The changing lung function at birth and the implications for resuscitation and for the prevention of hyaline membrane disease

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I. Newborn infants may fail to establish effective ventilation at birth for any of several reasons.
   A. Premature infants with immature surfactant system who are at high risk of hyaline membrane disease (HMD).
   B. Extremely low birth weight with or without mature surfactant system but with weak respiratory muscles and a compliant chest wall.
   C. Infants who had intrapartum asphyxia which:
      1. Increases risk of severity of HMD in infants with immature lungs
      2. Can lead to a form of respiratory distress in infants with mature lungs
   D. Many of these infants require assisted ventilation at birth.

II. Hyaline membrane disease occurs when the surfactant system is immature. However, the pathology of clinical HMD includes secondary changes which result from pulmonary ischemia and from ventilation of the surfactant deficient lung.
   A. Increased capillary permeability
      1. Pulmonary edema
      2. Plasma proteins in air spaces
   B. Interstitial hemorrhage
   C. Denuded airway epithelium

III. Establishment of effective ventilation after birth:
   A. High distending pressures needed for initial inflation of the airless lung.
   B. Creation on a functional residual capacity (FRC)
      1. Air retained during exhalation phase of first breaths
      2. Dependent on anti-atelectatic effect of surfactant
      3. As FRC increases, compliance increases (CL) and the pressure required for ventilation decreases
   C. Absorption of fetal lung fluid
      1. Absorption before birth
      2. Absorption after birth
      3. Further increase in CL as fluid is absorbed

IV. Pulmonary surfactant
   A. Synthesis in type II alveolar cells
   B. Secretion from cells into subphase
   C. Rapid absorption to fluid : gas interface
V. Surfactant secretion with lung inflation
   A. Secretion with first breaths
   B. Effect of large volume inflations
   C. Beta adrenergic pathway
   D. Adverse effect of atelectasis on secretion

VI. Assisted ventilation and resuscitation at birth of the asphyxiated and the premature infant.
   A. Pressure patterns needed for inflation and generation of FRC
   B. Prevention of atelectasis and secondary changes of HMD
   C. Controlled trial of lung inflation to prevent HMD
   D. Use of exogenous surfactant

VII. Consequences of rapidly improving CL
   A. The distending pressure which had been appropriate rapidly becomes inappropriately high
      1. Lung over distention and rupture
      2. Venous circulation
   B. Effects of changes in blood gas tension
      1. \( \text{PaO}_2 \) and Retinal circulation
      2. \( \text{PaO}_2 \) and cerebral and coronary circulations
      3. Pulmonary and systemic resistance

VIII. Physiologic approach to resuscitation
   A. System of physiologic monitoring
   B. Illustrative cases

IX. Selected References


