Respiratory Distress Syndrome
or
Hyaline Membrane Disease

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RDS (2 types):
1. HMD (Hyaline Membrane Disease):
- Related to surfactant (Low function or concentration).
- Primary cause: Prematurity.
- Single most important factor: Prematurity.

2. TTN (Transient Tachypnea of Newborn):
- Self-limited and benign.
- Not related to surfactant.
- Common in full-term babies.

Respiratory Distress Syndrome

Hyaline Membrane Disease (HMD) ناتج عن Surfactant deficiency:

- Relative deficiency
- Absolute deficiency (Incompatible with life)

- Viability with life = 24 weeks
- أفضل outcome إذا كان surfactant present
- Antenatal steroids ↓ RDS

- ***Definition*** : Acute lung disease of the newborn caused by *surfactant deficiency*.

- HMD is the most common cause of *respiratory failure* during the first days after birth .

Long-term Complications of RDS

- Intracranial hemorrhage
- Chronic pulmonary dysplasia
- Retinopathy of prematurity (ROP)

fetus 22 wks, what is the incidence of → Chronic pulmonary dysplasia (100%)
→ Intracranial H >40%
→ ROB > 40%

Frequency of RDS

- Incidence and severity is *inversely proportional* to *gestational age*
  - Approximately 50% of the neonates born at 26-28 weeks of gestation develop RDS
  - <30% of premature neonates born at 30-31 weeks develop RDS

Full term baby → incidence 5 حوالي%

- Incidence and severity is *inversely proportional* to B.WT
  - 71% reported in infants weighing 501-750 g
  - 54% reported in infants weighing 751-1000 g,
  - 36% reported in infants weighing 1001-1250 g
  - 22% reported in infants weighing 1251-1500 g

Incidence & severity inversely proportional to birth weight

نسب حسب الوزن:

- 501–750 g → 71%
- 751–1000 g → 54%
- 1001–1250 g → 36%
- 1251–1500 g → 22%

تصنيفات الوزن:

- Normal weight: 2.4 – 4.2 kg
- Low birth weight: < 2.5 kg
- Very low birth weight
- Extremely low birth weight: < 1 kg

Frequency of RDS

يوجد طفلان (babies 2)، الأول بعمر 35 أسبوع والثاني بعمر 37 أسبوع، وكلاهما يعانيان من Respiratory Distress Syndrome (RDS). الطفل المولود بعمر 35 أسبوع أُصيب بـ RDS بسبب (prematurity)، بينما الطفل المولود بعمر 37 أسبوع أُصيب بـ RDS بسبب GBS (Group B Streptococcus)، والتي تُعد من أهم الأسباب المؤدية إلى PPH. الحالة في الطفل الثاني تكون الأشد (most severe)، وذلك لأن GBS قد تؤدي إلى sepsis وتسبب respiratory infection تكون أكثر شدة، مما يؤدي إلى severe hypoxia. هذه الحالة قد تحتاج إلى high-frequency ventilation مع nitric oxide، ومع استمرار نقص الأكسجة يدخل الطفل في vicious cycle تنتهي بتدهور الحالة، مما يجعلها leading cause of death، ويكون prognosis سيئ وقد يصل إلى suffocation وحدوث وفاة.

- RDS has been reported in all races worldwide
- occurring most often in premature infants of Caucasian ancestry.
- RDS is encountered less frequently in the developing countries Because :
  - most deliveries occur at home
  - accurate records are unavailable to determine the frequency of RDS in developing countries

Respiratory Distress Syndrome

Contributing factors

- Neonates younger than 37 weeks
- Weight less than 2500g
- Maternal diabetes
- Cesarean delivery without preceding labour
- Fetal asphyxia
- Second part of twins
- White infants

Several contributing factors are associated with the development of Respiratory Distress Syndrome (RDS). These include neonates born at a gestational age of less than 37 weeks or with a birth weight less than 2500 g, as the incidence and severity of the disease are inversely related to gestational age and birth weight. Maternal diabetes is an important risk factor, as insulin inhibits surfactant function. In addition, cesarean delivery without preceding labor, particularly elective cesarean section, increases the risk of RDS compared with emergency cesarean section. Fetal asphyxia and the associated hypoxic-ischemic encephalopathy (HIE) also contribute to increased severity of RDS, and HIE is often more severe than prematurity in terms of prognosis. Other contributing factors include being the second twin and white ethnicity. These factors may lead to acute complications such as acute pulmonary infection, surfactant deficiency, respiratory failure, respiratory and metabolic acidosis, as well as chronic conditions such as chronic oligohydramnios and lung dysplasia, all of which increase the risk of RDS. Approximately 3–5% of infants with RDS may develop patent ductus arteriosus (PDA).

Respiratory Distress Syndrome

- **Secondary surfactant deficiency may occur in infants with the following:**
  - Pulmonary infections e.g. group B Strep
  - Pulmonary hemorrhage
  - Meconium aspiration pneumonia
  - Oxygen toxicity; barotrauma or volutrauma to the lungs
  - Congenital diaphragmatic hernia

Secondary surfactant deficiency may occur in some infants as a result of subsequent pathological conditions. These include pulmonary infections, particularly Group B Streptococcus, and pulmonary hemorrhage, which is considered one of the most serious causes and is commonly associated with sepsis, patent ductus arteriosus (PDA), and surfactant inactivation, with a mortality rate that may reach up to 95%. Other causes include meconium aspiration pneumonia and oxygen toxicity resulting from barotrauma or volutrauma to the lungs. In addition, congenital diaphragmatic hernia is a severe emergency condition, often associated with air leak syndrome. Affected infants typically present with a scaphoid abdomen and central cyanosis, and the mainstay of management in such cases is endotracheal intubation.

