UNIVERSITATEA DE STAT DE MEDICINĂ ȘI FARMACIE
„NICOLAE TESTEMIȚANU” DIN REPUBLICA MOLDOVA

# Basic syndromes of respiratory disorders in children

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# Learning objectives

To understand:

- anatomical and physiological features of the respiratory tract in children vs adults
- most frequent sign, symptoms and syndromes of respiratory diseases in children
- examination of children with respiratory diseases
- management of children with upper and lower acute respiratory disorders

# Peculiarities of the Respiratory System in Children

# Respiratory system

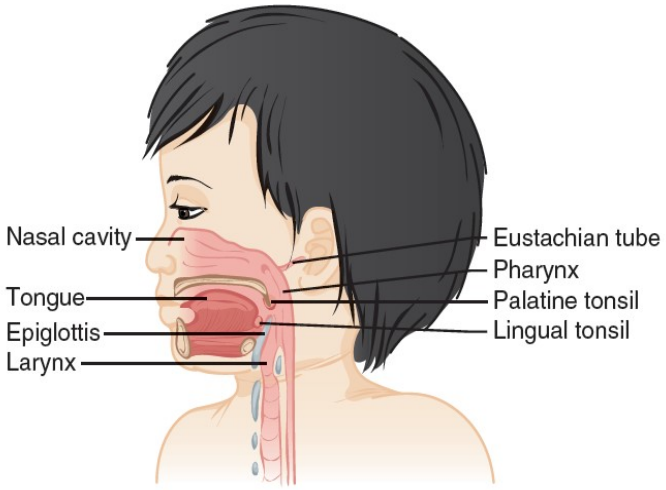



**Fig 16.1** Upper airway.

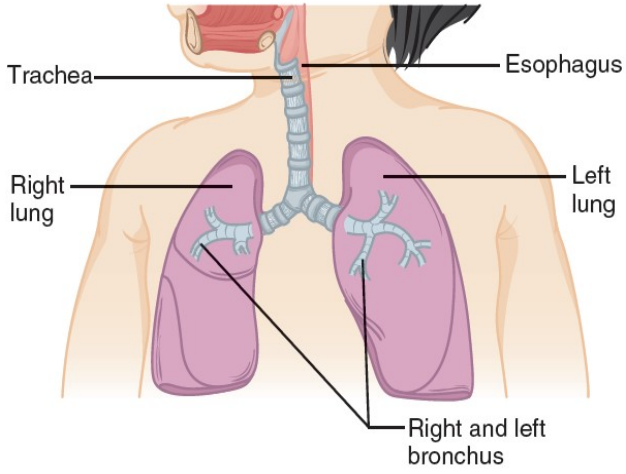


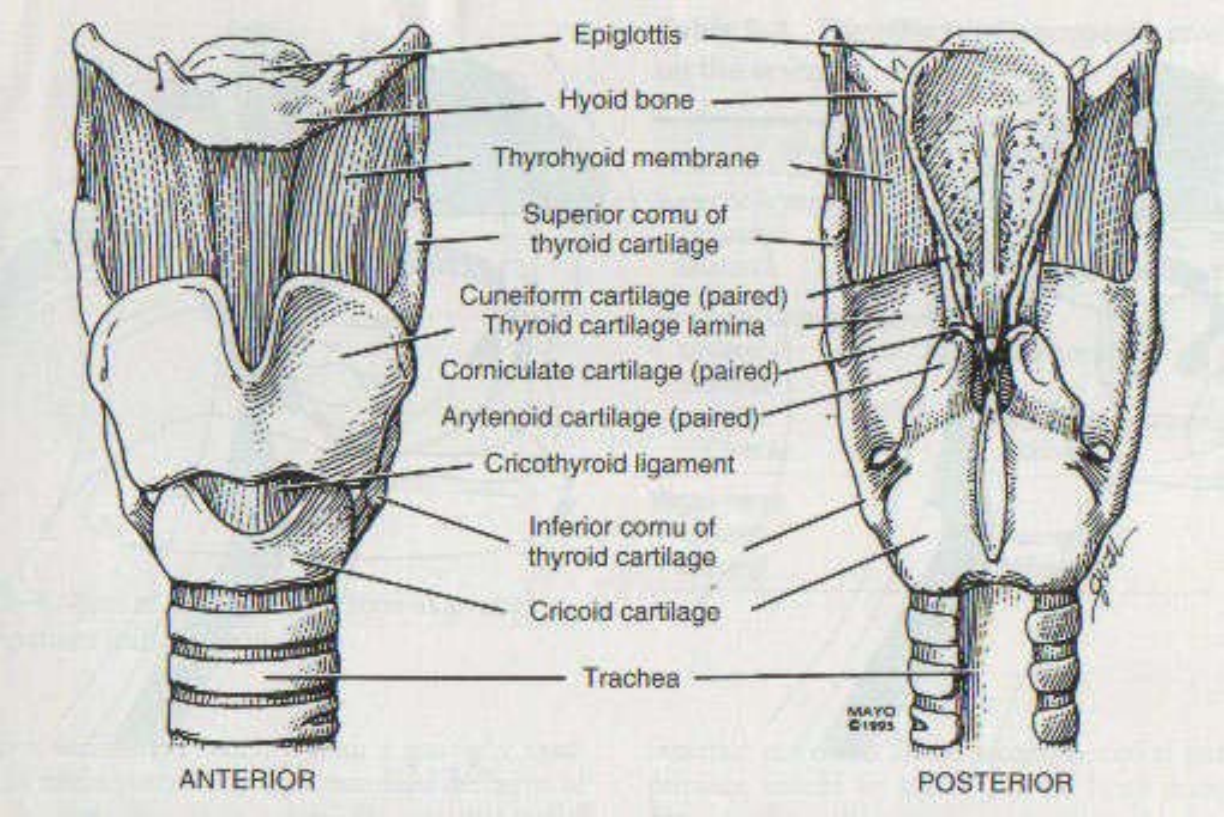

