Newborn Respiratory Disorders

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What Is **Neonatology** anyway?

- Neonatology is the medical specialty of taking care of newborn babies, sick babies, and premature babies.

- The word "neonatology" is stuck together from several root words and basically means "science of the newborn" :"neo" (Greek) = new, "natal"(Latin "natus") = to be born, "ology"(Greek) = science of.

Newborn babies?

an infant from the time of birth through the 28th day of life.

Premature newborn

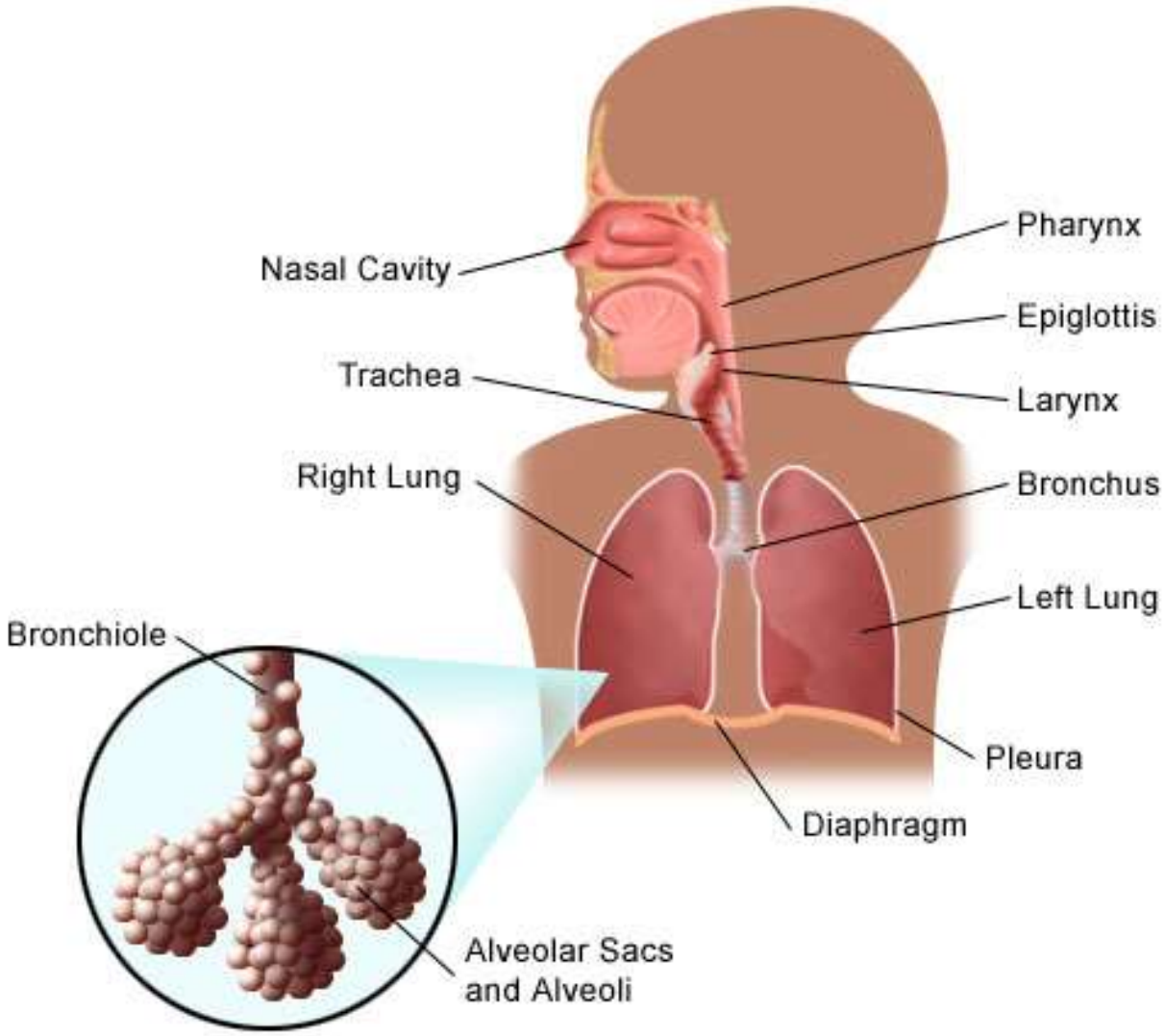
Infants born between 22 and 37 weeks (154-258 d.) of pregnancy

Full-term babies are born from 37 to 42 weeks (259-294 d.) of the estimated date of birth.

Postmature infant

babies born after 42 weeks of gestation.

Neonatal Respiratory System



Neonatal Respiratory System

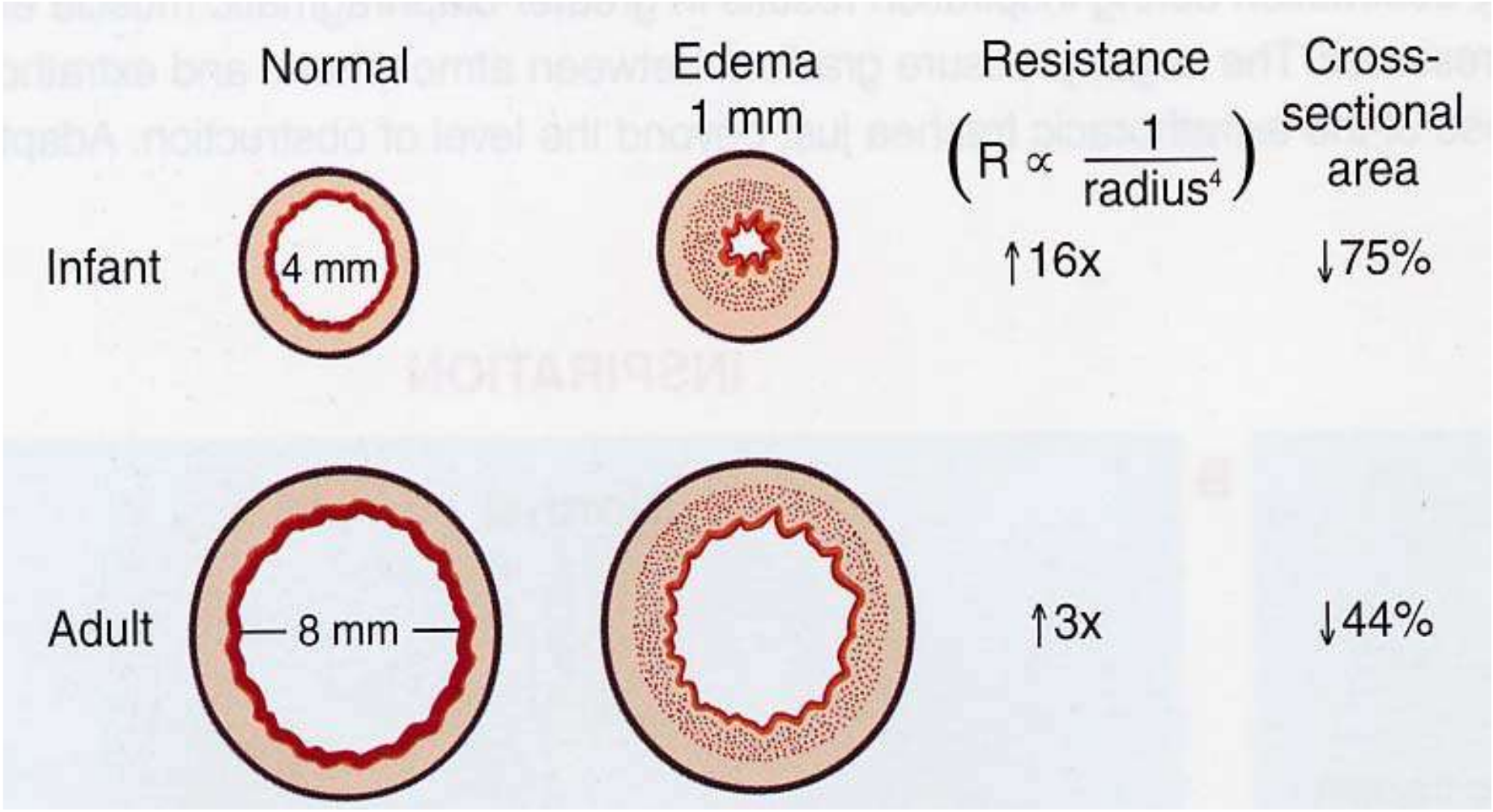
•The immaturity of the respiratory center, surfactant system;

•Labile respiratory rate (less then 30 breaths/min - bradypnea, tachypnea – more then 70 breaths/min);

•The bronchi have a narrow clearance and richly equipped with mucous blood vessels that leads to edema and bronchoconstriction;