Respiratory Distress Syndrome

- **Factors decrease the risk of RDS**
  - Use of antenatal steroids
  - Pregnancy-induced or chronic maternal hypertension
  - Prolonged rupture of membranes
  - Maternal narcotic addiction

يحدث Respiratory Distress Syndrome (RDS) بسبب نقص نسبي في السرفاكتانت، مما يؤدي إلى انخفاض lung compliance وانخفاض functional residual capacity مع زيادة dead space، وبالتالي يحدث collapse للحويصلات الهوائية وضعف في التهوية وتبادل الغازات. ينتج عن ذلك ventilation–perfusion (V/Q) mismatch كبير وحدوث right-to-left shunt، مما يؤدي إلى انخفاض PaO_2 وحدوث hypoxemia وارتفاع $PaCO_2$ مع CO_2 retention وانخفاض pH مسبباً respiratory acidosis. تؤدي hypoxemia و acidosis إلى pulmonary vasoconstriction وارتفاع pulmonary pressure مع انخفاض systemic pressure، مما يحافظ على بقاء PDA وPFO ويسمح بحدوث تحويلة دموية من اليمين إلى اليسار حيث ينتقل الدم غير المؤكسج من pulmonary artery إلى aorta بدل أن تكون نسبة تشبع الأكسجين في الأبهر حوالي 95% فتنخفض إلى قرابة 80%. تستمر هذه التغيرات لتدخل في vicious cycle تشمل زيادة التحويلة الدموية، ازدياد احتباس ثاني أكسيد الكربون، تفاقم الحموضة، وارتفاع المقاومة الوعائية الرئوية، مما يؤدي إلى persistent pulmonary hypertension of the newborn (PPHN) مع systemic vasodilation ونقص توصيل الأكسجين للأنسجة وحدوث metabolic acidosis، وقد ينتهي الأمر بتدهور شديد في الحالة التنفسية وحدوث فشل تنفسي إذا لم يتم التدخل العلاجي.

Respiratory Distress Syndrome

Pathophysiology

- Lung *surfactant deficiency* is the primary cause
- Pulmonary surfactant synthesis, in type II pneumocytes
- *surfactant production* begins at 24-28 weeks of gestation, and gradually increases until full gestation

Respiratory Distress Syndrome

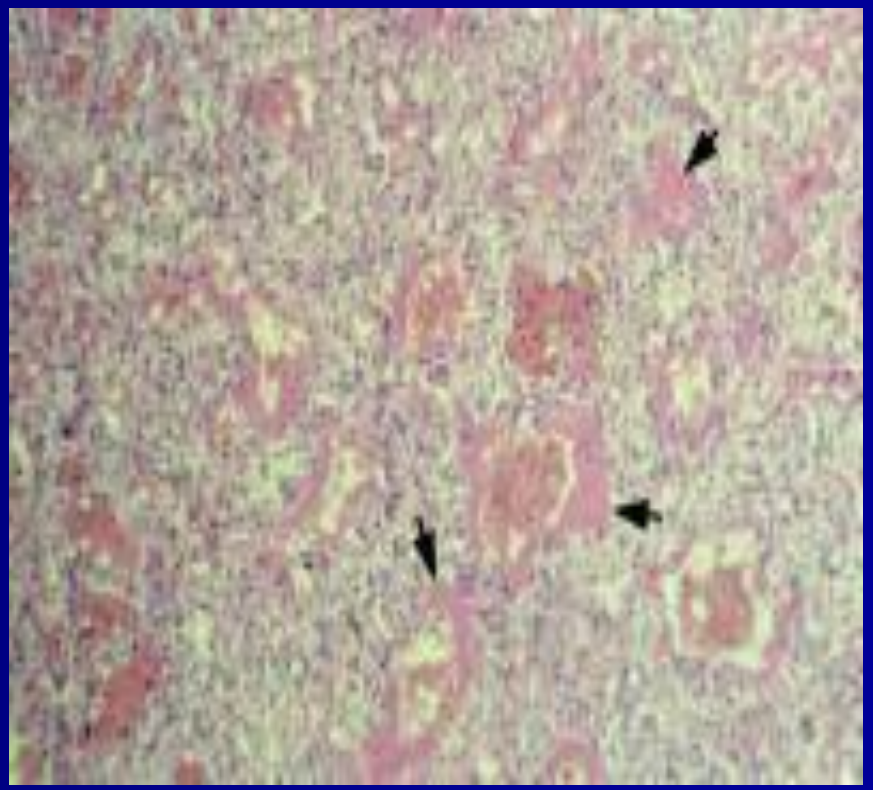
Pathophysiology

- The cause of respiratory distress syndrome is relative deficiency of surfactant, which decreases:
  - lung compliance
  - functional residual capacity
  - increased dead space.