**Fig 16.2** Middle and lower airways.

- The **upper airway**, containing the nasopharynx and oropharynx, serves as the pathway for gases exchanged during ventilation, the movement of oxygen into the lungs and carbon dioxide out of the lungs. The larynx divides the upper and lower airways.
- The **lower airways** (trachea, bronchi, and bronchioles) serve as the pathway of gases to and from the alveoli in the lungs.

# Respiratory system

Larynx composed of hyoid bone and a series of cartilages:

- Single: thyroid, cricoid, epiglottis
- Paired: arytenoids, corniculates, and cuneiform



# Peculiarities of the respiratory system in children

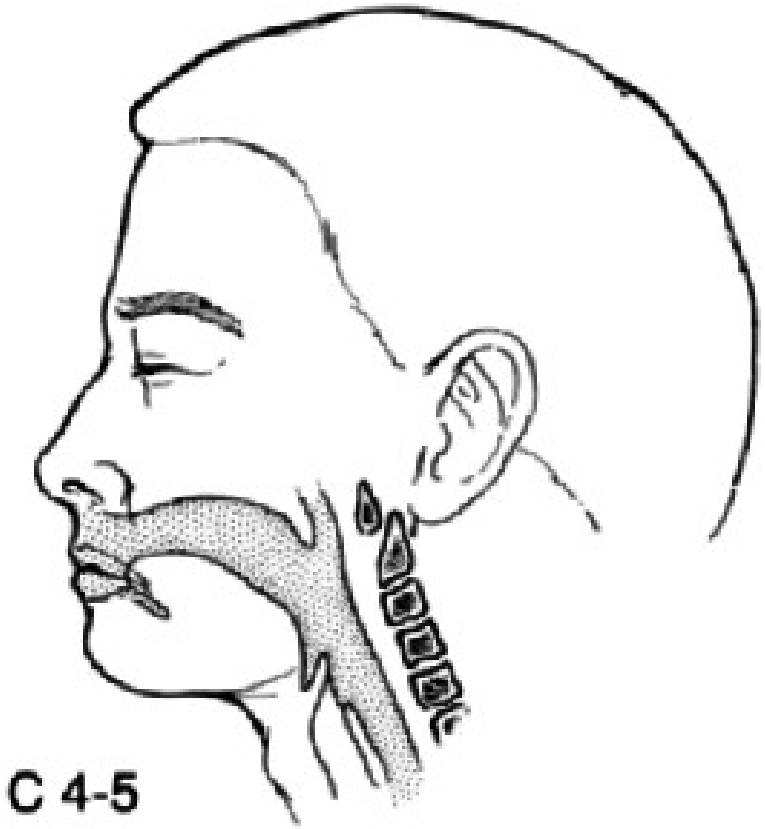
**5 Differences between Pediatric and Adult Upper airway**:

