

# Respiratory Disorders Common in the NICU

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## Disclosures

The following speaker of this CME activity has no relevant financial relationships with commercial interests to disclose.

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## Objectives

- Describe normal pulmonary anatomy, development and function
- Describe common respiratory diseases seen in the newborn
- Describe radiographic findings of common respiratory diseases
- Describe non-pulmonary causes of respiratory distress
- Identify treatment strategies for common respiratory problems



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## Lung Development

### Embryonic development: Weeks 1-5

- single lung bud develops & divides
- pulmonary vein develops & joins lung bud
- trachea develops
- lung lobes divide (3 right, 2 left)

### Pseudoglandular period: Weeks 6-16

- main conducting airways form (not terminal yet)
- main bronchi and capillary bed form with connecting blood supply

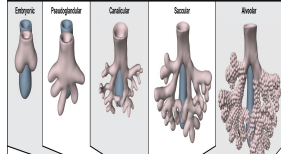
### Canalicular period: Weeks 16-26

- gas exchanging units form - type II alveolar epithelial cells appear
- capillaries invade terminal airways (no terminal alveoli present)

### Terminal sac period: Weeks 26-birth

- terminal alveoli formed - 26-32 weeks limited gas exchange, unable to release surfactant effectively

### Alveolar period: Weeks 32- 8 to 10 years, continued alveolar development



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## Normal Pulmonary Function

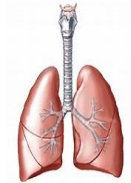
▶ Diaphragm - contracts and falls, generates negative intrathoracic pressure, allow air to flow down pulmonary tree for gas exchange at alveolar level

▶ Work needed to perform this exchange -significantly reduced by surfactant

▶ Surfactant - decreases surface tension  
increases lung compliance  
provides alveolar stability  
decreases opening pressure

\*\*\* What gestation is this naturally produced?

\*\*\* What gestation is this effectively excreted?



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## Respiratory Disease

- ▶ Progressive impairment of lungs to exchange gas at the alveolar level
- ▶ May occur in any portion of respiratory system
- ▶ Impairment of ventilation and oxygenation



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## Respiratory Distress Syndrome

Previously called Hyaline Membrane Disease (HMD)

Life threatening lung disorder - result from surfactant deficiency & lung immaturity

Incidence inversely proportional to gestational age

What gestation is most affected?

Distress begins soon after birth, increase symptoms within first 3-6 hours - hypoxia and hypoventilation

Risk - prematurity, LBW, cesarean delivery without labor, maternal diabetes, 2<sup>nd</sup> twin, male/female 2:1

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## Radiographic Findings of RDS

- Diffuse reticulogranular pattern - ("ground glass") caused by alveolar atelectasis
- Prominent air bronchograms - aerated bronchioles superimposed on non-aerated alveoli
- Low lung volumes
- Cannot be differentiated from neonatal pneumonia



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## Respiratory Distress Syndrome

Symptoms appear within minutes to several hours after birth

- ▶ Cyanosis
- ▶ Apnea
- ▶ Grunting
- ▶ Nasal flaring
- ▶ Tachypnea
- ▶ Shallow breathing
- ▶ Retractions



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## Retractions

Severe xiphoid, subcostal, and intercostal retractions



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## Management of RDS

### Prevention

- ▶ Antenatal ultrasound - more accurate assessment of gestational age and fetal well being
- ▶ Prevention of premature labor
- ▶ Maternal corticosteroids
  - When are these given?
  - What do they do?
- ▶ Assessment of fetal lung maturity
  - What is a reassuring L:S ratio?