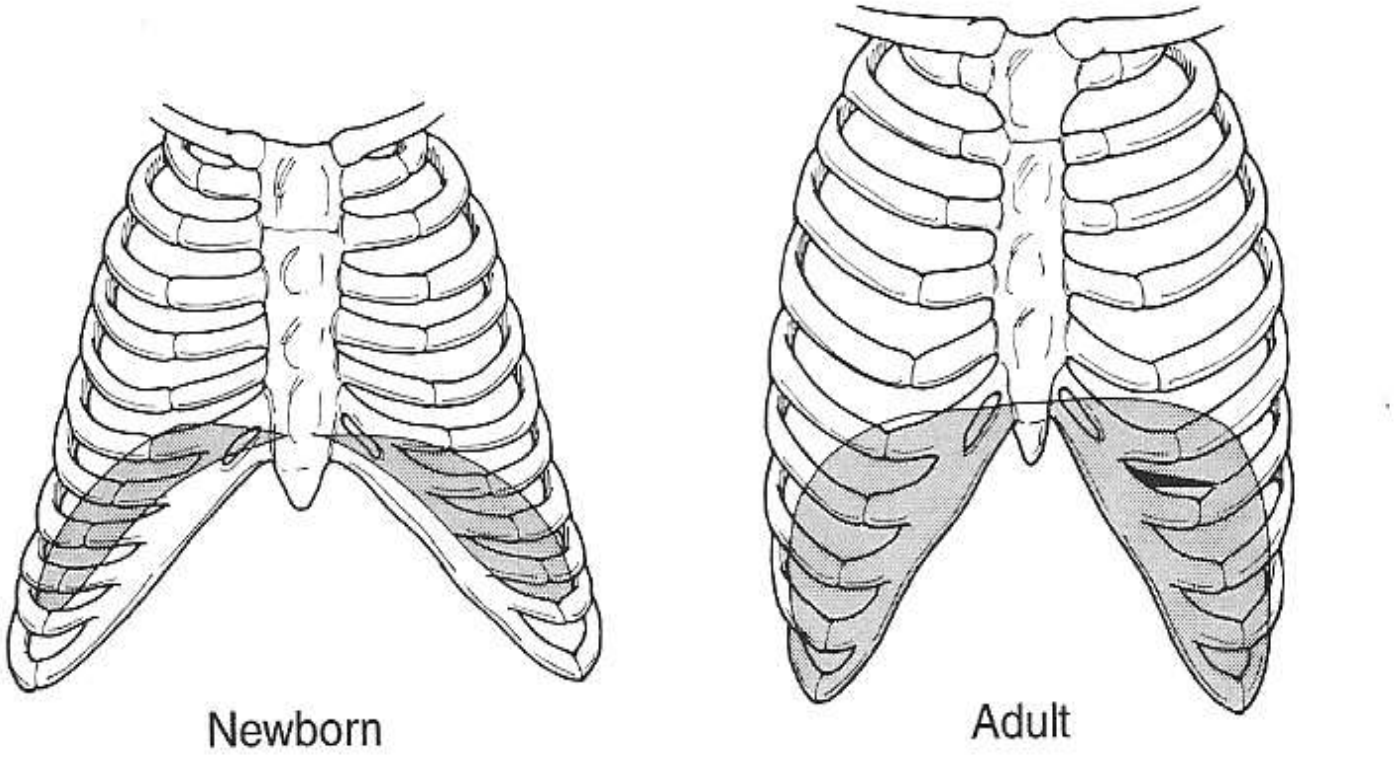
•Hypoplasia of acinuses, alveoli

Resistance



the major site of resistance in infants is the medium-sized bronchi

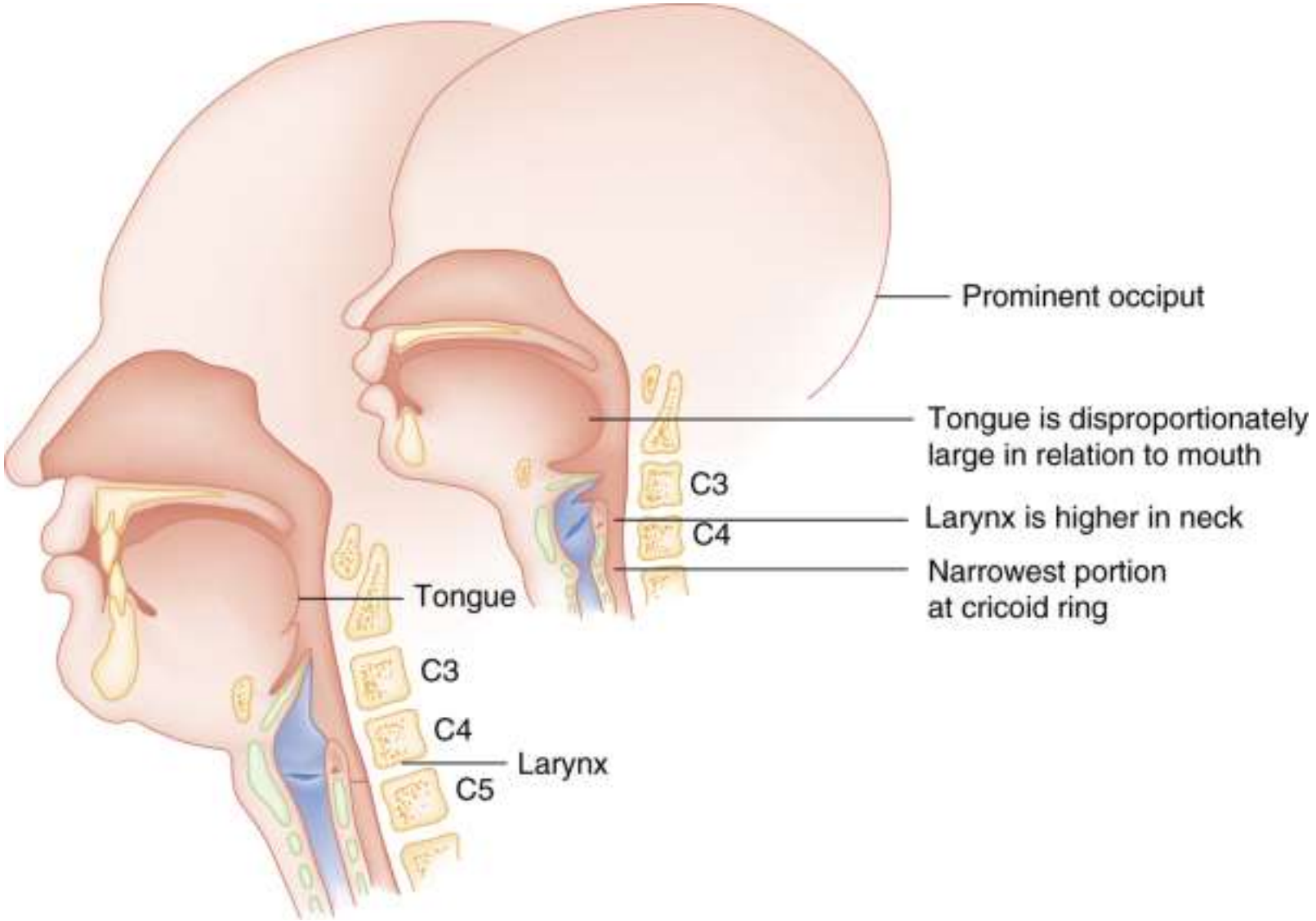
Neonatal Respiratory System

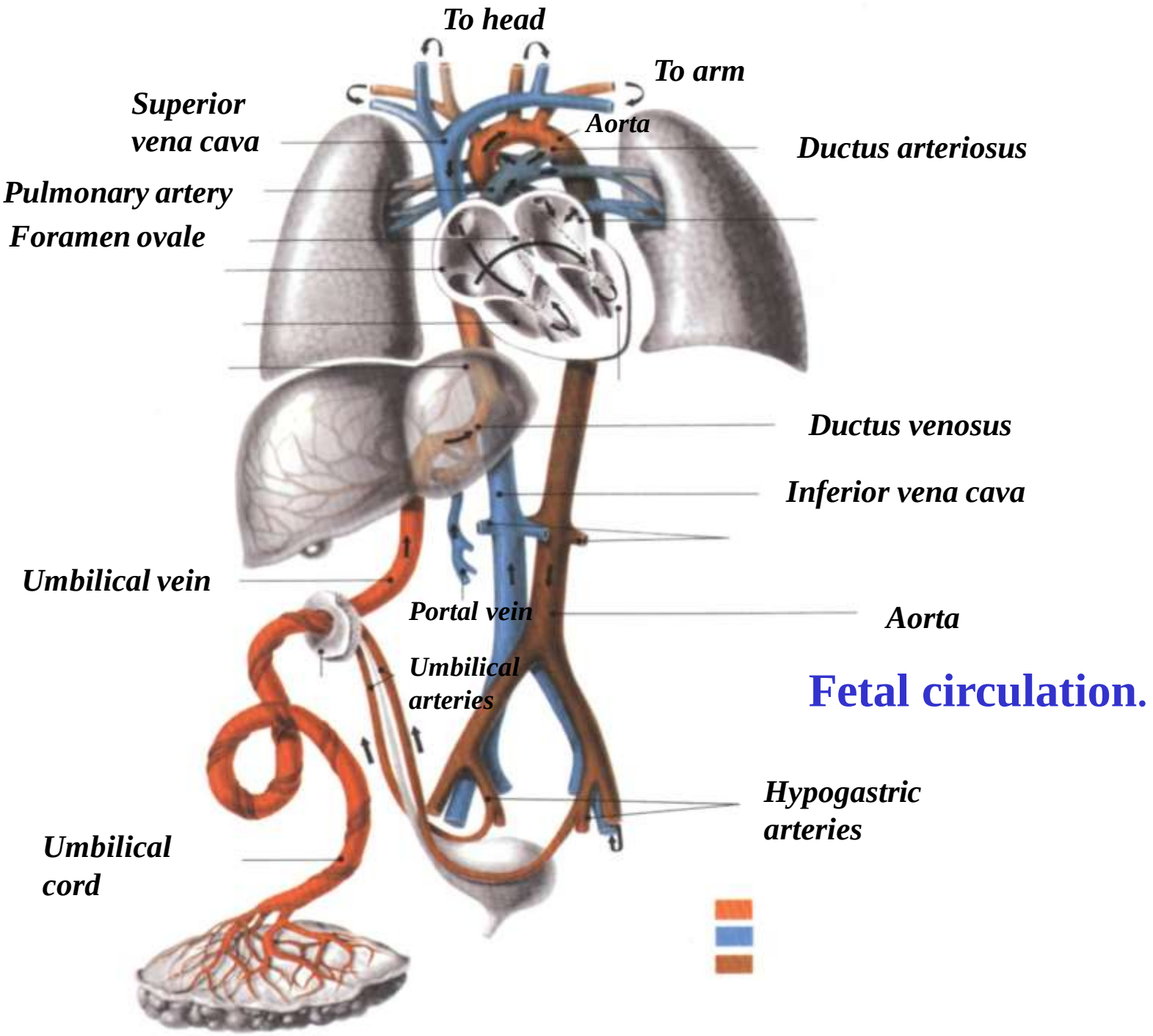


- The orientation of the ribs is horizontal in the infant;
- By 10 years of age, the orientation is downward.

Neonatal Respiratory System

Other Features





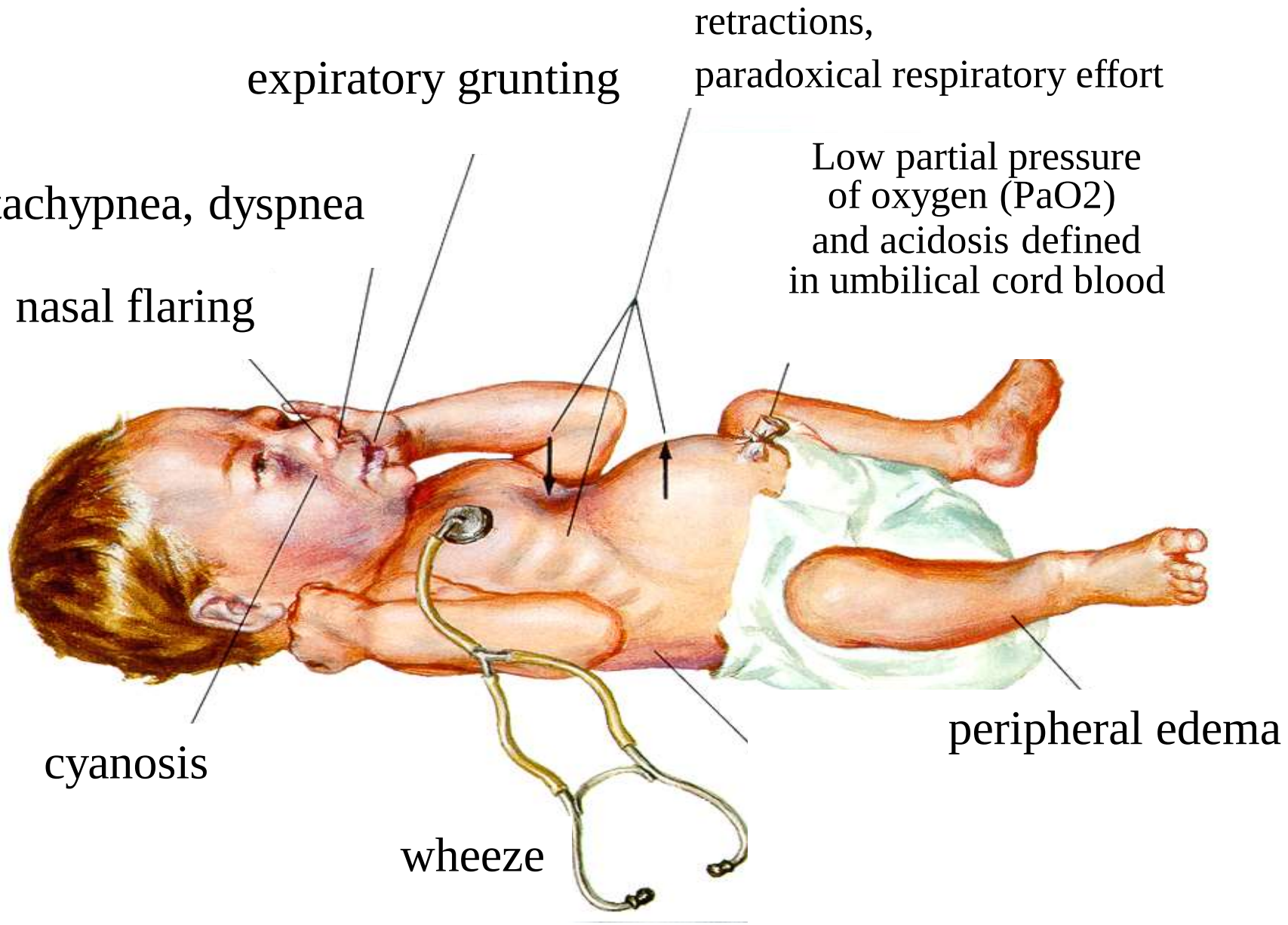
Fetal circulation.