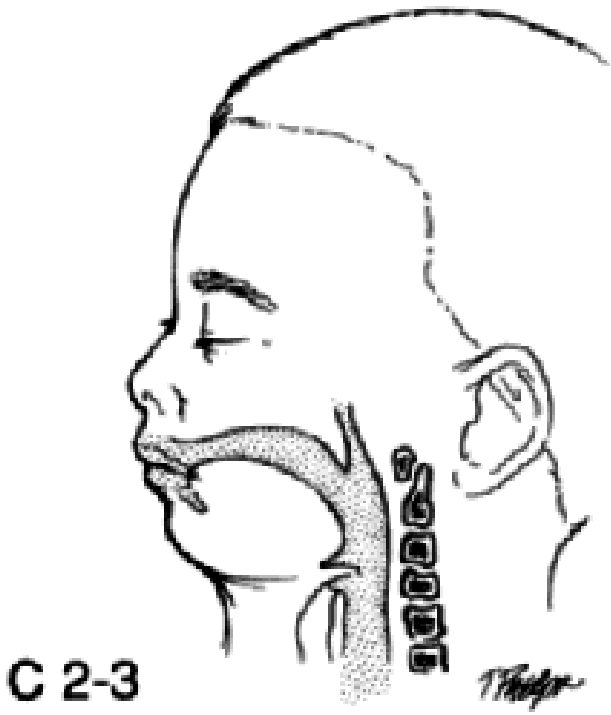
- More rostral larynx
- Relatively larger tongue
- Angled vocal cords
- Differently shaped epiglottis
- Funneled shaped larynx-narrowest part of pediatric airway is cricoid cartilage

# Peculiarities of the respiratory system in children

## More rostral larynx

- Laryngeal apparatus develops from brachial clefts and descends caudally
- Infant's larynx is higher in neck (C2-3) compared to adult's (C4-5)



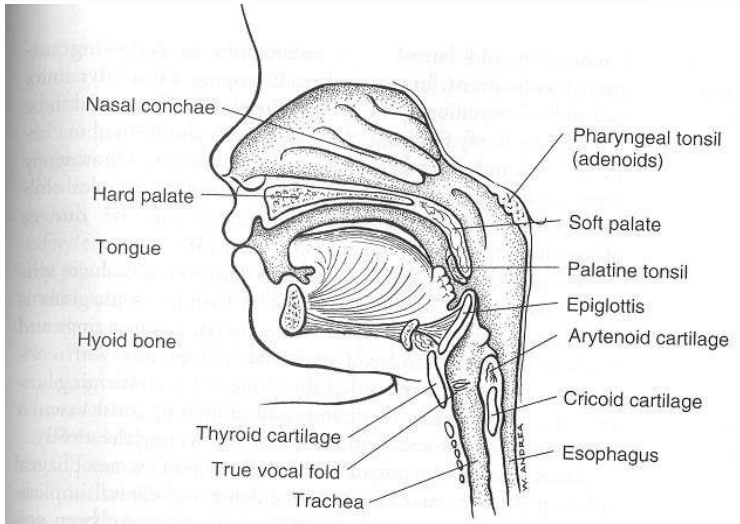
# Peculiarities of the respiratory system in children

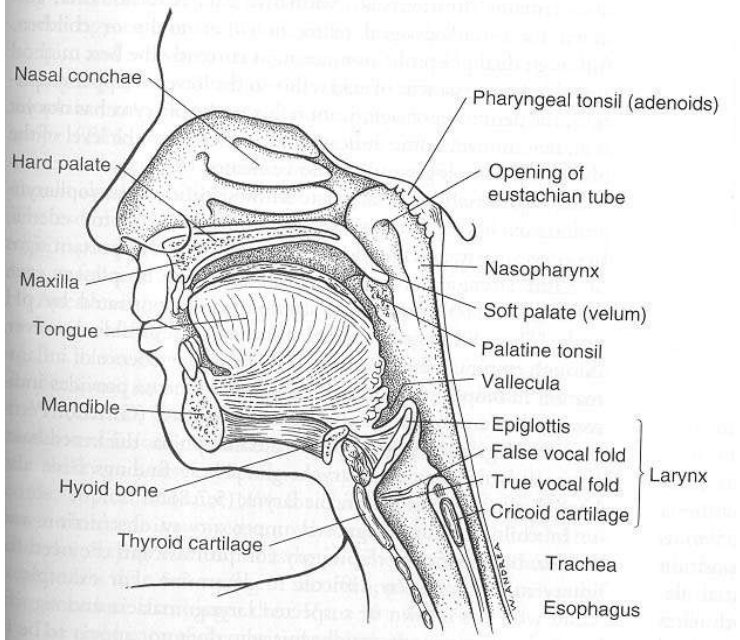
## Relatively larger tongue

- Obstructs airway
- Obligate nasal breathers
- Difficult to visualize larynx
- Straight laryngoscope blade completely elevates the epiglottis, preferred for pediatric laryngoscopy

## Angled vocal cords

- Infant's vocal cords have more angled attachment to trachea, whereas adult vocal cords are more perpendicular
- Difficulty in nasal intubations where "blindly" placed ETT may easily lodge in anterior commissure rather than in trachea