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## Management of RDS

Respiratory support until disease resolves

- ❑ PEEP (CPAP)
- ❑ Endotracheal intubation
- ❑ Gentle mechanical ventilation - profound hypoxemia
- ❑ Oxygen therapy - pulse oximetry, titrate
- ❑ Surfactant replacement
  - CXR evidence of RDS
  - Requires greater than 30-40% oxygen
  - Mean airway pressure at/or > 10 cm H<sub>2</sub>O
  - Intubate/administer via ETT - extubate back to CPAP or continue ventilation to support
- ❑ Nutritional support - grow lungs



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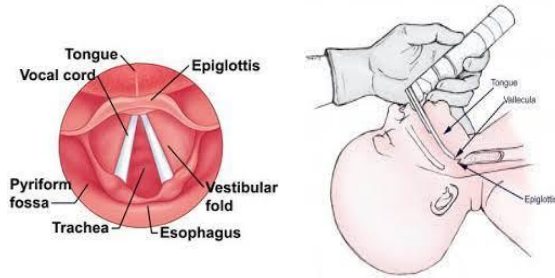
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## Endotracheal Intubation



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## Suctioning

Visible secretions, decreased aeration, desaturations, respiratory distress

### Nasopharyngeal suctioning

Safe measurement - ear lobe to nose tip

Suction as catheter withdrawn slowly 5-10 seconds

Suction pressure 80-100cmH2O

Sizes 5Fr (<1.5Kg) 5-7Fr (1.5-2Kg) 8Fr (2-4Kg) 10Fr (>4Kg)

\*\*\* Can be needed if supported on CPAP

### Endotracheal suctioning

Suction only to tip of ETT - never exceed > 0.5cm beyond tip prevent mucosal irritation/injury

Measurement of length to suction - predetermined based on length of ETT, adaptors and suction catheter size

Use inline "closed" suctioning

2.5ETT (5Fr) 3.0ETT (5-7Fr) 3.5-4.0ETT (8Fr)

\*\*\* Use safe suctioning cards

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## Pneumonia

Congenital or acquired infection of lungs

**Causes** - transplacental, delivery, aspiration of fetal fluid/meconium, acquired

**What % of term babies affected? Preterm?**

**Risk** - maternal chorioamnionitis, prolonged ROM, foul smelling fluid, fetal tachycardia, critically ill

**Symptoms** - tachypnea, grunting, retractions, cyanosis, hypoxemia, hypercapnia, hypoglycemia, shock, profound hypoxemia and PPHN

**Management** - antibiotics, monitor glucoses, blood pressure, oxygen with assisted ventilation, monitor and support oxygenation and ventilation, correct acidosis

**CXR** - patchy to diffuse infiltrates, sometimes "whited-out", pleural effusions



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## Transient Tachypnea of the Newborn

Delayed reabsorption of normal lung fluid (*wet lung syndrome*)

Most common respiratory distress - term/near term

**Symptoms** - comfortable tachypnea -soon after delivery, minimal cyanosis, duration 1-3 days

Diagnosis of exclusion

**Risk factors** - term/near term, cesarean section without labor, rapid labor, macrosomia, maternal sedation

**CXR** - hyperinflation, clear lungs - perihilar linear densities, fluid in fissures

**Treatment** - close observation, low flow supplemental oxygen, sometimes CPAP



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## Meconium Aspiration Syndrome (MAS)

In utero- asphyxial event - stimulates intestinal peristalsis - resulting meconium expelled into amniotic fluid

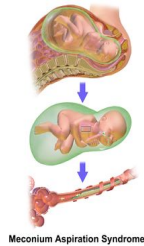
Meconium fluid aspiration into airway/lungs

▶ 12-20% of infants - meconium-stained amniotic fluid  
Only 5% develop MAS

▶ Affects 20% pregnancies after 40 weeks

▶ **Onset** - immediately after birth, peaks 12-48 hours

▶ **Complications** - air leaks, pneumonia, PPHN, metabolic acidosis, hypoglycemia, hypocalcemia, poor neurologic outcomes if severe hypoxemia



Meconium Aspiration Syndrome

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## Meconium Aspiration Syndrome (MAS)

Produces disease by several mechanisms:

▶ Meconium physically obstructing - glottis, trachea, smaller airways

▶ Atelectasis and air trapping = hyperinflation

▶ Promotes inflammatory response - chemical pneumonitis

▶ Inhibits surfactant function

▶ Increases pulmonary vascular resistance = right to left shunting (PPHN)



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## Meconium Aspiration Syndrome (MAS)

### Prevention

Early recognition - who's at risk & compromised  
Fetal monitoring

### Signs & Symptoms

History - meconium exposure  
Yellow staining - cord, skin & nails  
Tachypnea, crackles, cyanosis in mild cases  
Grunting, flaring, intercostal retractions  
Profoundly depressed at birth = asphyxia, chronic hypoxia  
Respiratory and metabolic acidosis