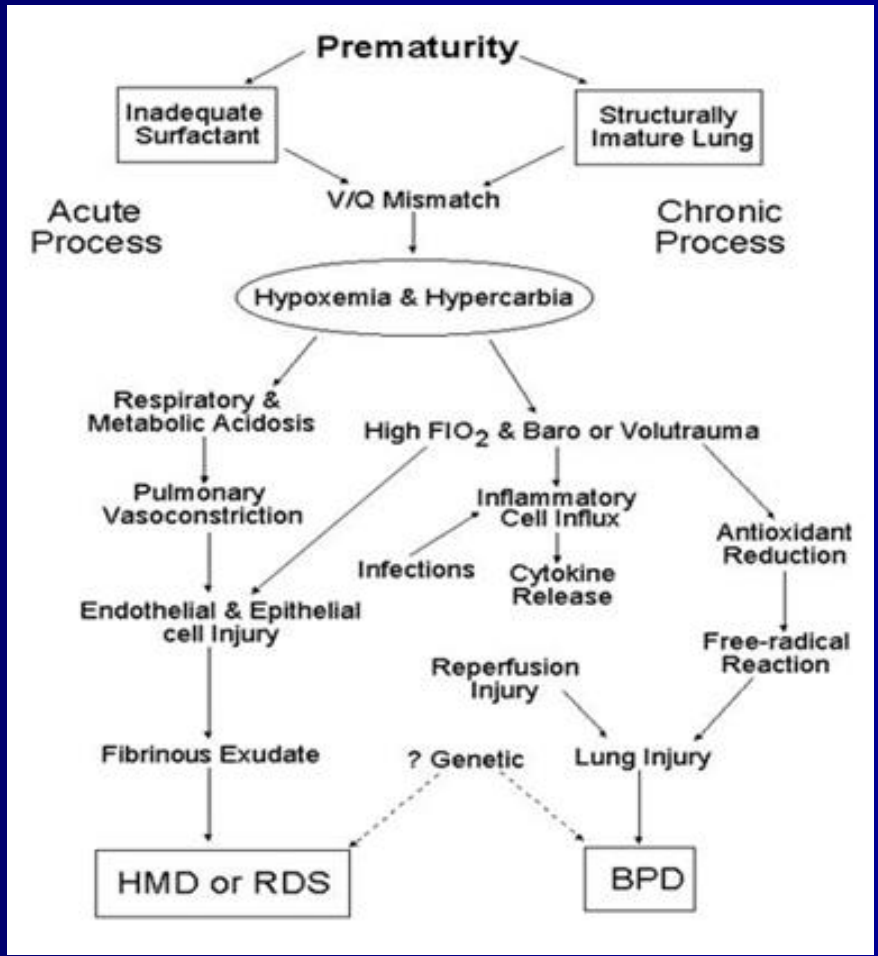
1. large ventilation-perfusion (V/Q) mismatch
2. right-to-left shunt

Pathophysiology of RDS
macroscopic evaluation

- lungs appear airless and ruddy
- Diffuse atelectasis of distal airspaces
- Progressive atelectasis damages endothelial and epithelial cells lining distal airways, resulting in :
  - exudation of fibrinous matrix derived from blood.
- Hyaline membranes that line the alveoli may form within a half hour after birth.

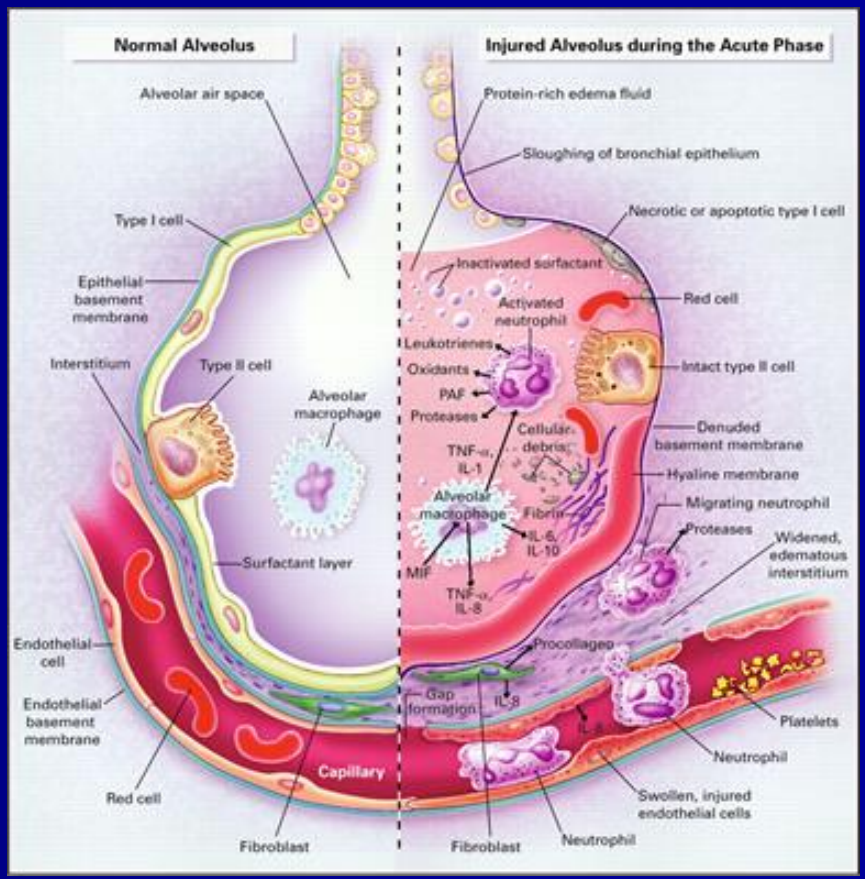


Pathophysiology of RDS



PULMONARY SURFACTANT

1. Chemical mixture that *decreases surface tension*
2. Lines the air-fluid interface in alveoli
3. Prevents atelectasis at the end of expiration
4. Synthesized in alveolar type II cells and stored in lamellar bodies



Composition of Pulmonary Surfactant

Pulmonary surfactant is composed of approximately 90% phospholipids, mainly lecithin and sphingomyelin, while the remaining 10% consists of surfactant apoproteins. There are four types of surfactant proteins: A, B, C, and D, which are classified according to their relationship with water. Hydrophilic (water-attracting) proteins include apoproteins A and D, whereas hydrophobic (water-repelling) proteins include apoproteins B and C.