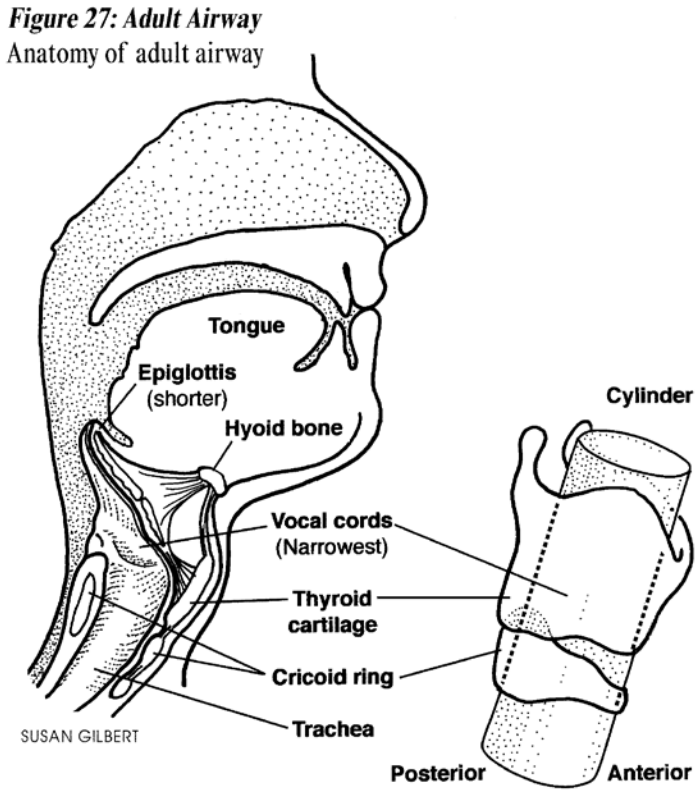


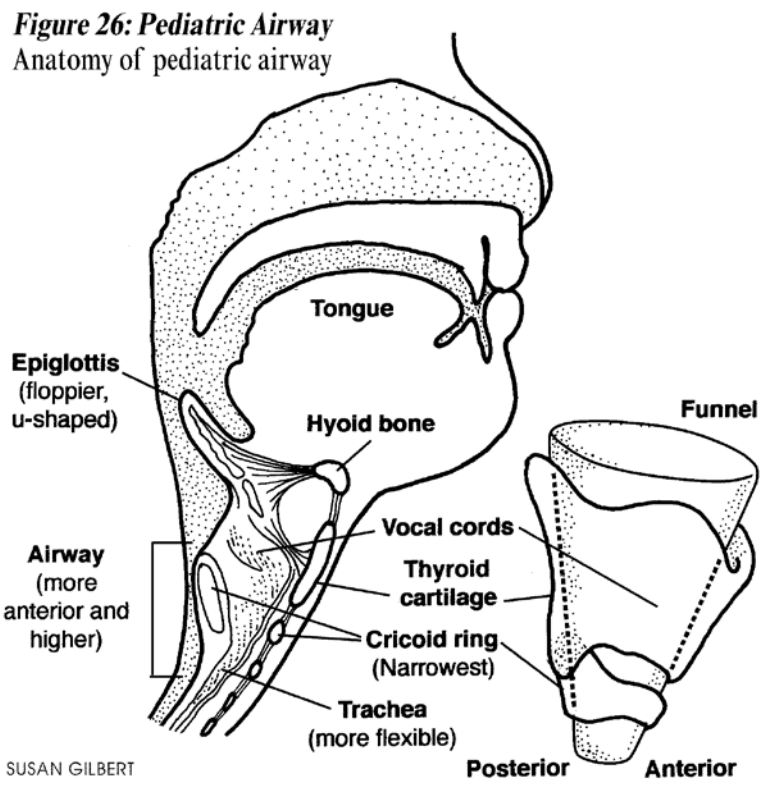



# Peculiarities of the respiratory system in children

## Differently shaped epiglottis:

- Adult epiglottis broader, axis parallel to trachea
- Infant epiglottis *ohmega* (Ω) shaped and angled away from axis of trachea
- More difficult to lift an infant's epiglottis with laryngoscope blade