- **Neonatal respiratory problems are life-threatening and requires immediate intervention!**

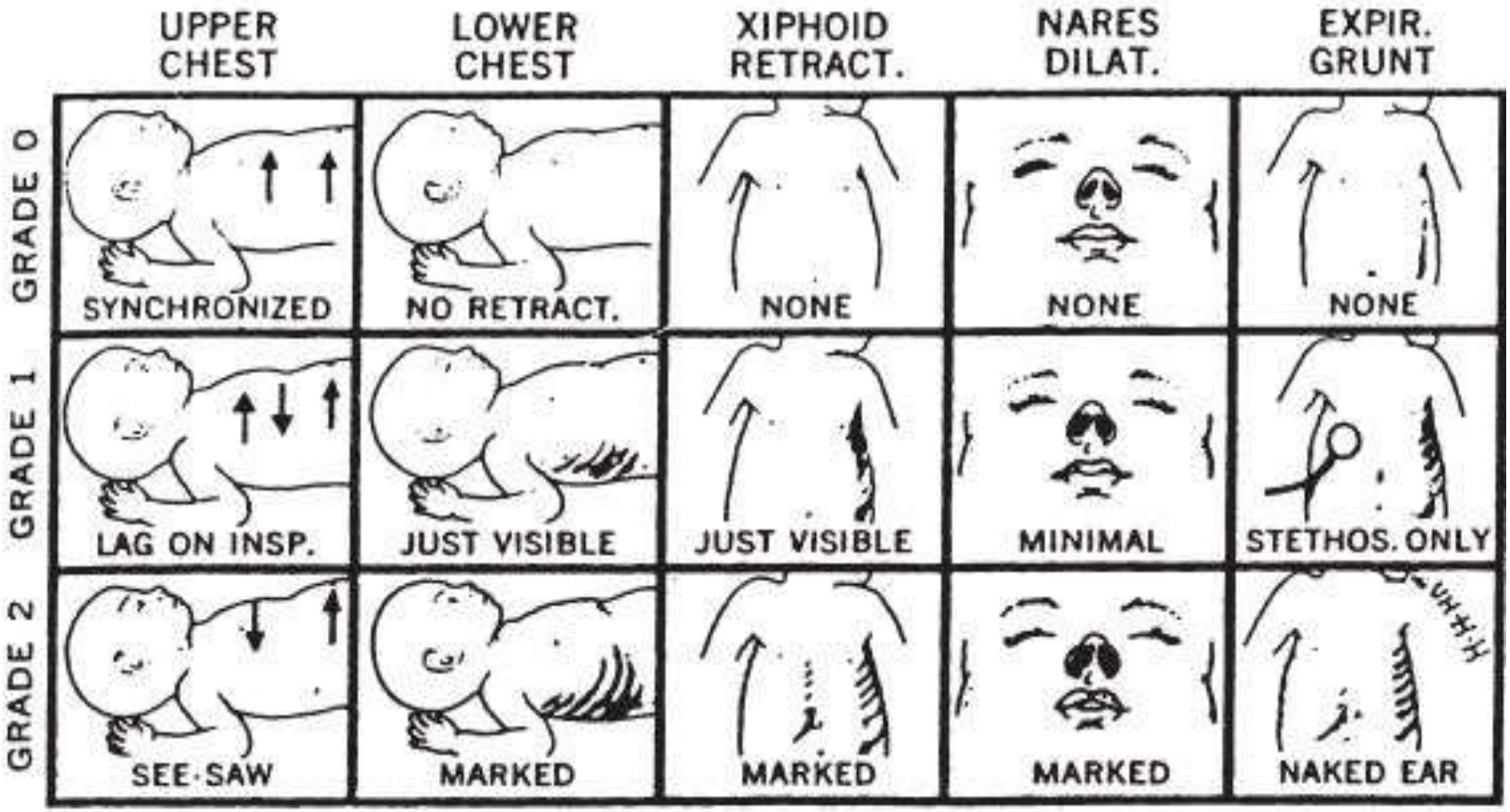
- **Respiratory disease is a common cause of neonatal morbidity and mortality. (*first place in the structure of neonatal morbidity*)**

- **Respiratory distress occurs in approximately 7 percent of infants, and preparation is crucial for physicians providing neonatal care.**

How a newborn with respiratory problems looks like?



Silverman Score



Score 10 = Severe respiratory distress

Score ≥ 7 = Impending respiratory failure

Score 0 = No respiratory distress

Downe Score

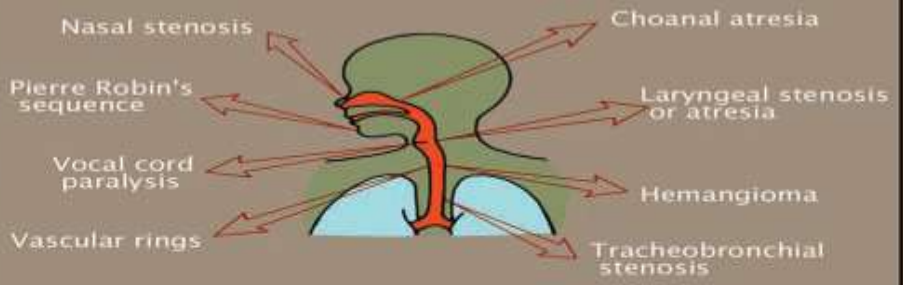
Table (22-1): Evaluation of respiratory distress using Downes' score

Test	Score		
	0	1	2
Respiratory rate	<60/minute	60-80/minute	>80/minute
Retractions	No retractions	Mild retractions	Severe retractions
Cyanosis	No cyanosis	Cyanosis relieved by O_2	Cyanosis on O_2
Air entry	Good bilateral air entry	Mild decrease in air entry	No air entry
Grunting	No grunting	Audible by stethoscope	Audible with ear
Evaluation			
Total	**Diagnosis**		
<4	No respiratory distress		
4-7	Respiratory distress		
>7	Impending respiratory failure; blood gases are required		

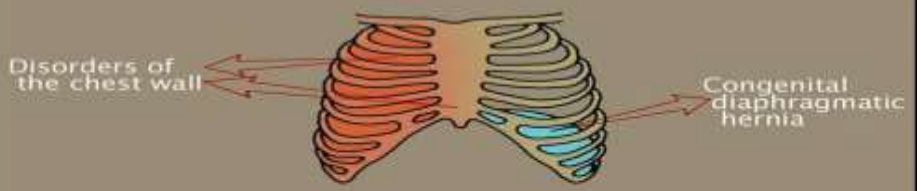
Differential diagnosis for infants in respiratory disorders.

1. Respiratory Diseases

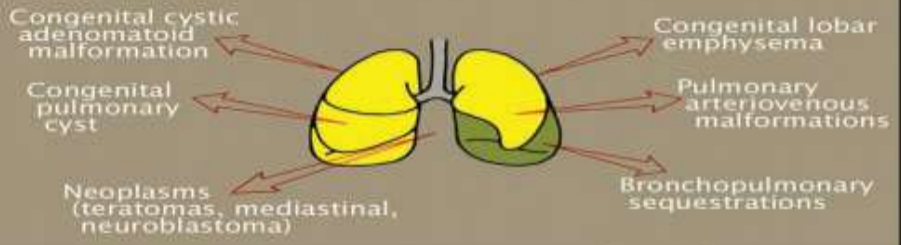
A. Airway Obstructions



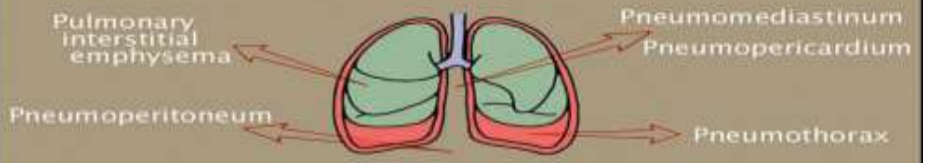
B. Disorders of the Chest Wall and Diaphragm



C. Malformation of the Mediastinum and Lung Parenchyma



D. Air Leak Syndromes



2. Cardiac Diseases

A. Cyanotic

- Transposition of great arteries
- Total anomalous pulmonary venous return
- Ebstein's anomaly
- Tricuspidal atresia
- Pulmonic stenosis
- Tetralogy of Fallot
- Severe congestive heart failure

B. Acyanotic

- Hypoplastic left heart syndrome
- Interrupted aortic arch
- Critical aortic coarctation
- Patent ductus arteriosus

E. Pulmonary Parenchymal and Vascular Diseases

Lung parenchymal diseases

- Transient tachypnea of newborn
- Meconium aspiration syndrome
- Hyaline membrane disease
- Pneumonia
- Congenital alveolar proteinosis
- Pulmonary edema

Persistent pulmonary hypertension of the newborn

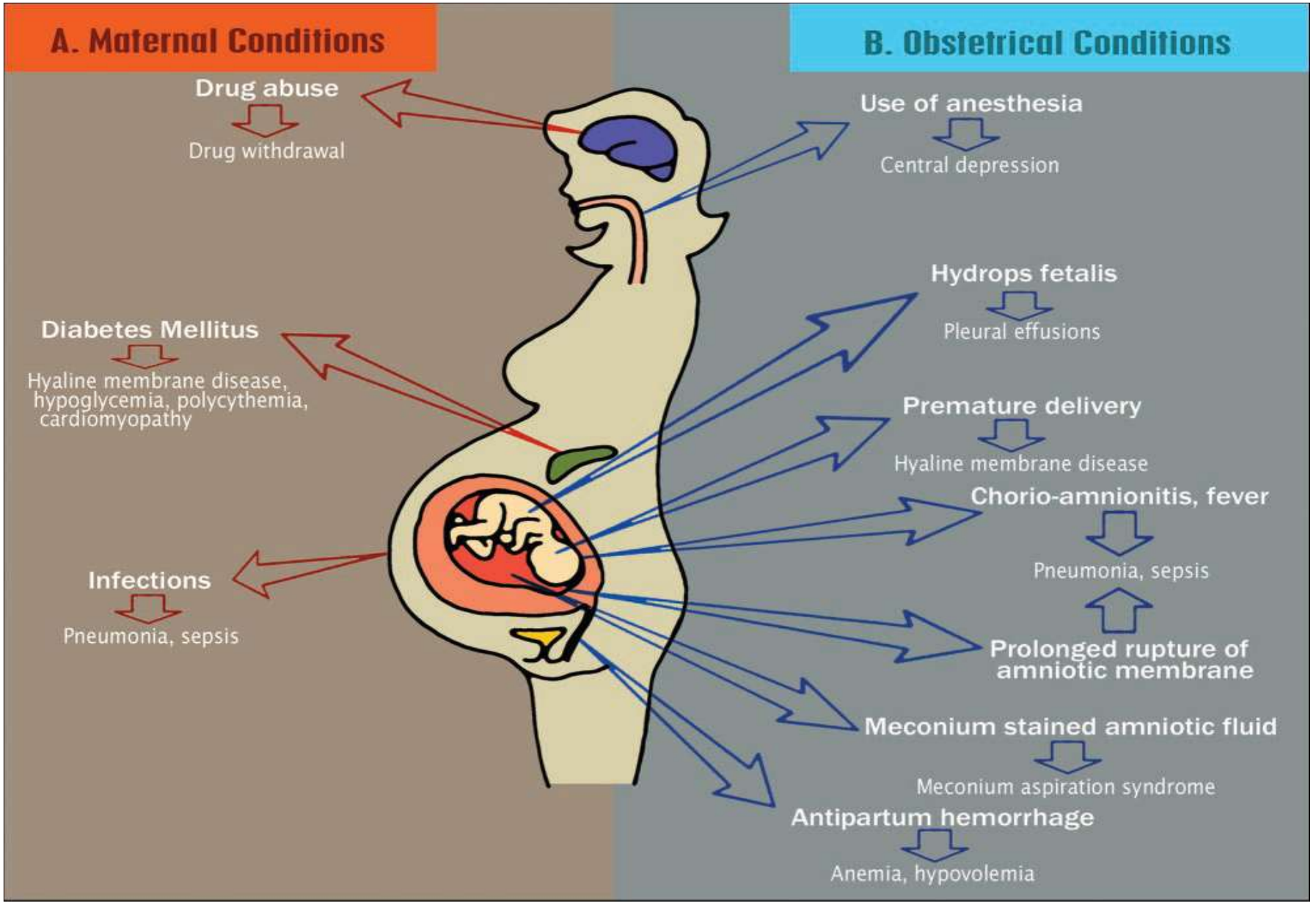
3. Neurological Disorder

- Birth trauma
- Intraventricular hemorrhage
- Meningitis
- Hypoxic ischemic encephalopathy
- Primary seizure disorder
- Obstructed hydrocephalus
- Infantile botulism
- Spinal cord injury
- Muscular diseases (myasthenia gravis, poliomyelitis)

4. Other Miscellaneous Diseases

- Sepsis
- Anemia or polycythemia
- Hypo or hyperthermia
- Hypo or hypernatremia
- Hypoglycemia
- Inborn errors of metabolism
- Maternal medication (magnesium sulfate, opiates) or drug abuse

Maternal and obstetric conditions associated with respiratory disorders in neonates.



Newborn Respiratory Disorders

- Respiratory distress syndrome (RDS)
- Meconium aspiration syndrome (MAS)
- Pneumonia
- Bronchopulmonary dysplasia (BPD)
- Transient tachypnea of newborn (TTN)

Respiratory distress syndrome (RDS, IRDS, hyaline membrane disease)

- Acute lung disease of the newborn caused by pulmonary ***surfactant deficiency***
- Increase in incidence with decreasing gestational age (correlating with structural and functional lung immaturity)

< 28 wk: 60-80%

32-34 wk: 15-30%

>37 wk: 5%

Risk factors

- ***Prematurity***
- ***Infant of diabetic mother (IDM)***: **5-6 times higher than non-IDM**
- ***Cesarean delivery without preceding labor***
- ***Precipitous labor***
- ***Fetal asphyxia***
- ***Second of twins***
- ***Cold stress***
- ***Males***

Decreased risk

- *Use of antenatal steroids*
- *Pregnancy-induced or chronic maternal hypertension*
- *Prolonged rupture of membranes*
- *Maternal narcotic addiction*
- *Chronic intrauterine stress*
- *Intrauterine growth restriction (IUGR)*
- *Thyroid hormones*

What is surfactant?