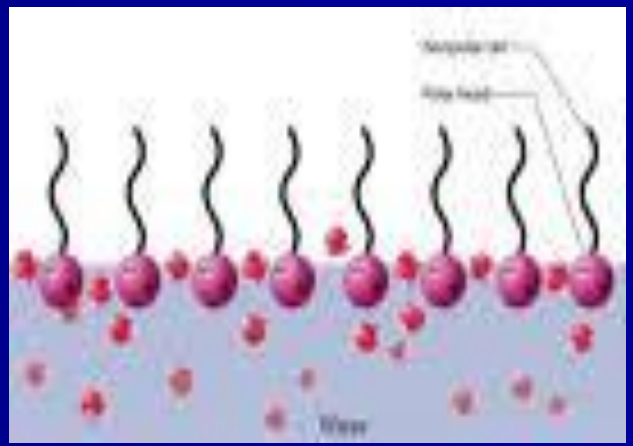
Pulmonary Surfactant

Function of lung surfactant

Alveolar Mechanics During Expiration

Water is considered the most important structural component within the alveoli. During expiration, contraction of the chest muscles generates mechanical power that tends to collapse the alveoli. This collapsing force is opposed by the surfactant, as surface tension and surfactant proteins generate an internal opposing (explosive or elastic) force. At end-expiration, equilibrium is reached when the mechanical force of the respiratory muscles equals the internal opposing force of the surfactant, at which point expiration ceases.

- decreases *surface tension* during expiration
- allows the alveolus to remain *partly expanded*
- maintains *functional residual capacity*



Pulmonary Surfactant

Function of lung surfactant

- Pulmonary surfactant deficiency
  - Atelectasis causes lung inflammation and respiratory epithelial cell injury
  - Decrease fluid absorption and lung edema
  - Accumulation of neutrophils in the lung

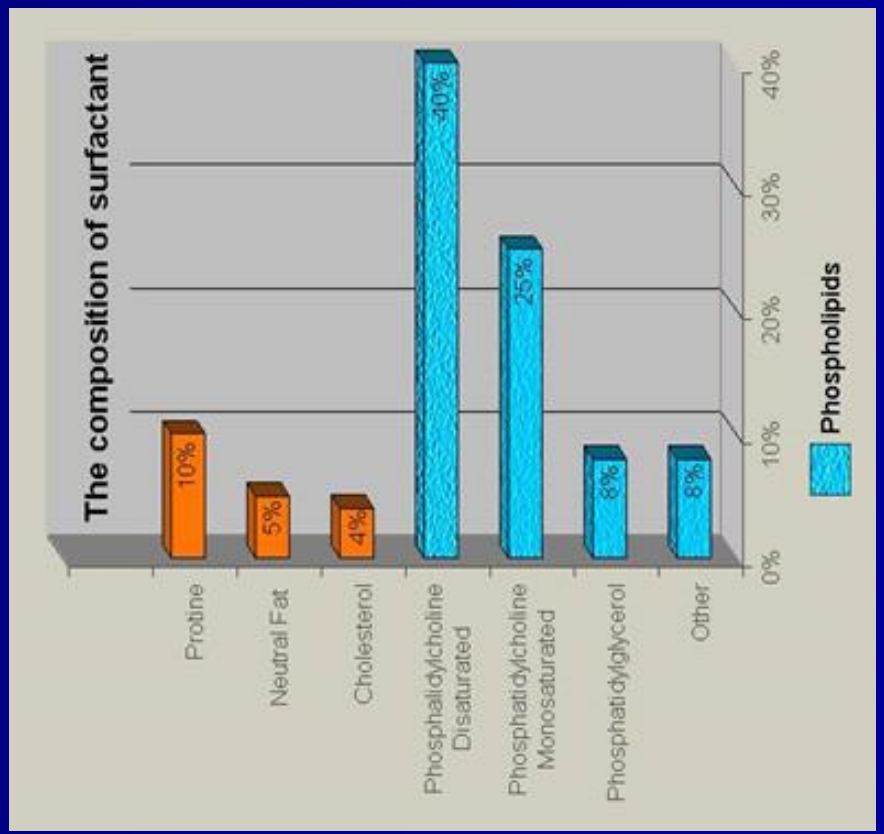
Pulmonary Surfactant

- Surfactant is a complex *lipoprotein* composed of *6 phospholipids* and *4 apoproteins.*

Pulmonary Surfactant

Structure of lung surfactant

- **Lipids 90%** of lung surfactant
  - Dipalmitoylphosphatidyl choline *DPPC (Lecithin)* is *functionally* the principle phospholipid



Pulmonary Surfactant

Structure of lung surfactant

- **Protein 10% of lung surfactant**
  - Consists of small proteins
    - Hydrophobic protein
      - SP-B and SP-C
    - Hydrophilic proteins
      - SP-A and SP-D

Pulmonary Surfactant

Structure of lung surfactant

Apoprotein B plays a crucial role in the formation and structural integrity of pulmonary surfactant. Mutations in apoprotein B are extremely rare, and according to clinical experience, only isolated cases may be encountered over many years of practice.

- **Protein of Pulmonary Surfactant**
  - ***SP-B***
    - Required for *normal pulmonary function*
    - Mutation result in deficiency SP-B Can cause severe lung disease that is lethal in perinatal period

Patients with apoprotein B mutations require regular medical treatment every 12 hours. These conditions are progressive and severe, and affected children commonly begin to develop pulmonary fibrosis by the age of 10–11 years.