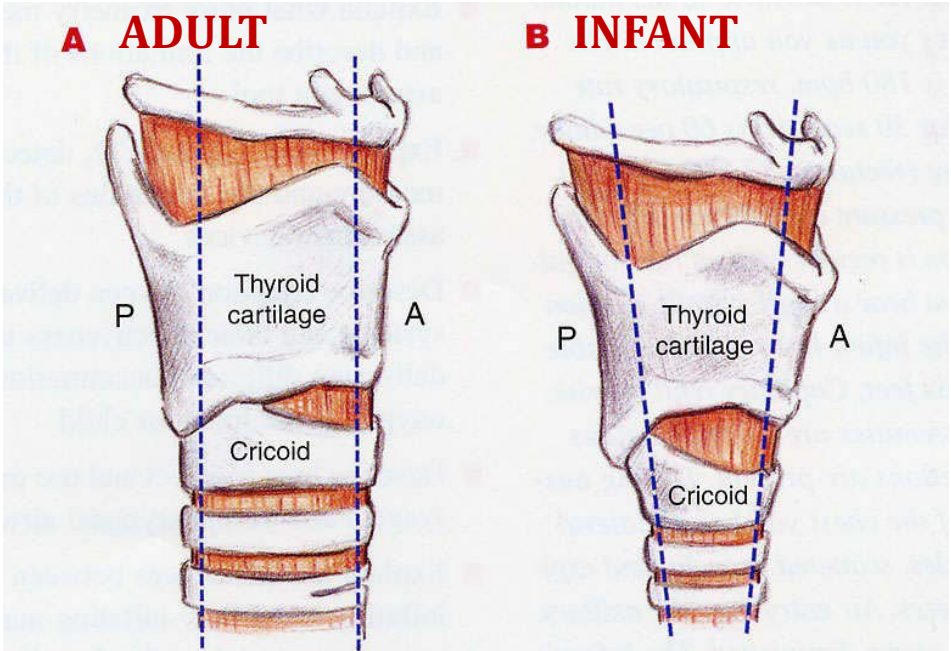


# Peculiarities of the respiratory system in children

## Funneled shape larynx:

- Narrowest part of infant's larynx is the undeveloped cricoid cartilage, whereas in the adult it is the glottis opening (vocal cord)
- Tight fitting ETT may cause edema and trouble upon extubation
- Uncuffed ETT preferred for patients < 8 years old
- Fully developed cricoid cartilage occurs at 10-12 years of age



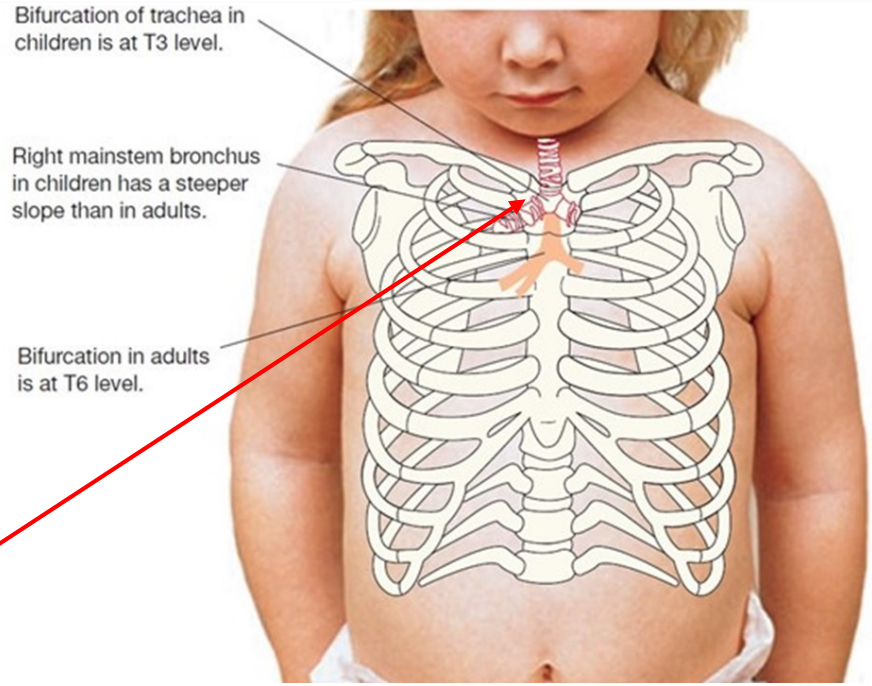
# Pediatric Respiratory Physiology

- Extrauterine life not possible until 24-25 weeks of gestation
- Two types of pulmonary epithelial cells: Type I and Type II pneumocytes
  - Type I pneumocytes are flat and form tight junctions that interconnect the interstitium
  - Type II pneumocytes are more numerous, resistant to oxygen toxicity, and are capable of cell division to produce Type I pneumocytes
- Pulmonary surfactant produced by Type II pneumocytes at 24 wks GA
- Sufficient pulmonary surfactant present after 35 wks GA
- Premature infants prone to respiratory distress syndrome (RDS) because of insufficient surfactant
- Alveoli continue developing and increasing in number for the first 5 to 8 years of age, followed by further development in size and complexity

# Peculiarities of the respiratory system in children

- The infant's airway diameter is approximately 4 mm (0.16 in.), about the width of a drinking straw, in contrast to the adult's airway diameter of 20 mm (0.8 in.).