Surfactant Composition

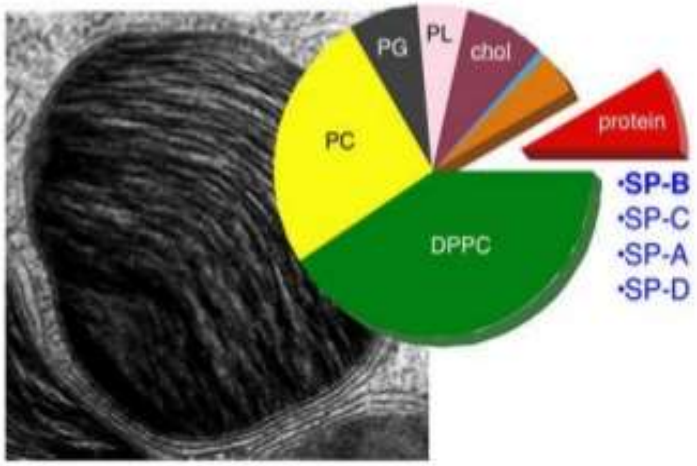
- **Phospholipids** — **80%**
  - dipalmitoyphosphatidylcholine (DPCC) — 60%
  - Phosphatidylglycerol/ethanolamine/inositol — 20%
- **Neutral Lipids** — **10%**
  - Mostly Cholesterol
- **Surfactant Proteins** — **10%**
  - SP-A; SP-D: hydrophilic
  - SP-B; SP-C: hydrophobic

L/S ratio: predictor of foetal lung maturity

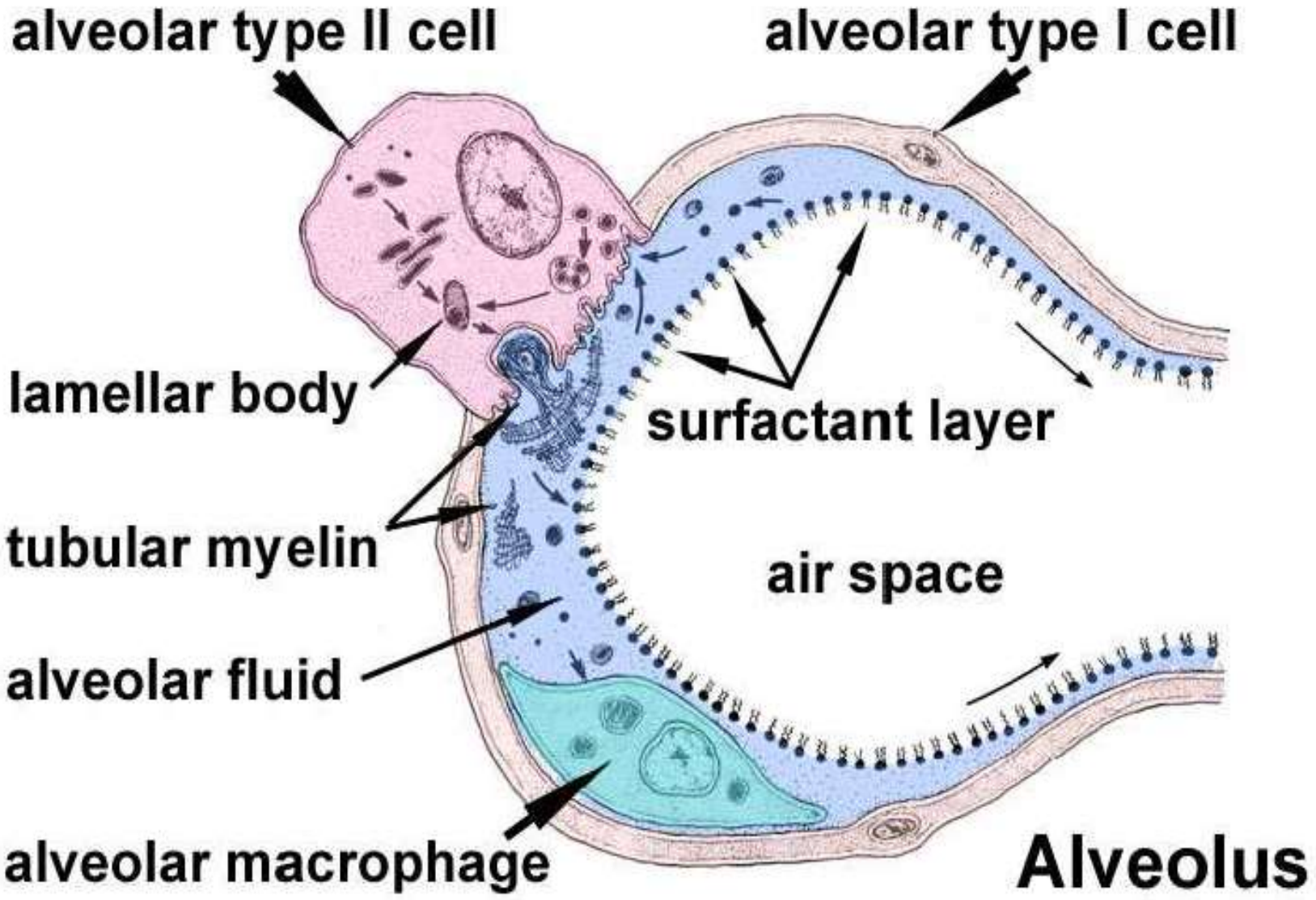
L – lecithin

S – Sphyngomyelin

Surfactant Composition



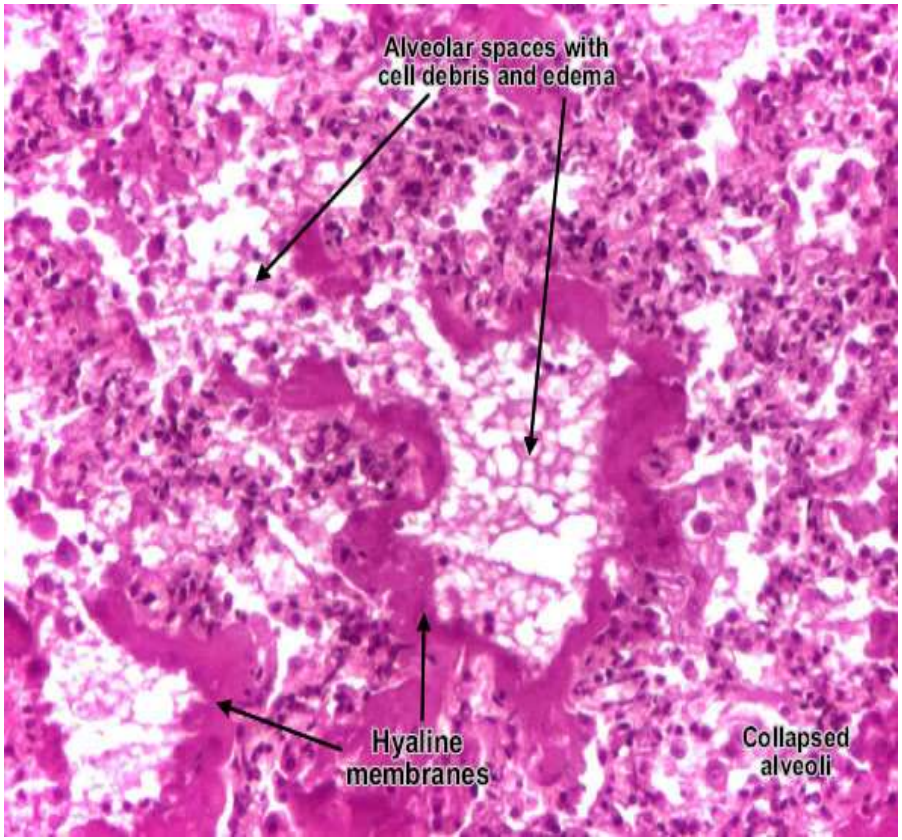
Schematic show surfactant metabolism.



Functions of pulmonary surfactant (PS)

- *decreases surface tension in during expiration*
- *prevent atelectasis*
- *maintains functional residual capacity*
- *regulates inflammatory responses*

Respiratory distress syndrome



Pathophysiology

•**The absence or deficiency of surfactant results in increased alveolar surface tension, leading to alveolar collapse (*atelectasis*), hypoventilation and decreased lung compliance**

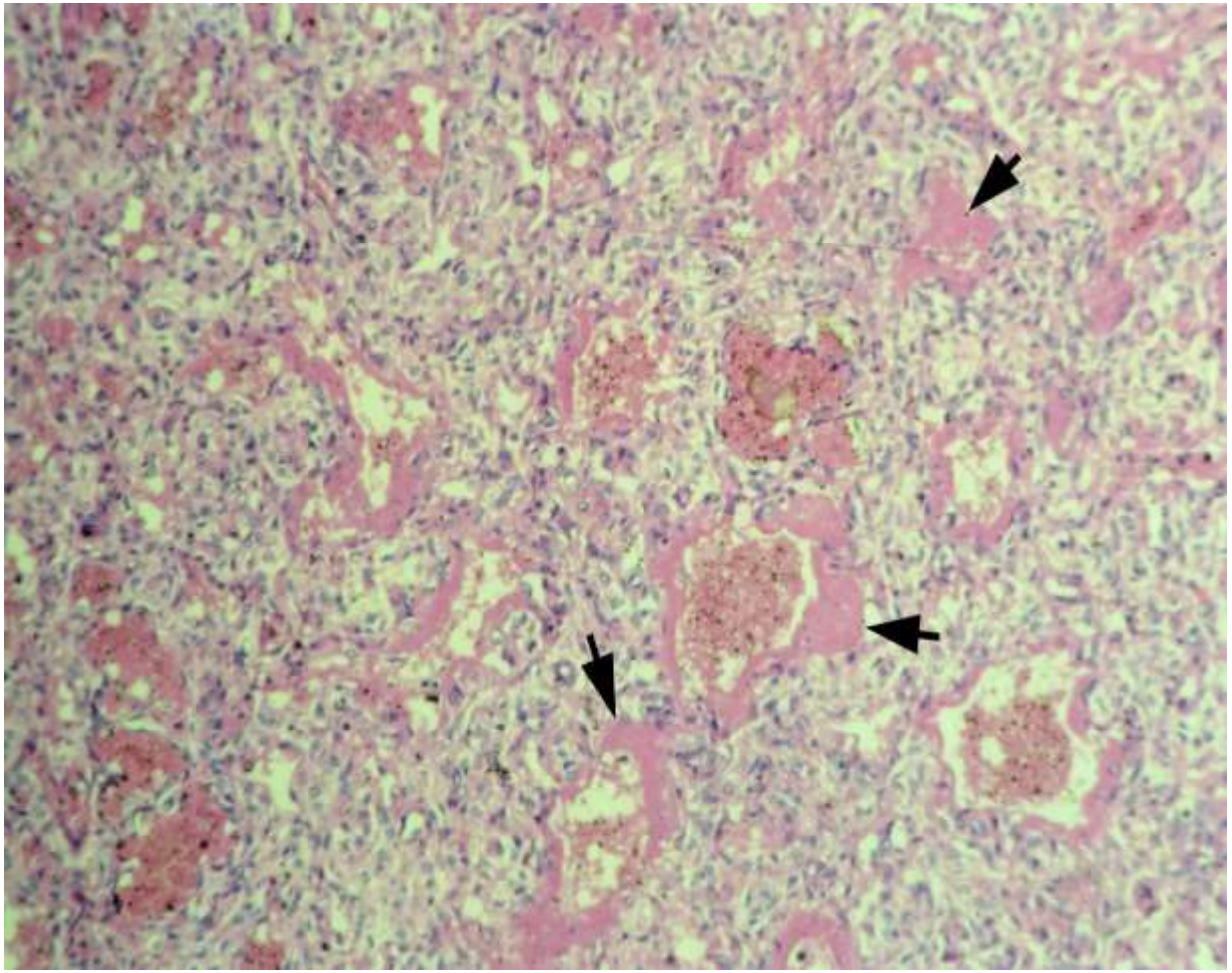
•**Collapsed areas of the lung may continue to receive capillary blood flow, but gas exchange does not occur.**

•**Hypoxemia, hypercarbia develop, which leads to respiratory acidosis. Hypoxia at the cellular level results in anaerobic metabolism and metabolic *acidosis*, increased pulmonary vascular resistance and vasoconstriction, leading to pulmonary hypoperfusion, *right-to-left shunting* and additional hypoxemia**