Pulmonary Surfactant

Structure of lung surfactant

- **Protein of Pulmonary Surfactant**
  - ***SP-C***
    - Promotes formation of phospholipid film lining of alveoli
      - Human with SP-C deficiency develop interstitial pulmonary fibrosis in early childhood
      - SP-C deficiency do not cause respiratory distress at birth

Pulmonary Surfactant

Structure of lung surfactant

- **Protein of Pulmonary Surfactan**
  - ***SP-A and SP-D***
    - They are host defense of the lung
      - Kill bacteria
      - Kill viruses
    - They have carbohydrate recognition domain allows coating, and phagocytosis of virus and bacteria

Pulmonary Surfactant

Timing of lung surfactant

- The timing of lung surfactant or (Lecithin) production :
  - At 32-34 weeks fetal cortisol increase
  - Stimulate Type II pneumocyte cells
  - By 34-36 weeks sufficient amount of Lecithin ***secreted*** into alveolar lumen & ***Excreted*** into the amniotic fluids
    - *Lecithin concentration in amniotic fluid indicate lung maturity*

Respiratory Distress Syndrome

Differential Diagnosis

Several conditions should be considered in the differential diagnosis of Respiratory Distress Syndrome (RDS). One of the most important is Transient Tachypnea of the Newborn (TTN), which usually improves with time, whereas RDS typically deteriorates. Oxygen requirements are generally less in TTN compared to RDS. On chest X-ray, TTN is characterized by prominent perihilar streaking, fluid in the fissures, small pleural effusions, and sometimes patchy infiltrates.

- **TTN**
  - **Usually improve while RDS deteriorate**
  - **Oxygen requirement is less in TTN**
  - **X-RAY**
    - **Prominent perihilar streaking**
    - **Fluid in the fissures**
    - **Small pleural effusions may be seen**
    - **Patchy infiltrates have also been described ?**

Another important differential diagnosis is bacterial pneumonia, particularly Group B Streptococcus (GBS) infection. It is often very difficult to distinguish clinically from RDS, therefore empiric antibiotic therapy is recommended until cultures are confirmed to be negative.

- **Bacterial pneumonia**
  - **Very difficult to distinguish therefore antibiotic is necessary tell culture in negative**

Respiratory Distress Syndrome

Differential Diagnosis

Several conditions should be considered in the differential diagnosis of Respiratory Distress Syndrome (RDS). These include anemia and hypoglycemia, both of which can present with respiratory distress-like symptoms. Aspiration syndromes, particularly meconium aspiration, may also mimic RDS, as meconium can inhibit surfactant function and lead to respiratory failure. Hypothermia is another important condition that increases oxygen consumption and worsens respiratory distress. In addition, pulmonary air leaks, such as pneumothorax, may present with acute respiratory deterioration and should always be excluded. Diaphragmatic hernia is an important structural cause of neonatal respiratory distress, and cardiac anomalies may also present with features similar to RDS.

- Anemia
- Hypoglycemia
- Aspiration syndrome e.g. Meconium
- Hypothermia
- Pulmonary air leaks e.g. Pneumothorax
- Diaphragmatic hernia
- Cardiac anomalies
  - *Echocardiogram should be considered if*
    - *severe arterial hypoxemia*
    - *no improvement after respiratory support & surfactant administration*

Cardiac anomalies that may mimic or coexist with RDS include conditions such as total anomalous pulmonary venous return (TAPVR), transposition of the great arteries (TGA) with or without ventricular septal defect (VSD), and tricuspid atresia with or without atrial septal defect (ASD). These conditions can cause severe hypoxemia due to impaired pulmonary or systemic circulation. Therefore, echocardiography should be considered in neonates with severe arterial hypoxemia or in those who show no improvement despite adequate respiratory support and surfactant administration.

Respiratory Distress Syndrome

Differential Diagnosis

- **Congenital anomalies**
  - diaphragmatic hernia
  - chylothorax
  - congenital cystic adenomatoid malformation of the lung
  - lobar emphysema

Respiratory Distress Syndrome

Diagnosis

- **It is a Clinical diagnosis**
- **Progressive signs of respiratory distress are noted soon after birth and include the following**
  - *Tachypnea*
  - *Hypoxia*
  - *Cyanosis*
  - *Expiratory grunting (from partial closure of glottis)*
  - *Subcostal and intercostal retractions ?*
  - *Nasal flaring ?*
  - *Extremely immature neonates may develop **apnea** and hypothermia*

Respiratory Distress Syndrome (RDS) is primarily a clinical diagnosis. Affected neonates show progressive deterioration soon after birth, manifested by worsening tachypnea, hypoxia, and central cyanosis. Clinical signs of respiratory distress include tachypnea, hypoxia, and cyanosis, which appears as a bluish discoloration due to increased deoxygenated hemoglobin (usually >25%). Expiratory grunting occurs as a result of partial closure of the glottis, which helps maintain alveolar pressure and prevent collapse. Increased work of breathing leads to subcostal and intercostal retractions due to high negative intrathoracic pressure, as well as nasal flaring, which occurs in response to increased airway resistance and the need for higher airflow. In extremely immature neonates, respiratory control may be inadequate, resulting in apnea and hypothermia, both of which are associated with a poor prognosis.

Respiratory Distress Syndrome

Prenatal Diagnosis

- History of premature delivery
- Ratio of lecithin/sphingomyelin
  - L/S ratio 2:1 indicate lung maturity
    - ***Lecithin :*** indicate lung maturity
    - ***Sphingomyelin :*** remains constant during pregnancy