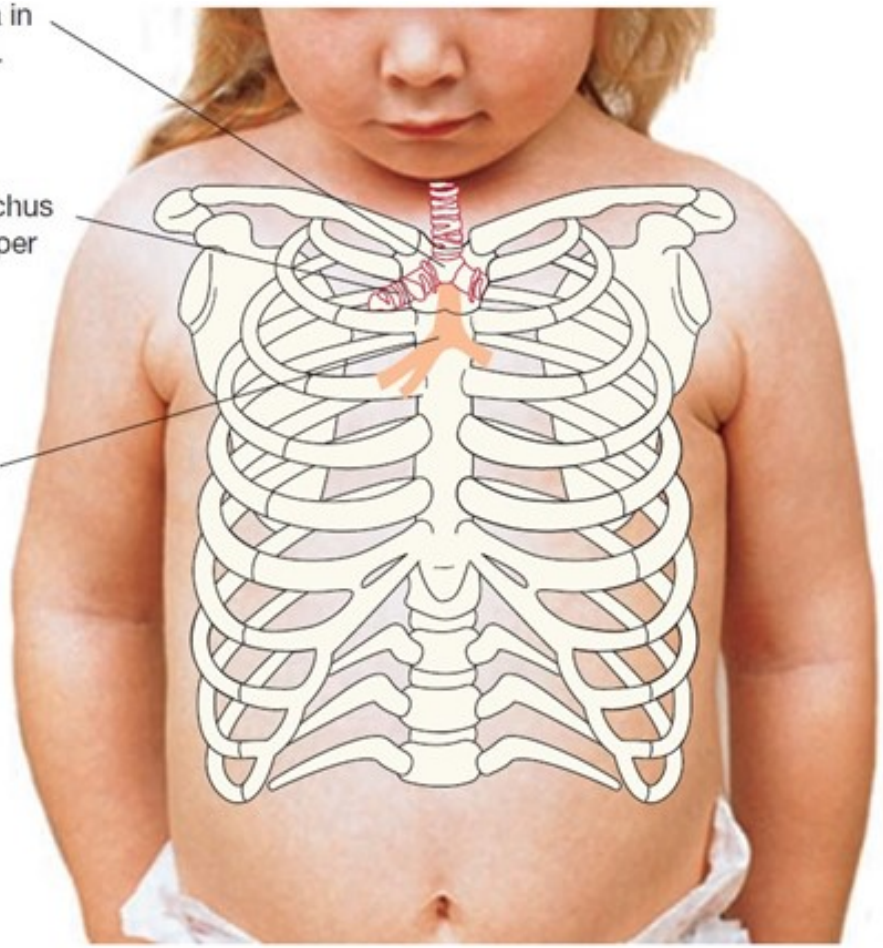
- The trachea primarily increases in length rather than diameter during the first 5 years of life.




- The tracheal division of the right and left bronchi is higher in a child's airway and at a different angle than the adult's.

**The child's little finger is a good estimate for the child's tracheal diameter and can be used for a quick assessment of airway size!**

# Peculiarities of the respiratory system in children




In children, the trachea is shorter and the angle of the right bronchus at bifurcation is more acute than in the adult. When you are resuscitating or suctioning, you must allow for these differences. Do you think that the angle of the right bronchus is significant in foreign-body aspiration? Why?

# Peculiarities of the respiratory system in children

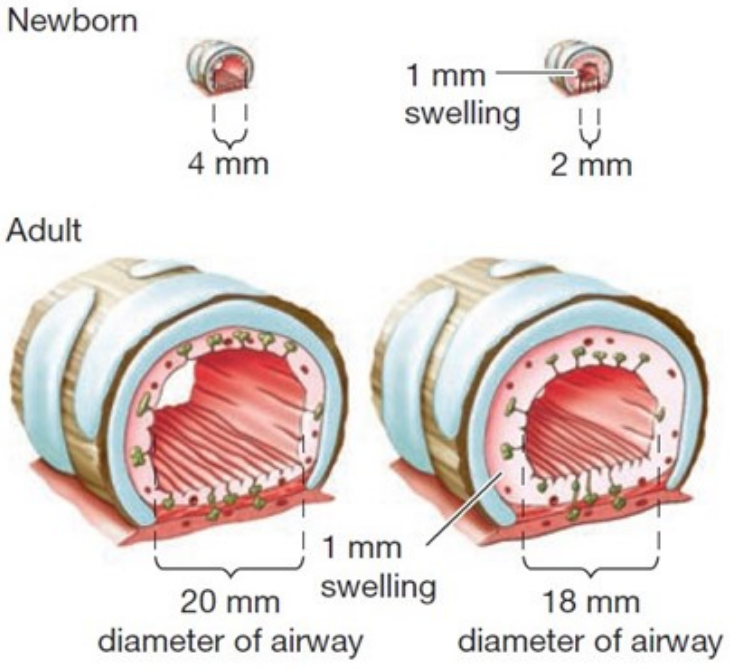
- The cartilage that supports the trachea is more flexible, and the airway may be compressed when the head and neck are flexed toward the chest.
- The child's narrower airway causes a greater increase in **airway resistance** (the effort or force needed to move oxygen through the trachea to the lungs) in any condition causing airway inflammation or edema
- Work of breathing for each kilogram of body weight is similar in infants and adult
- Oxygen consumption of infant (6 ml/kg/min) is twice that of an adult (3 ml/kg/min)