Respiratory distress syndrome

Pathophysiology

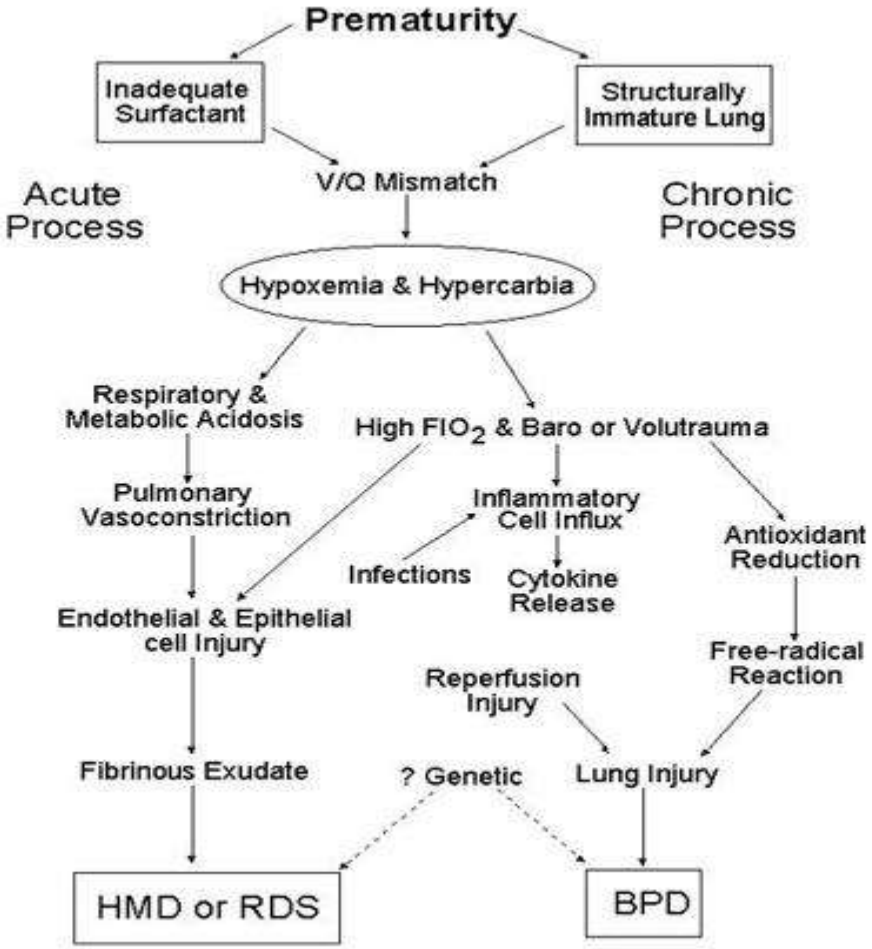
•**Hypoxia initiate release of inflammatory cytokines and chemokines causing more endothelial and epithelial cell injury, leakage of proteins into the alveolar space that forms a *hyaline membrane***



Microscopic appearance of lungs of an infant with respiratory distress syndrome. Hematoxylin and eosin stain shows hyaline membranes (pink areas).

Respiratory distress syndrome

Pathophysiology



Infants may recover completely or develop chronic lung damage, resulting in bronchopulmonary dysplasia (BPD). A chronic process often ensues in infants who are extremely immature and critically ill and in infants born to mothers with chorioamnionitis, resulting in BPD.

FiO2 = fraction of inspired oxygen; HMD = hyaline membrane disease; V/Q = ventilation perfusion.

Respiratory distress syndrome

Diagnosis of RDS

- History of premature delivery
- Concentration of lecithin in amniotic fluids. Ratio of lecithin/sphingomyelin (L/S ratio 2:1 indicate lung maturity)
- Physical examination (tachypnea or apnea, cyanosis, expiratory grunting, subcostal and intercostal retractions, nasal flaring)
- Full blood count (electrolytes, glucose, renal and liver function, blood gases). Pulse oximetry: **aim for SPO_2>85%** Cultures to rule out sepsis
- Chest radiograph
- Echocardiogram

Respiratory distress syndrome

Clinical Manifestations

- Appear within minutes of birth, may not be recognized for several hours in larger preterm
- Tachypnea (>60 breaths/min), nasal flaring, subcostal and intercostal retractions, cyanosis and expiratory grunting
- Breath sounds may be normal or diminished and fine rales may be heard
- Progressive worsening of cyanosis and dyspnea. Cyanosis and pallor increase
- Apnea and irregular respirations are ominous signs
- In most cases, symptoms and signs reach a peak within 3 days, after which improvement occurs gradually.

Respiratory distress syndrome

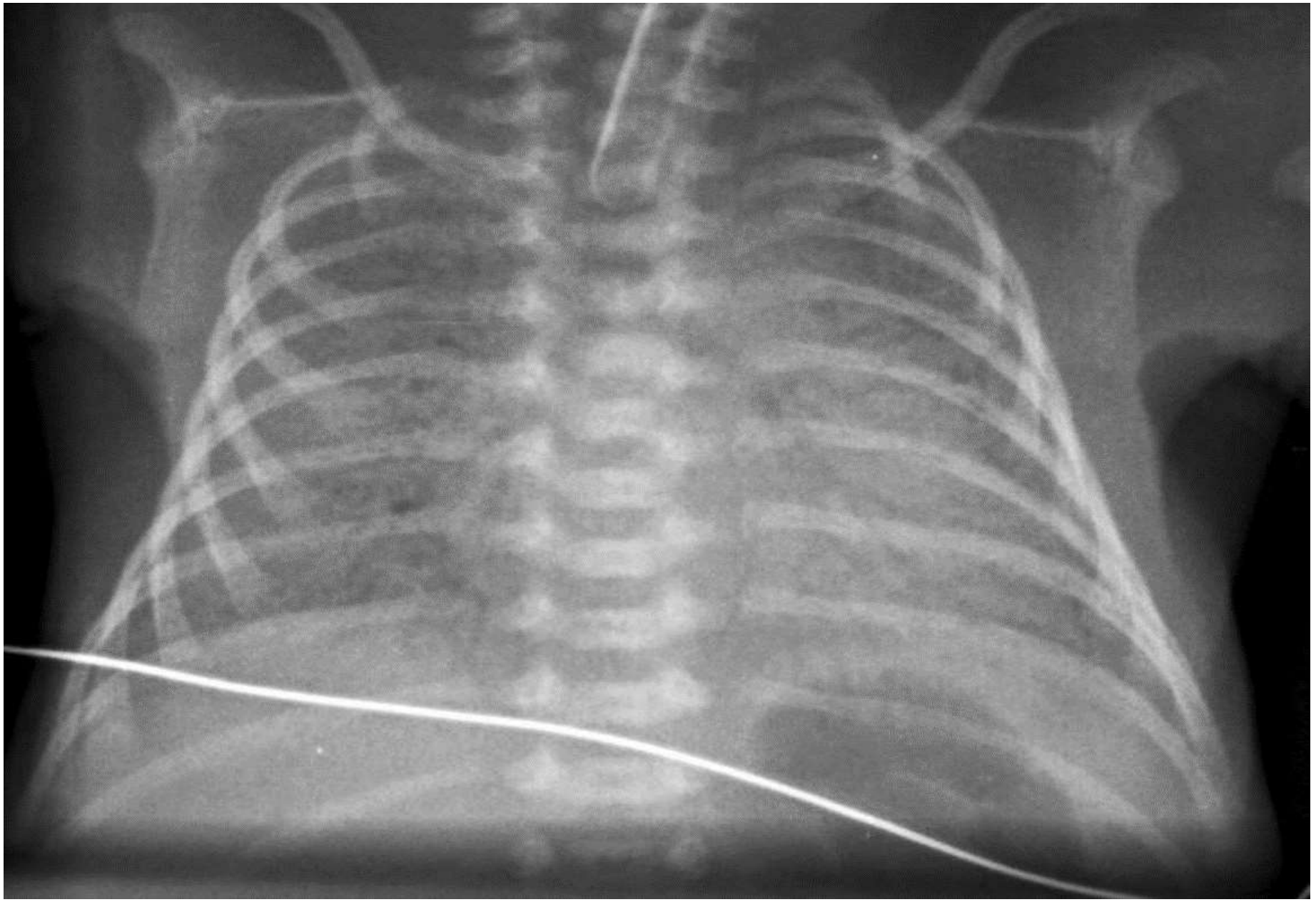
Chest x-ray

Findings can be graded according to the severity:

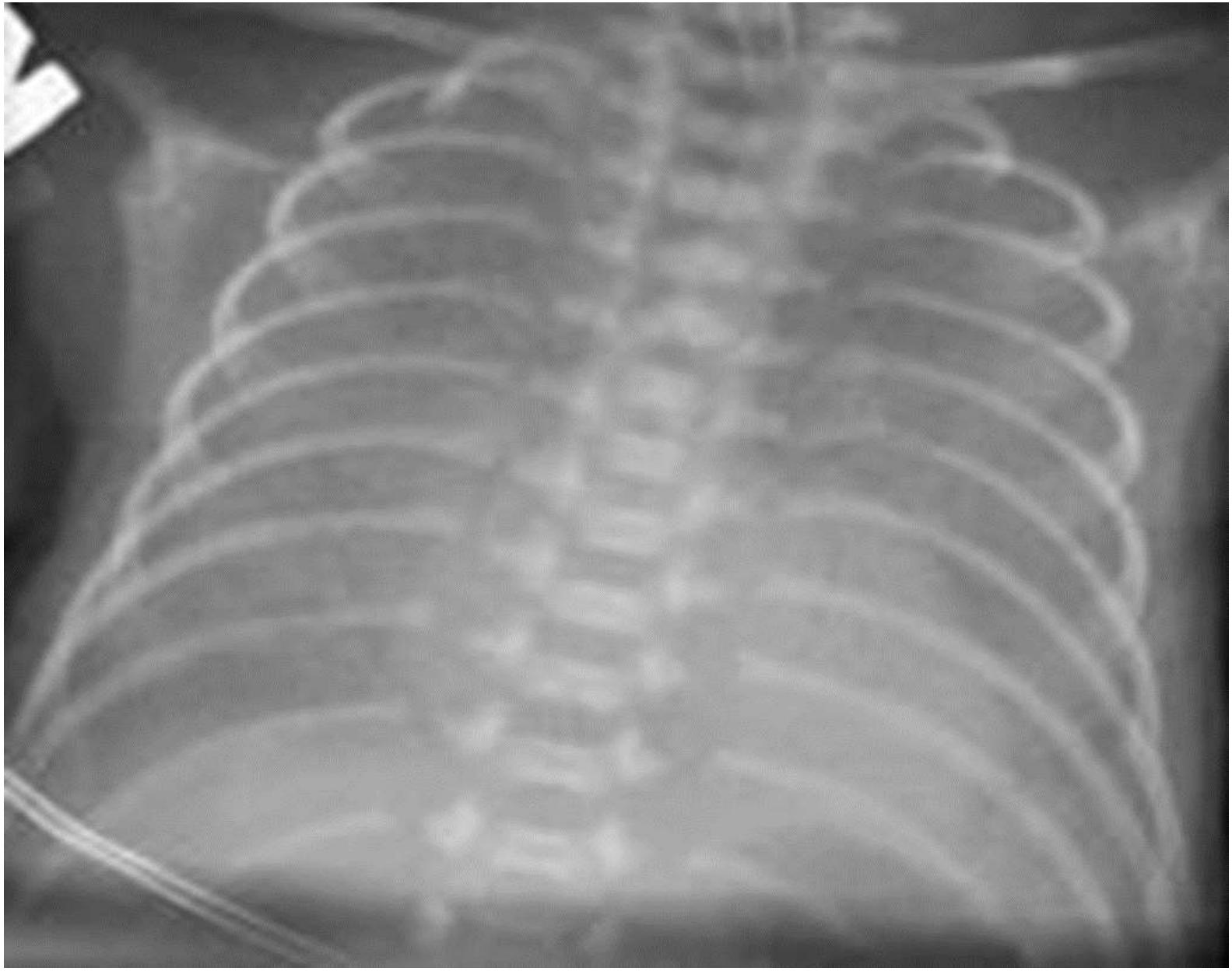
- Grade 1 (mild cases): the lungs show fine homogenous «***ground glass»*** shadowing
- Grade 2: widespread ***air bronchogram*** become visible
- Grade 3: confluent alveolar shadowing
- Grade 4: complete ***white lung fields*** with obscuring of the cardiac shadow