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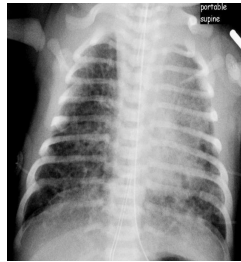
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## Meconium Aspiration Syndrome (MAS)

### Radiographic evidence

- ▶ Marked air trapping
- ▶ Hyperexpansion
- ▶ Bilateral coarse patchy infiltrates
- ▶ Air leaks
- ▶ Areas of atelectasis



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## Meconium Aspiration Syndrome (MAS)

### Treatment

- NRP guidelines - NO routine tracheal suctioning
- Improve oxygenation/ventilation - blood gases, assisted ventilation, HFV, iNO
- Require minimal supplemental oxygen to ECMO
- Surfactant replacement - inactivation, reduces air leaks and severe respiratory failure
- Mortality <5%, primarily caused by associated PPHN (pressure in lungs is high causing unoxygenated blood to bypass lungs and shunt to body)
- Treatment - Respiratory support - Ventilator, HFOV, oxygen, iNO, sedation/pain gtts, frequent monitoring oxygenation/ventilation



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## Bronchopulmonary Dysplasia

Chronic pulmonary disorder followed by course of RDS  
Persistent oxygen dependency after 28 days age or at 36 weeks PMA

Ranges mild to severe

**Risk Factors** - prematurity (<32wks), male, RDS, chorioamnionitis, extreme/low birthweight, inflammation, mechanical ventilation, oxygen exposure, PDA, excessive fluid intake

**Symptoms** - retractions, diffuse rales, wheezing, hypoxia, hypercapnia, right-sided heart failure (pulmonary edema)

**Treatment** - prevent further injury, minimize support, improve lung function, promote good nutrition, diuretics, caffeine

**Prevention** - prevent prematurity and RDS, antenatal corticosteroids, strategies to reduce exposure to oxygen, ventilation strategy to minimize tidal volume, adequate nutrition

\*\* Early extubation or avoid intubation using non invasive means for ventilation and/or oxygenation

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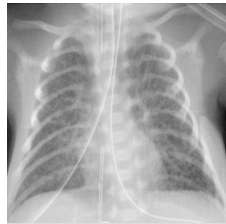
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## Bronchopulmonary Dysplasia

### Radiographic findings

- ▶ Fine, hazy appearance, infiltrates
- ▶ Diffuse coarse lung markings
- ▶ Bubbly, cystic pattern
- ▶ Hyperinflation
- ▶ Cardiomegaly



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## Air Leak Syndromes

### Pneumothorax

- ▶ Spontaneously occur 1-2% live births
- ▶ **Risk factors** - prematurity, positive pressure ventilation, underlying lung disease
- ▶ **Symptoms** - unequal breath sounds, muffled heart tones, asymmetric chest shape, hypotension, bradycardia
- ▶ **CXR** - free air in hemithorax & visible edge of collapsed lung ("sail sign")
- ▶ **Treatment** - respiratory support, supplemental oxygen

Symptomatic - needle aspiration, chest tube/pigtail

Asymptomatic - clinically follow - resolve 1-2 days



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## Chest Tubes/Pigtails

### Treatment of Symptomatic Pneumothorax

- May try needle aspiration first
- Place chest tube/pigtail

### Procedure

- Verify correct side of pneumothorax - check CXR
- Time-out procedure
- Under sterile technique - APP/MD places pigtail
- Evacuate air with sterile syringe or connect to suction -20mmHg under water pressure with closed drainage system
- Repeat CXR to check for improvement/resolution of pneumothorax
- \*\*\* Consider morphine/pain management prior to procedure
- \*\*\* When no bubbling will trial water seal before discontinue