**Greater oxygen consumption = increased respiratory rate**

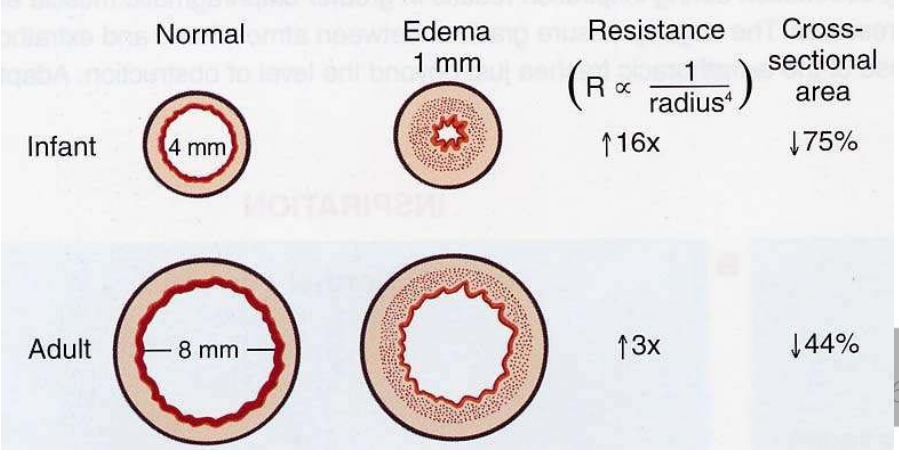
# Pediatric Respiratory Physiology

- Tidal volume is relatively fixed due to anatomic structure
- Minute alveolar ventilation is more dependent on increased respiratory rate than on tidal volume
- Lack Type I muscle fibers, fatigue more easily
- Functional residual capacity (FRC) of an awake infant is similar to an adult when normalized to body weight
- Ratio of alveolar minute ventilation to FRC is doubled, under circumstances of hypoxia, apnea or under anesthesia, the infant's FRC is diminished and desaturation occurs more precipitously

# Physiology: effect of edema




An infant's airway diameter is approximately 4 mm (0.16 in.), in contrast to the adult's 20–mm (0.8-in.) airway diameter. An inflammatory process in the airway causes swelling that narrows the airway, and airway resistance increases. Note that swelling of 1 mm (0.04 in.) reduces the infant's airway diameter to 2 mm (0.08 in.), but the adult's airway diameter is only narrowed to 18 mm (0.7 in.). Air must move more quickly in the infant's narrowed airway to get the needed amount of air into the lungs. The friction of the quickly moving air against the side of the airway increases airway resistance. The infant must use more effort to breathe and must breathe faster to get adequate oxygen.