Grade 1

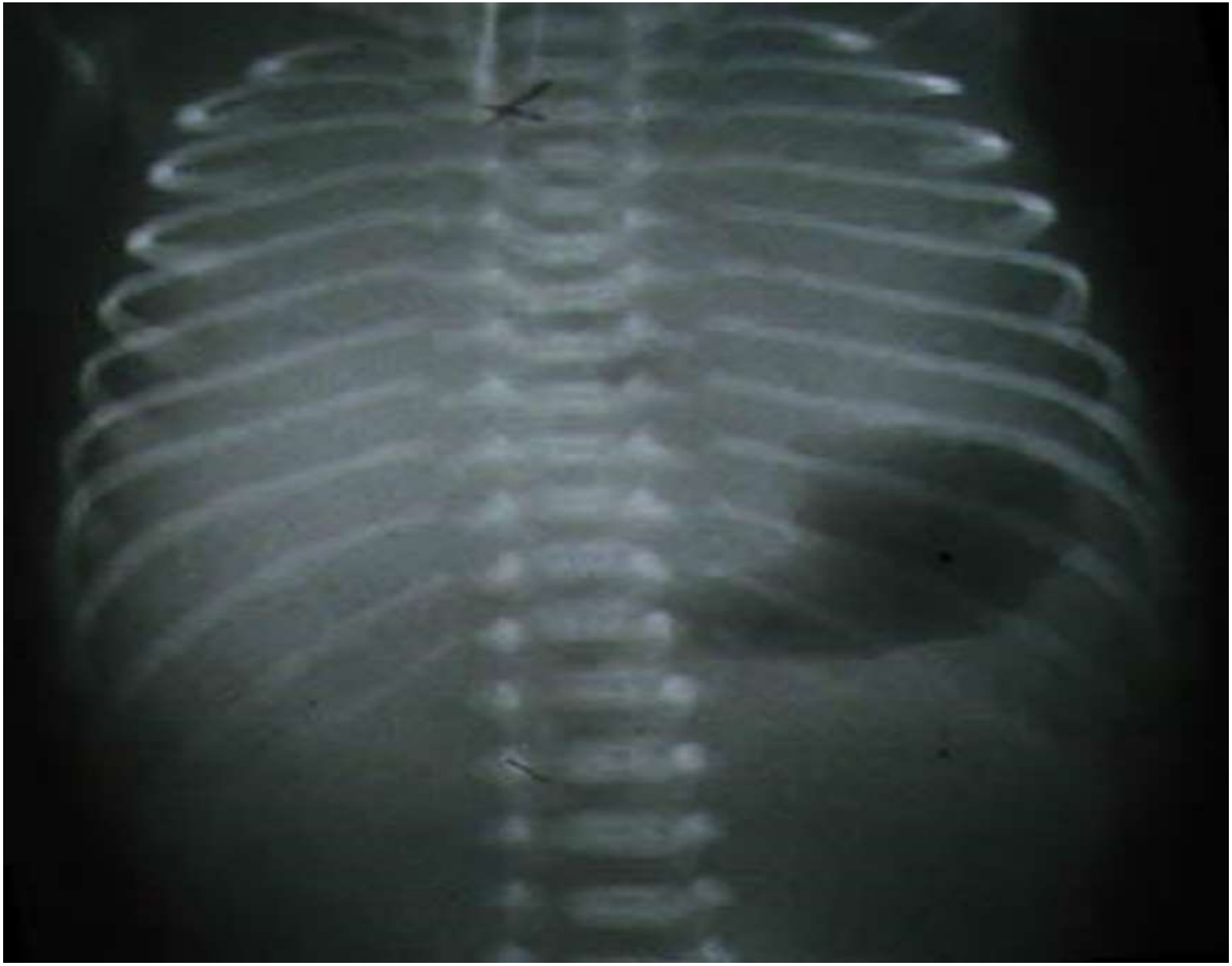
Grade 2



Grade 3



Grade 4

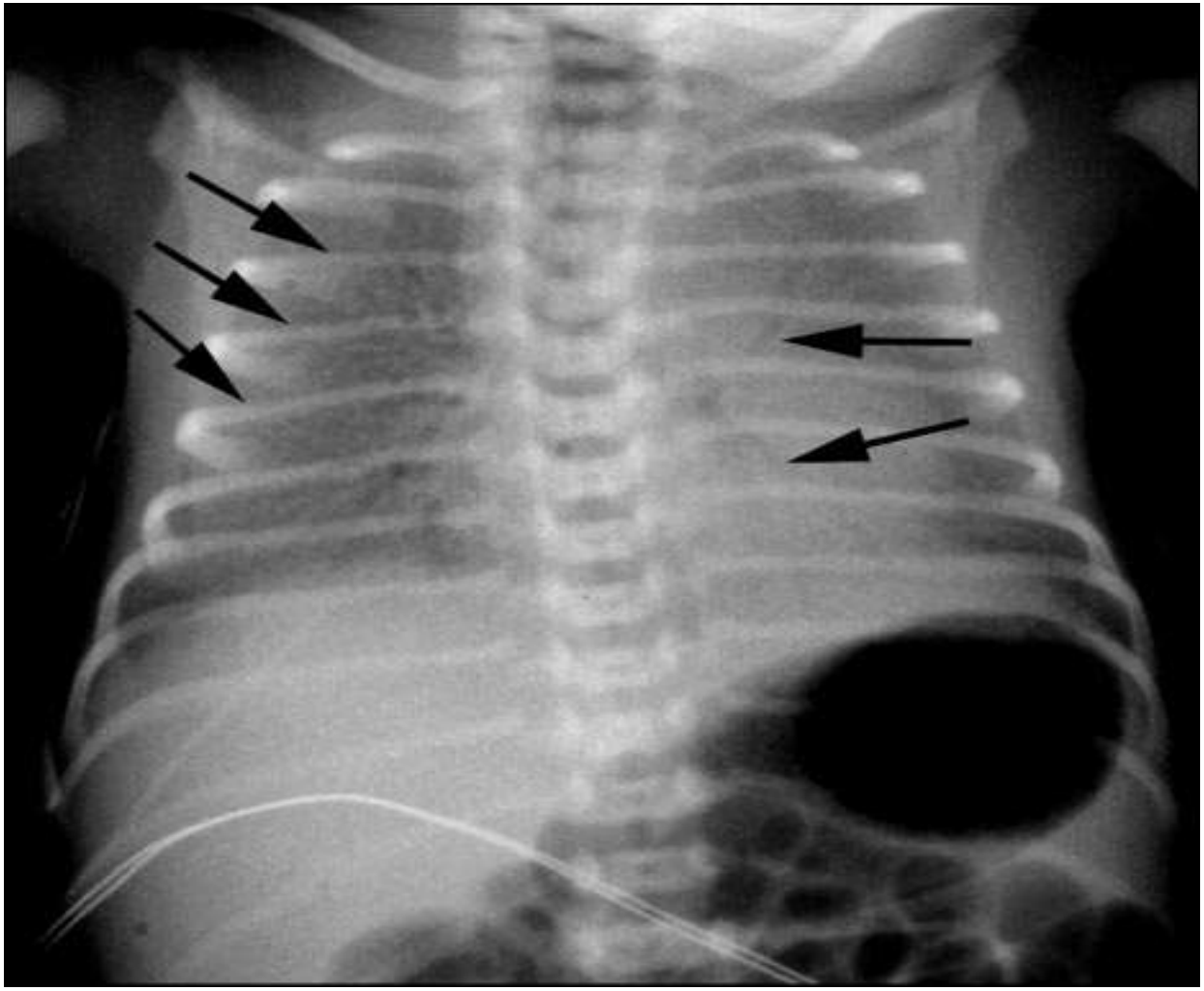


Respiratory distress syndrome

Chest radiograph

Respiratory distress syndrome

Chest radiograph



Chest radiograph of a preterm infant who has RDS. Arrows on the right lung field point at the diffuse ground glass appearance. Arrows on the left demonstrate prominent air-filled bronchi (air bronchogram).

Respiratory distress syndrome

Management

•Delaying premature birth. Good control of maternal diabetes

•Administration of corticosteroids to women

betamethasone - 4 mg every 8 h for six doses before delivery

•Postnatally surfactant replacement therapy

•Continuous Positive Airway Pressure (CPAP). Respiratory Management

•Mechanical ventilation. Oxygen.

•Antibiotic therapy. Vitamin A.

•Thermoregulation

Treatment of RDS

Surfactant

Curosurf - extracted from material derived from minced pig lung

Dosage: Intratracheal: **200 mg/kg**/dose; may repeat **100 mg/kg**/dose at 12-hour intervals for up to 2 hour intervals for up to 2 additional doses; maximum total dose: 5 mL/kg

Alveofact - extracted from cow lung lavage fluid

Dosage: Intratracheal: **1,2 ml/kg**/dose up to a maximum of 4 dose.

1,2ml (54mg)

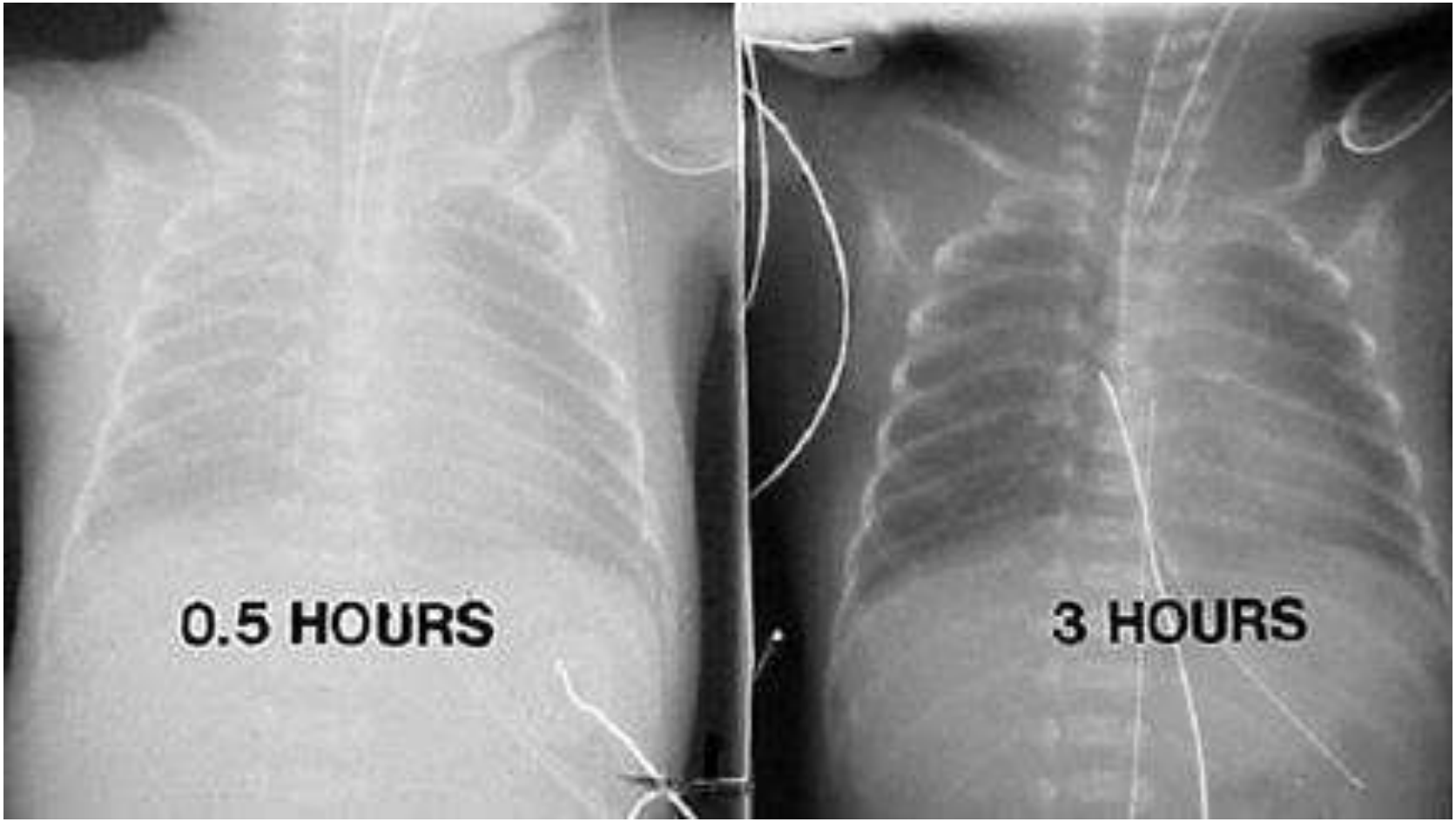
Treatment of RDS

Surfactant

Survanta - extracted from minced cow lung with additional DPPC, palmitic acid and tripalmitin.
Dosage: Intratracheal: **100 mg/kg**/dose; 6-12 hourly up to a maximum of 4 dose.

Surfaxin - is a ***synthetic*** formulation of pulmonary surfactant (SP-B).
Dosage: Intratracheal: **5,8 ml/kg**/dose

Chest radiograph



Chest radiographs in a premature infant with respiratory distress syndrome before and after surfactant treatment. Left: Initial radiograph shows air bronchogram, reticular granular appearance. Right: Repeat chest radiograph obtained when the neonate is aged 3 hours and after surfactant therapy demonstrates marked improvement.