Respiratory Distress Syndrome

Diagnosis

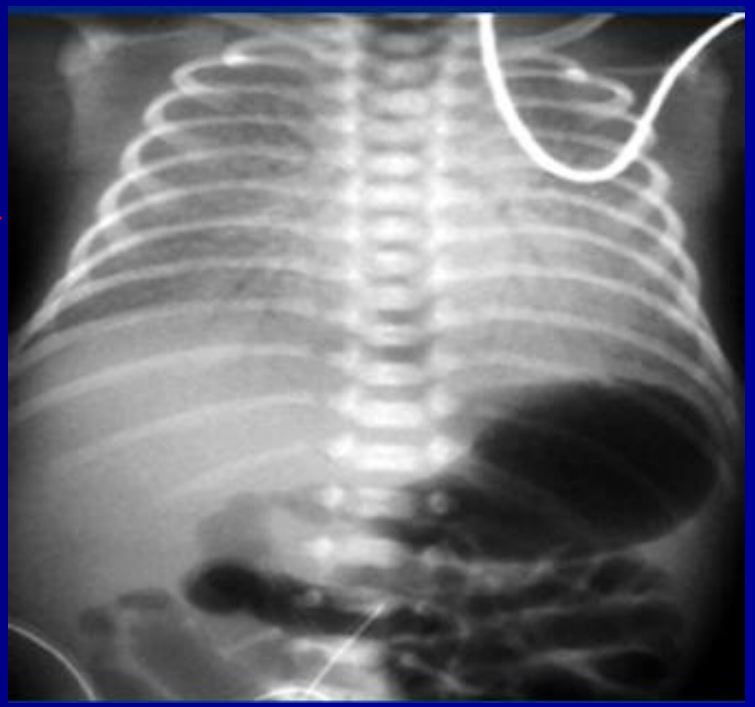
- **CXR**
  - Bilateral, diffuse reticular granular or ground-glass appearances
  - Air bronchograms
  - Poor lung expansion
    - *Prominent air bronchograms represent aerated bronchioles superimposed on a background of collapsed alveoli.*
  - Heart is normal or enlarged.
  - Cardiomegaly may be the result of:
    - *Prenatal asphyxia*
    - *Maternal diabetes*
    - *PDA*
    - *Congenital heart anomaly*
    - *poor lung expansion.*

Respiratory Distress Syndrome
Diagnosis

- Radiologic findings of RDS can be similar to pneumonia
  - Group B beta-hemolytic streptococci.
- If streaky opacities, the diagnosis of: ***Ureaplasma*** **or** ***Mycoplasma*** pneumonia should be considered and confirmed by means of tracheal aspirate cultures grown in the appropriate medium.

CXR of RDS

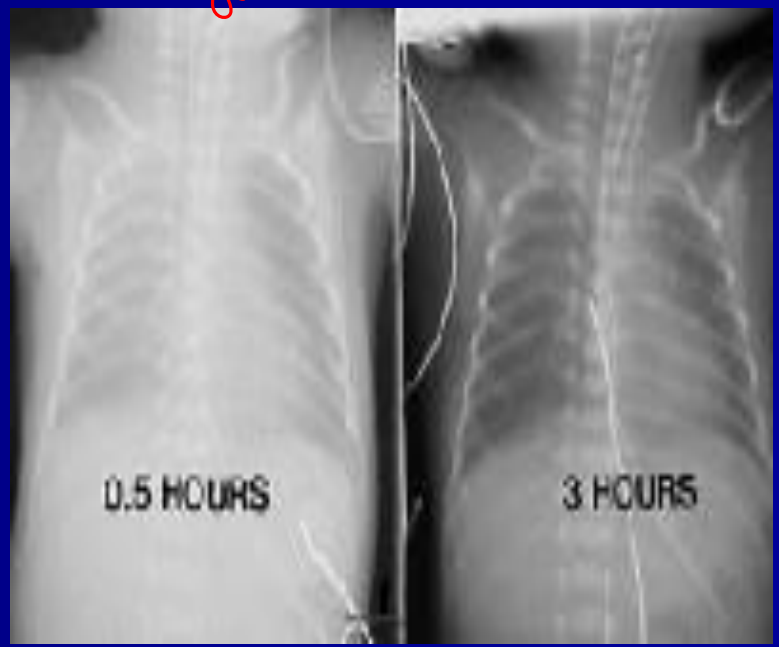
- Ground glass appearance
- Air bronchogram ↑ Dead space
- Poor lung expansion



CXR of RDS

Sever type of RDS (white lung)

- **Left: Initial radiograph shows**
  - poor lung expansion
  - air bronchogram
  - reticular granular appearance.
- **Right: At 3 hours**
  - after surfactant therapy
  - marked improvement



- Endotracheal tube (to open the lung)
- High lung volume
- Severe type → white lung with ground-glass appearance
- After surfactant → lung becomes more normal
- Rapid weaning → prevents cyanosis and complications (e.g. pneumothorax, hemodynamic issues)

Respiratory Distress Syndrome

Diagnosis

- **Blood gases**
  - Blood gases show respiratory and metabolic acidosis along with hypoxia. due to Rt to Lf shunt
    - **Respiratory acidosis** occurs because :
      - alveolar atelectasis
      - overdistension of terminal airways
    - **Metabolic acidosis,** is primarily lactic acidosis, results from
      - poor tissue perfusion
      - anaerobic metabolism.
    - **Hypoxia**: occurs from right-to-left shunting of blood through the pulmonary vessels, patent ductus arteriosus (PDA), patent foramen ovale
- **Pulse Oximetry**

Respiratory Distress Syndrome

Diagnosis

- Full blood count
- Cultures to rule out sepsis
- Electrolytes, glucose, renal and liver function
- Echocardiogram:
  - *diagnosing PDA*
  - *determine the direction and degree of shunting*
  - *making the diagnosis of pulmonary hypertension*
  - *excluding structural heart disease*

Respiratory Distress Syndrome

Diagnosis

- **Pulmonary Function**
  - Compliance decrease
  - Functional residual capacity is reduced
  - Hypoxemia secondary to mismatch of ventilation
    - PDA and foramen ovale plays rule in hypoxemia due to R-L shunting
  - Alveolar ventilation is decreased

Treatment of RDS

Treatment of RDS is mainly supportive and is based on three main pillars: oxygenation, surfactant therapy, and infection control, with ventilation (ETT) used when needed. Prematurity is the most important risk factor for RDS.

