unit, including another 1 week course of mechanical ventilation and nutritional difficulty. Baby Jane went home on oxygen therapy 6 months after admission. She was followed and treated for reactive airway problems, which led to his home use of bronchodilator therapy.