Meconium Aspiration Syndrome (MAS)

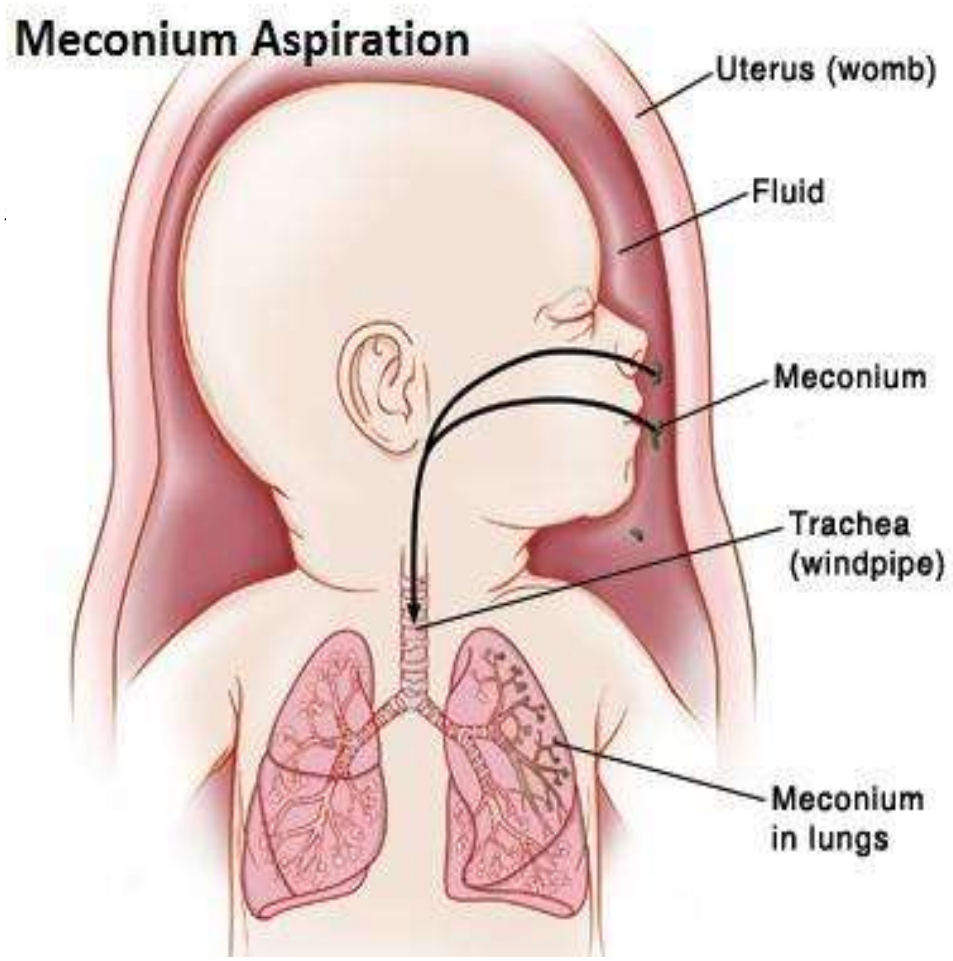
8% – 25% of all births >34 weeks gestation have meconium in amniotic fluid
~10% of those infants develop MAS

Infants at Risk

- Term or postterm infants
- Term or postterm, small-for-gestational-age infants
- Any event causing fetal distress, such as:
  – Reduced placental or uterine blood flow
  – Maternal hypoxia and/or anemia
  – Placental or umbilical cord accidents
- African-American race
- Chorioamnionitis/infection

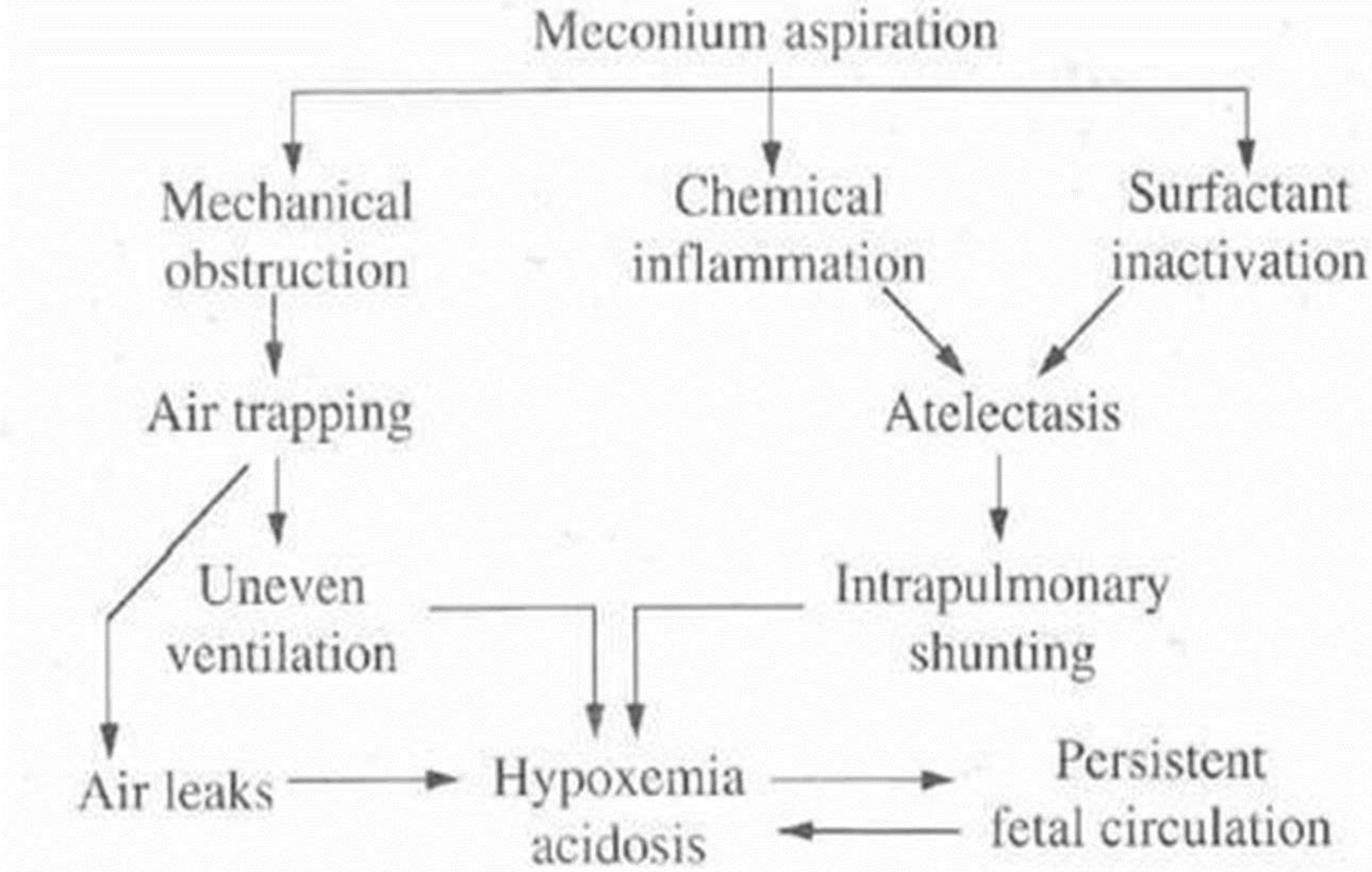
Meconium Aspiration Syndrome

• Meconium consists of water, desquamated cells from the alimentary tract, skin, lanugo hair, bile pigments, lipid, and mucopolysaccharides.
• Meconium is directly toxic to the lungs can be aspirated before, during, or after delivery.
• Meconium is normally retained in the fetal gut until postnatal life, but passage of meconium occurs in response to fetal distress.
• The rectal sphincter tone or muscle may relax after vagal reflex stimulation and release meconium into the amniotic fluid.
• Respiratory distress can range from mild to severe, with varying degrees of cyanosis, tachypnea, retractions, grunting, nasal flaring, and rales.



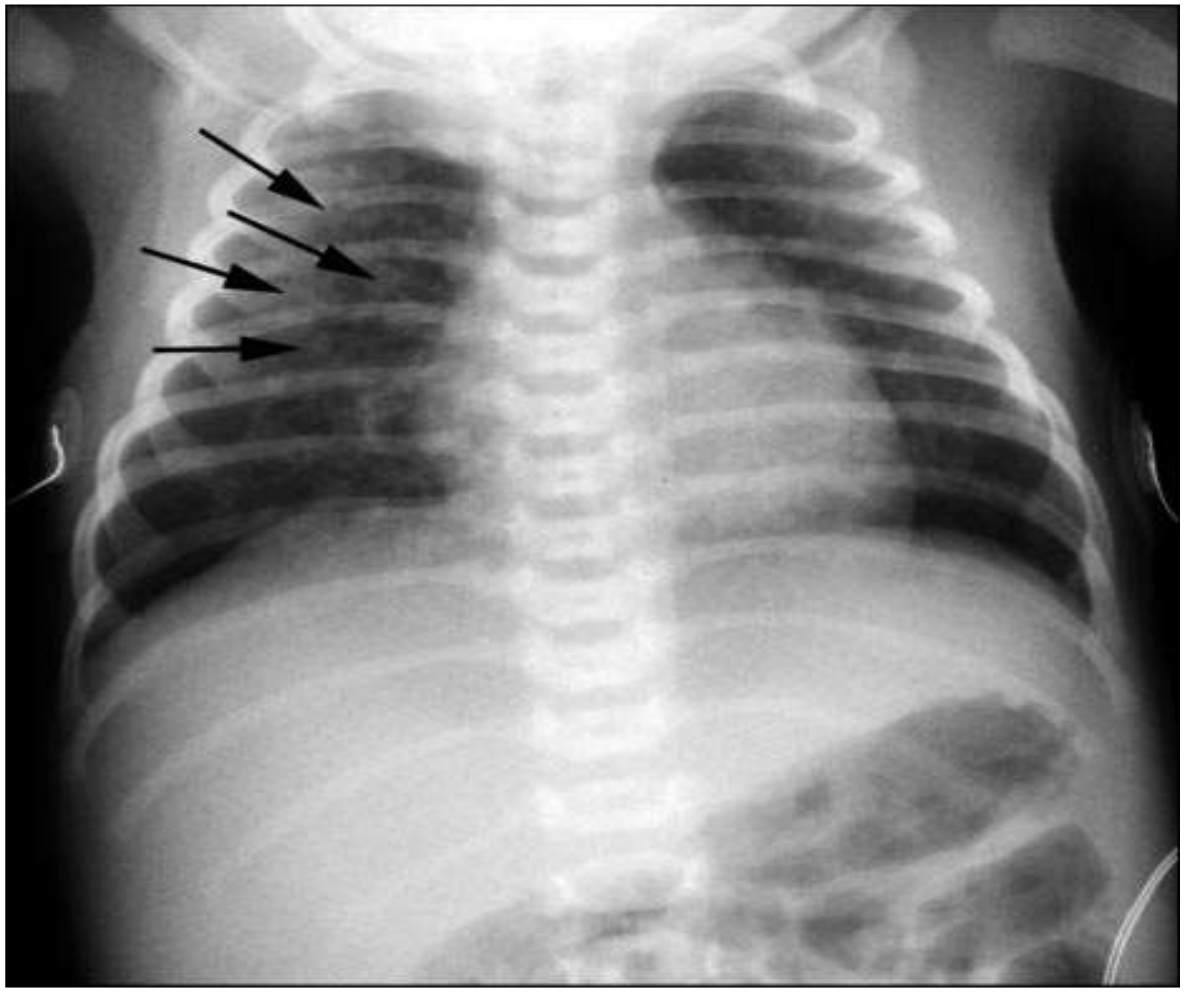
Meconium Aspiration Syndrome

Pathophysiology



Meconium Aspiration Syndrome

Chest radiograph



Chest radiograph of an infant who has meconium aspiration syndrome, with course **patches of atelectasis** (arrows).
Areas of hyperinflation also are present, best seen at both lung bases.

Meconium Aspiration Syndrome

Management

- Visualization of the vocal cords and tracheal suctioning before ambu bagging should be done only if the baby is not vigorous
- Empty stomach contents to avoid further aspiration.
- ***Consider CPAP***, if FiO2 requirements >0.4; however CPAP may aggravate air trapping and must be used cautiously.
- ***Mechanical ventilation***: in severe cases (paCO2 >60 mmHg orpersistent hypoxemia (paO2 <50 mmHg).
- ***Correct systemic hypotension*** (hypovolemia, myocardial dysfunction).
- ***Manage of renal problems***, if present.
- ***Surfactant therapy*** in infants whose clinical status continue to deteriorate.