Goals of treatment

The main goals are to ensure adequate tissue oxygenation while avoiding oxygen toxicity and ventilator-induced lung injury.

- Oxygen
- Surfactant
- Infection control

Target Oxygenation

The target PaO_2 in neonates with RDS is 50–80 mmHg. Prolonged exposure to high oxygen levels should be avoided; if PaO_2 exceeds 100 mmHg for 24 hours, this indicates hyperventilation, which increases the risk of PVL, ROP, and BPD. Therefore, hyperventilation must be avoided.

Oxygenation should be monitored continuously using arterial blood gases (ABG) or oxygen saturation. A practical bedside estimation can be used:

$PaO_2 \approx SpO_2 - 30$

For example:

- SpO_2 88% → $PaO_2 \approx$ 58 mmHg
- SpO_2 92% → $PaO_2 \approx$ 62 mmHg

The recommended SpO_2 target is 88–92%.

Respiratory Treatment of RDS

Oxygen delivery
- Nasal cannula may be used initially
- If >25% oxygen is required → escalate respiratory support
- Failure of CPAP or worsening respiratory status → intubation and mechanical ventilation

- Oxygen:
  - Maintain Pao2 50-80mmHg
  - Spo2 88-92%
- Nasal cannula
  - if >25% oxygen is required

1. Oxygenation
- Target SpO_2: 88–92%
- Inspired oxygen (FiO_2): usually 50–80%, adjusted according to saturation
- Target $PaCO_2$: 35–45 mmHg

⚠ Excess oxygen → oxygen free radicals → Bronchopulmonary dysplasia (BPD)

⚠ Over-ventilation → ↓ $PaCO_2$ (hypocarbia) → Retinopathy of prematurity (ROP)

$PaCO_2$ < 35 mmHg is dangerous and may cause:
- Apnea
- Periventricular leukomalacia (PVL)
- Hypoxic-ischemic encephalopathy (HIE)
- Mild permissive hypercapnia is sometimes accepted, but hypocarbia should be avoided.

Respiratory Treatment of RDS

Initial respiratory support
- Start with Nasal CPAP as early as possible after delivery
- Early CPAP reduces the need for mechanical ventilation

CPAP settings :
- FiO_2: 21–60% (may increase up to 80% if needed)
- PEEP: 5–7 cmH_2O

- Nasal CPAP
  - Using CPAP soon after delivery *reduces the number of babies requires ventilation*
- Indication of CPAP
  - In delivery room for babies at risk of RDS
  - Babies on low flow oxygen with respiratory distress
- Mechanical ventilation ?

Indications for Mechanical Ventilation
1. Gestational age < 30 weeks
2. Recurrent apnea requiring tactile stimulation
3. Severe apnea requiring bag-mask ventilation (Ambu bag)
4. Congenital diaphragmatic hernia
5. Meconium aspiration syndrome
6. PaO_2 < 55 mmHg on blood gases
7. $PaCO_2$ > 55 mmHg
8. Failure of CPAP

Carbon Dioxide Targets

Normal $PaCO_2$ in neonates during the first 7 days of life is 45–55 mmHg.
After 7 days, in ventilated neonates, $PaCO_2$ up to 70 mmHg is acceptable, a strategy known as permissive hypercapnia, which helps reduce ventilator-induced lung injury.

Maintaining Desired Oxygen Saturation

Management depends on gestational age:

Neonates < 30 weeks

- Require intubation and surfactant therapy with mechanical ventilation
- These babies have stiff lungs and need a certain level of pressure to maintain lung expansion
- After giving surfactant, lung compliance improves, so the ventilator pressure must be reduced as soon as possible
- Failure to reduce pressure after surfactant administration can result in pneumothorax

Clinical example:
A 30-week neonate with RDS is started on mechanical ventilation and given surfactant. After 2 hours, the baby deteriorates with hypotension, cyanosis, and chest retractions. This is most likely due to pneumothorax caused by high ventilatory pressure (confirmed by X-ray or transillumination).

- Tidal volume target: 7–14 mL/kg

Neonates > 30 weeks
Management is stepwise:

1. Nasal cannula
2. CPAP
3. Intubation and surfactant if deterioration occurs

- CPAP settings:
- PEEP: usually 5–10 cmH_2O (commonly 6–8 in neonates)
- FiO_2: up to 100% if needed
- Provides continuous positive airway pressure
- CPAP is mainly used in mild cases

Apnea Management

- First-line treatment: Caffeine citrate
- If apnea persists → CPAP
- Supportive measures include gentle stimulation and handling

Surfactant therapy

- Improves lung compliance and oxygenation
- Leads to rapid radiological and clinical improvement
- Allows early weaning from ventilation, reducing complications

Respiratory Treatment of RDS surfactant

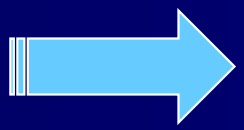
- Natural lung surfactant
  - ***Alveofact*** - extracted from cow lung lavage fluid
  - ***Curosurf*** - extracted from material derived from minced pig lung
  - ***Infasurf*** - extracted from calf lung lavage fluid
  - ***Survanta*** → use in Jordan - extracted from minced cow lung with additional DPPC, palmitic acid and tripalmitin

Treatment of RDS

- **Curosurf** (Poractant alfa**)**
  - Dosage: Intratracheal: Initial: 2.5 mL/kg/dose (200mg/kg/dose); may repeat 1.25 mL/kg/dose (100mg/kg/dose) at 12-hour intervals for up to 2 additional doses; maximum total dose: 5 mL/kg
- **Precautions**:
  - Correction of acidosis, hypotension, anemia, hypoglycemia, and hypothermia is recommended prior to administration