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## Air Leak Syndromes

### Pulmonary Interstitial Emphysema

- ▶ Alveolar overdistension -gas traps into interstitial tissue - outside airways
- ▶ Consequence of positive pressure ventilation - common severe RDS, poor lung compliance
- ▶ CXR - microcystic areas throughout, hyperinflated lungs, flattened diaphragm
- ▶ Treatment - gentle ventilation - smaller tidal volumes (HFJV), monitor closely pneumothoraces, non-invasive ventilation (CPAP)



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## Pulmonary Hemorrhage

- Grossly bloody secretions in endotracheal tube
- Usually occurs first week of life
- Sudden deterioration in respiratory status
- Occurs 5-7% of LBW infants with RDS
- Risk factors-** ventilated, low birth infant, multiple birth, low Apgar scores
- Symptoms-** hypoxia, severe retractions, shock, apnea, bradycardia and cyanosis
- Associated with trauma, coagulopathy, hypoxia, hypervolemia, pulmonary edema (PDA), surfactant, RDS, severe hypothermia, infection
- Treatment-** increase PEEP, carefully suction airway, oxygen, intubation, epinephrine via ETT, blood transfusion, correct acidosis

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## Diaphragmatic Hernia

Defect diaphragm, abdominal viscera into chest - majority (80-85%) left sided, <5% anterior

**Presents** immediately, diminished sounds, shift heart tone, barrel chest, scaphoid abdomen, severe distress

Pulmonary hypoplasia, vasoconstriction, PPHN

**At delivery** - immediate intubation, avoid PPV/face mask ventilation, surfactant, bowel decompression, gentle mechanical ventilation - monitor PIP/PEEP, iNO, central lines, frequent blood gases/lactates

**Goals** - minimize lung trauma, improve PPHN

Sedation - fentanyl and precedex/midazolam gtts

Avoid paralytics unless considering ECMO

Pressors (MAP >40 - increase systemic circulation - dopamine, hydrocortisone)

**Hypoplastic lungs** - predicted lung volume < 15% usually severe - ECMO

**Genetics** - 15-35% chromosomal anomalies



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## Lung Hypoplasia

**Hypoplastic lungs** - small, underdeveloped, can affect breathing - also heart function, ability to feed, hearing and overall development

May lead to **pulmonary hypertension**

**Causes** - diaphragmatic hernia, congenital pulmonary airway malformation (CPAM), giant omphalocele, oligohydramnios, renal disease (polycystic kidneys, renal agenesis), Thanatophoric dwarfism, hydrops fetalis

**Treatment** - primarily supportive, minimize lung injury, oxygen, assisted ventilation, high frequency ventilation, and extracorporeal membrane oxygenation (ECMO), give good nutrition - grow lungs

**Prognosis** - dependent on development lungs and PPHN

Mortality rate -as high as 75% (CDH 50%)

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## Apnea of Prematurity

### Etiology of Apnea

- ▶ Primary vs. secondary
- ▶ Central apnea, obstructive apnea, or most commonly mixed apnea (initial central apnea followed by obstruction of airway)
- ▶ Neuronal immaturity = cause central apnea
- ▶ Occurs more frequently during sleep (REM or active sleep)
- ▶ Decreased oxygen saturation correlates with duration of apnea

### Risk Factors

- ▶ Decrease gestational age increases incidence of apnea  
85% of preterm infants <34 weeks gestation have apnea of prematurity
- ▶ Spontaneously resolves - 36 -38 weeks

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## Apnea of Prematurity

### Care and Monitoring

- ▶ Continuous EKG/Pulse Oximetry
- ▶ Reduction environmental stimulus
- ▶ Gentle tactile stimulation
- ▶ Continuous control/monitoring temperatures
- ▶ Positioning - prevent airway obstruction



### Discharge Criteria

- ▶ Monitor - apnea-free 3-10 days before discharge
- ▶ Documentation  
Exam, stimulation, activity of baby (feeding, asleep)

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## Apnea of Prematurity

### Treatment

- ▶ Respiratory support -nasal cannula, HFNC, CPAP (provides PEEP), mechanical ventilation (if severe requires stimulation or PPV or fails CPAP)
- ▶ Caffeine- stimulates central nervous system, long half-life, daily administration, early onset of action  
(Bolus dose 20-30 mg/kg/dose)  
(Maintenance 5-10 mg/kg/dose)
- ▶ Tincture of time



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