Transient Tachypnea of the Newborn (TTN)

- TTN (known as wet lung) is a relatively mild, self limiting ***disorder of near-term or term.*** The most commonly cause of transient tachypnea is delayed absorption of fetal lung fluid.
- The onset of symptoms is usually ***0.5–6 hours after birth***; ***tachypnea is the most common symptom***. Grunting, nasal flaring and retractions may occur with varying severity.
- Auscultation usually reveals ***good air entry*** with or without crackles
- These manifestations usually persist for 12-24 hrs, but can ***last up to 72 hrs***
- ***Spontaneous improvement of the neonate is an important marker of TTN.***

Transient Tachypnea of theNewborn (TTN)

Infants at Risk

- Term and late-preterm infants
- Precipitous delivery
- Cesarean delivery
- Male infants
- Prenatal exposure to methamphetamine

Management

•Treatment of TTN consists of oxygen (usually <40%),

•pulse oximetry and/or transcutaneous monitoring,

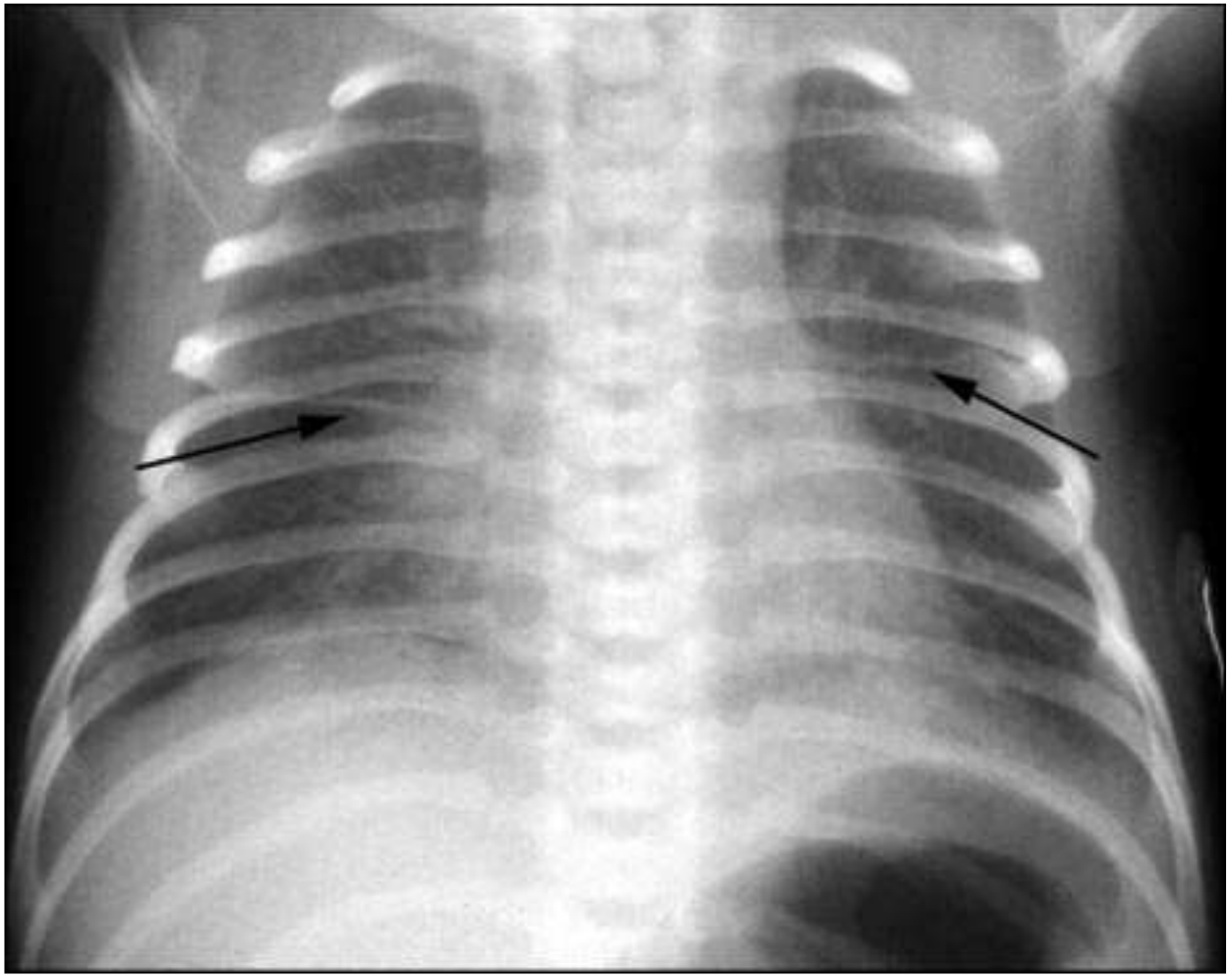
•antibiotics (if infection is suspected),

•general supportive neonatal care.

•Oral feedings should be delayed to prevent aspiration from high respiratory rates.

Transient Tachypnea of the Newborn

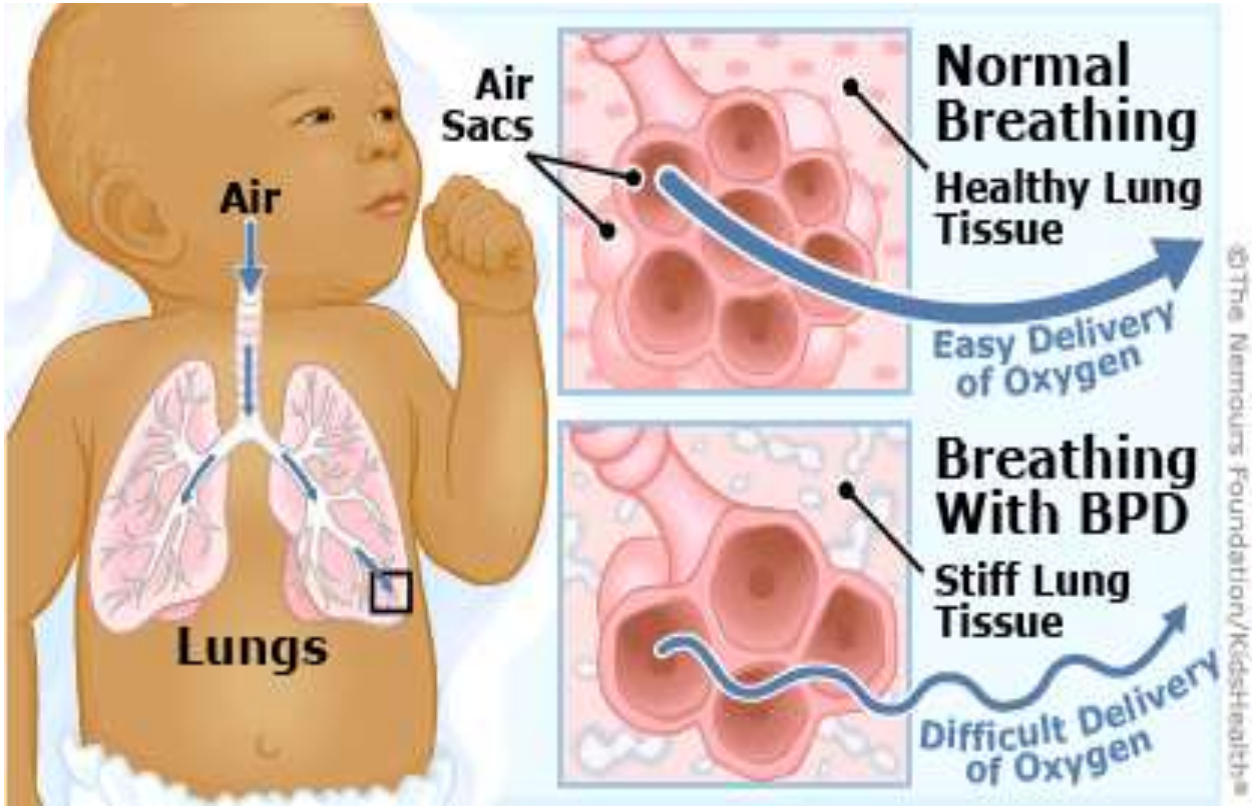
Chest radiograph



Chest radiograph of an infant who has transient tachypnea of the newborn. Arrows point at ***fluids in the interlobar fissures***. Note the increased pulmonary interstitial markings in both lung fields. Chest x-ray usually shows evidence of clearing by 12-18 hrs with complete resolution by 48-72 hrs.

Bronchopulmonary dysplasia (BPD)

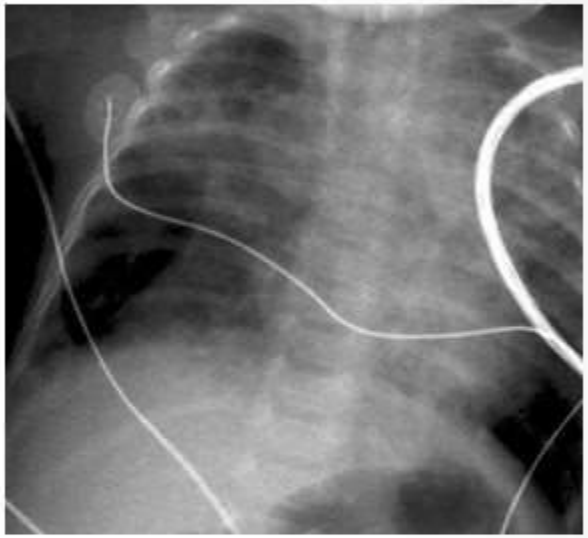
Chronic Lung Disease (CLD)



BPD is a chronic lung disease defined as a requirement for oxygen. BPD is related directly to the ***high volume*** and/or ***pressures*** used for mechanical ventilation or to manage infections, inflammation, and vitamin A deficiency. BPD increases with decreasing gestational age (incidence of 23%–85% in very low-birth-weight preterm infants).

Bronchopulmonary dysplasia (BPD)

- "Old BPD" (before surfactant and steroids)
  - Cystic changes, heterogeneous aeration
- "New BPD" (after surfactant and steroids)
  - More uniform inflation and less fibrosis, absence of small and large airway epithelial metaplasia and smooth muscle hypertophy
  - Some parenychmal opacities, but more homogenous aeration and less cystic areas
  - PATHOLOGIC HALLMARKS: larger simplified alveoli and dysmorphic pulmonary vasculature



Bronchopulmonary dysplasia (BPD)

Management

- Administration oxygen and positive-pressure ventilation
- Pharmacologic management includes diuretics, bronchodilators, and steroids
- Postnatal use of surfactant therapy, gentler ventilation, vitamin A, low-dose steroids may reduce the severity of BPD.

Pneumonia

Incidence

- 1% of term neonates
- 10% of preterm neonates

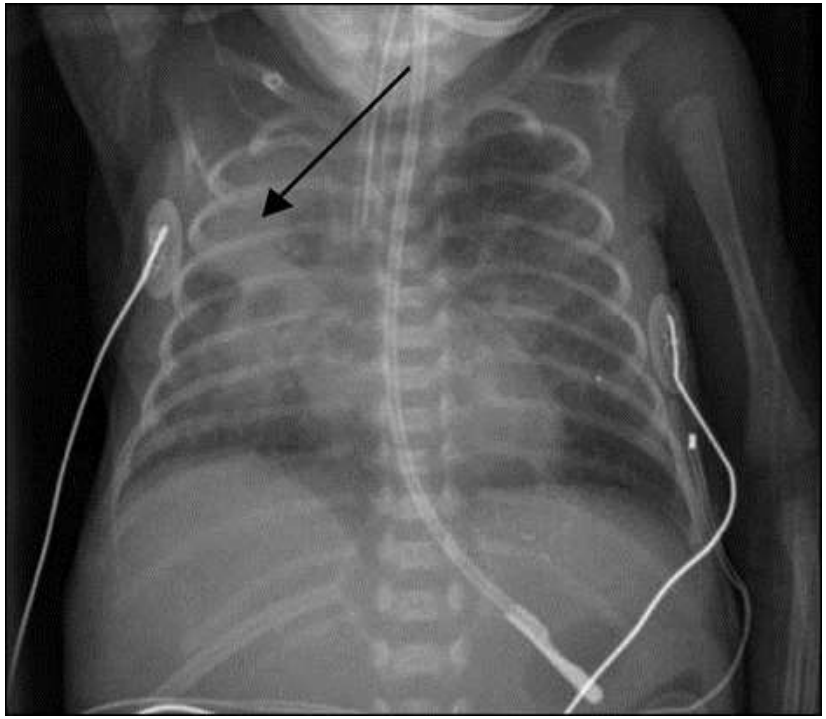
Infants at Risk

- Premature infants
- Prolonged rupture of membranes >12 hours
- Maternal fever
- Maternal viral, bacterial, or other infection
- Prolonged labor
- Maternal urinary tract infection
- Amnionitis
- Immature immune system
- Invasive procedures such as intubation and assisted ventilation
- Nosocomial infections acquired in the NICU

Prognosis

•Overall mortality from sepsis, both related and unrelated to pneumonia, ranges from 5% to 10% in term infants

•67% in infants with a birth weight <1500 g.



When to Call a Neonatologist for Respiratory Disorders in an Infant

- **Stabilization of the infant in respiratory distress**

- **Heart disease is suspected and echocardiography or medications (such as prostaglandins) are not available**

- **Need for respiratory support, supplemental oxygen, or medications beyond what is available at the institution**

- **Concerns for evolving pulmonary hypertension, especially in an infant who has meconium aspiration syndrome**

- **Concerns for evolving sepsis in an infant who has pneumonia**

- **Inability to ventilate**

- **Pulmonary hemorrhage**

- **Persistent or progressing pneumothorax fetus and newborn**

References

- Practical Neonatology Polin & Yoder
- Nelson Essential of Pediatrics fifth edition
- www.slideshare.net