Treatment of RDS

- Warnings!!
  - **Curosurf:** if transient episodes of bradycardia and decreased oxygen saturation occur



Discontinue the dosing procedure and initiate measures to alleviate the condition

  - **Curosurf:** produces rapid improvements in lung oxygenation and compliance that may require immediate reductions in ventilator settings and Fio2

Side effects of Animal-Derived Surfactant

- Transient hypoxia
- Bradycardia
- *Acute airway* ***obstruction***
- Transient full in blood pressure and cerebral blood flow
- Slight increase in risk of pulmonary hemorrhage
- No long-term effect on babies
- Fewer pneumothorces with slightly reduced mortality rate compared to infant treated with synthetic surfactant
- Potential sensitization to animal proteins

Treatment of RDS

- **Supportive treatment**
  - Temperature regulation: prevent hypothermia.
  - Fluids, metabolism, and nutrition: closely monitor and maintain blood glucose, electrolytes, acid balance, calcium,phosphorous, renal function, and hydration.
  - Once the infant is stable, intravenous nutrition with amino acids and lipid.
  - After the respiratory status is stable, initiate small volume gastric feeds (preferably breast milk) via a tube to initially stimulate gut development

Treatment of RDS

- **Supportive treatment**
  - ***Circulation and anemia***: monitor heart rate, peripheral perfusion, and blood pressure. Blood or volume expanders may be required.
  - ***Antibiotics*** : start antibiotics in all infants who present with respiratory distress at birth after obtaining blood cultures.
    - Discontinue antibiotics after three to five days if blood cultures are negative.
  - Support of parents and family: keep the parents well informed. Encourage parents to frequently visit and stay with their baby

Prevention of RDS

- **American Academy of Pediatrics recommendation 2008**
  - Intubation of infant born at or before 30 weeks gestation in the delivery
  - Prophylactic natural surfactant therapy is administrated through the ET as soon as the infant is stable after intubation
    - Do not delay surfactant for CXR
    - No CXR is necessary to confirm proper tube placement

Prevention of RDS

- Antenatal Steroids should be given to any pregnant women at 24 to 34 weeks of gestation with intact membranes at high risk for preterm delivery.

- After administration of surfactant and if the infant is active and exhibit spontaneous respiratory effort :
    - extubation and stabilization on CPAP rather than continued intubation and M.V

Prevention of RDS

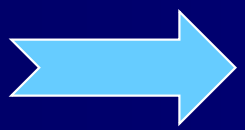
- Prophylactic surfactant therapy is not recommended in infant greater than 30 weeks gestation
- Delaying premature birth.
  - Tocolytics may delay delivery by 48 hours and therefore enable time for antenatal corticosteroids to be given.
- Good control of maternal diabetes
- Avoid hypothermia in the neonate

Complications **of RDS**

- Acute complications
  - Alveolar rupture
  - Infection
  - Intracranial hemorrhage and periventricular leukomalacia
  - Patent ductus arteriosus (PDA)
  - Pulmonary hemorrhage
  - Necrotizing enterocolitis (NEC) and/or GI perforation
  - Apnea of prematurity
- Chronic complications
  - Bronchopulmonary dysplasia (BPD)
  - Retinopathy of prematurity (ROP):
  - Neurologic impairment

Acute complications

- Alveolar rupture:
  - when an infant with respiratory distress syndrome suddenly deteriorates with hypotension, apnea, or bradycardia or when metabolic acidosis is persistent.



pneumomediastinum, pneumopericardium, interstitial emphysema, pneumothorax

- Infection

- Intracranial hemorrhage and periventricular leukomalacia:
  - is observed in 20-40% of premature.
  - Cranial ultrasonography is performed in the first week and thereafter as indicated
  - Prophylactic indomethacin therapy and antenatal steroids have decreased the frequency
  - periventricular leukomalacia associated with Hypocarbia and chorioamnionitis

Acute complications

- Patent ductus arteriosus (PDA) with increasing left-to-right shunt:
  - Suspect PDA in any infant who
    - deteriorates after initial improvement or
    - who has bloody tracheal secretions..
- Pulmonary hemorrhage: especially after surfactant therapy.
- Necrotizing enterocolitis (NEC) and/or GI perforation

Acute complications

- Apnea of prematurity:
  - Apnea of prematurity is common in immature infants
  - Manage apnea of prematurity with
    - methylxanthines (caffeine)
    - (CPAP)
    - assisted ventilation in refractory incidents.
  - Exclude
    - Septicemia
    - seizures
    - gastroesophageal reflux
    - metabolic causes

Chronic complications

- Bronchopulmonary dysplasia (BPD)
  - Defined as a requirement for oxygen at 36 weeks CGA.
  - BPD is related directly to the high volume and/or pressures used for mechanical ventilation.
  - BPD increases with decreasing gestational age.
  - Rx PBD by
    - Postnatal use of surfactant therapy ?
    - gentle ventilation
    - vitamin A
    - low dose steroids and inhaled nitric oxide

Chronic complications

- Retinopathy of prematurity (ROP):
  - Infants with respiratory distress syndrome and a PaO2 >100 mm Hg are at increased risk for ROP.
  - An ophthalmologist examines the eyes of all premature infants at 34 weeks' gestation and thereafter as indicated.
  - Neurologic impairment occurs in approximately 10-70%.

Prognosis

- Very low birth weight <501 grams survival rate is 10% and 100% risk of BPD and very high risk of ROP
- Birth weight between 1001-1500 grams survival rate is ~ 96% and few develop BPD and ROP as well

References

- Practical Neonatology Polin & Yoder
- Nelson Essential of Pediatrics
- e-Medicine
- Up-to-date