**If radius is halved, resistance increases 16 x**

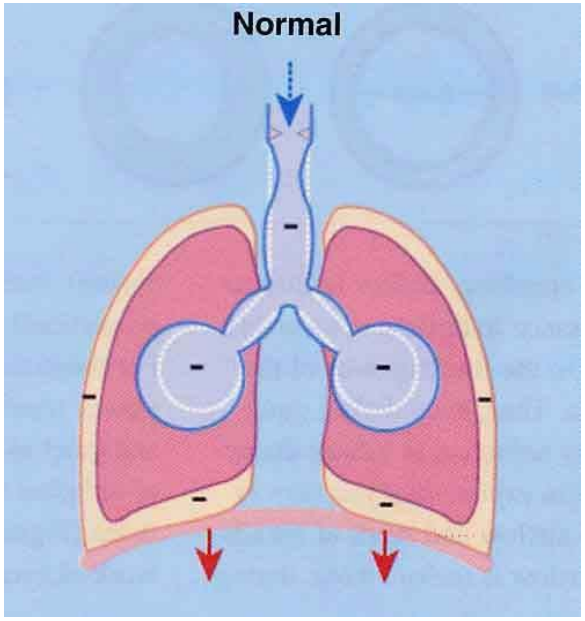
**Poiseuille's law**

$$R = 8nl/\pi r^4$$

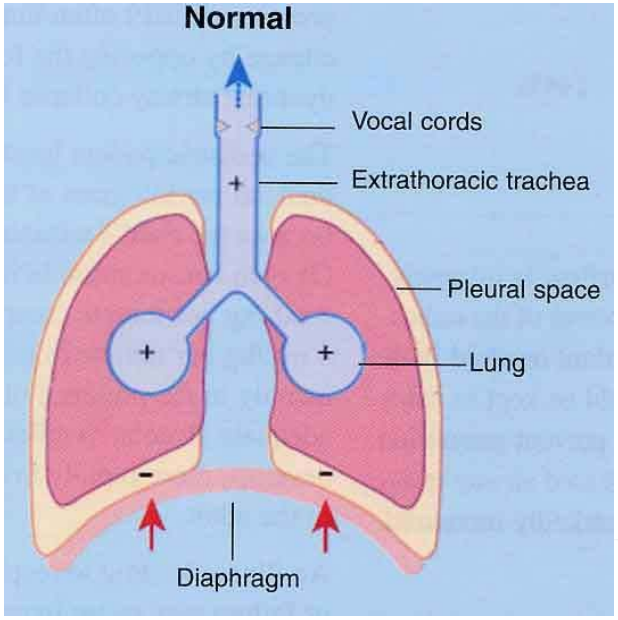
# Respiratory physiology

- The intercostal muscles work with the diaphragm to perform the work of breathing. The diaphragm is a muscle that separates the abdominal and thoracic cavity contents. When the diaphragm contracts, it creates negative pressure that increases the thoracic volume and pulls air into the lungs.
- The lungs and chest wall have the ability to expand during inspiration (compliance) and then to recoil or return to the resting state with expiration.

**Inspiration**



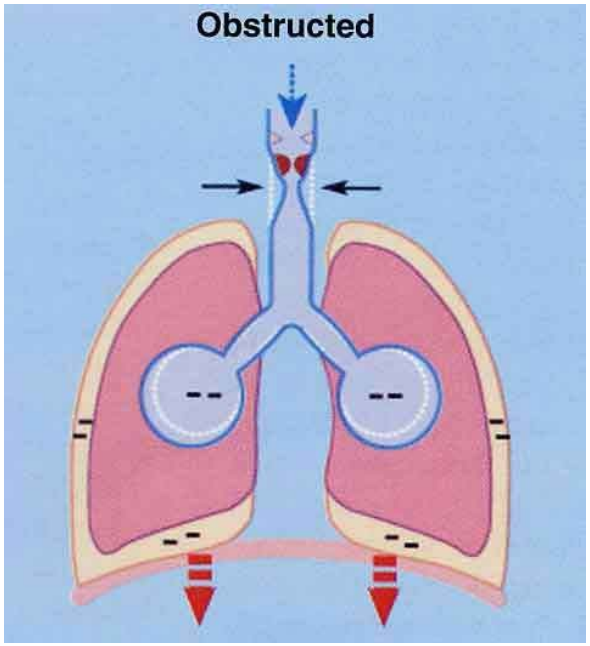

**Expiration**



# Physiology: effect of obstruction

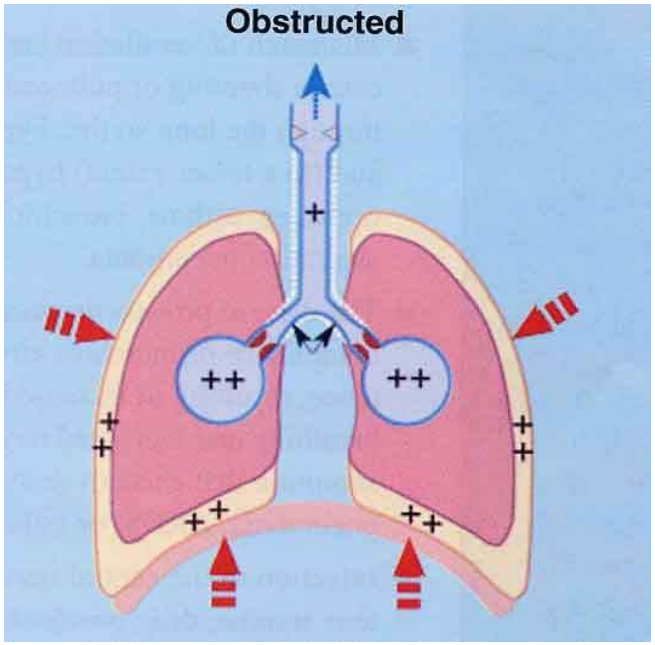
- The work of breathing is tied to the muscular effort required for ventilation, which can be increased in cases of airway obstruction or disorders that increase the stiffness of the lungs.

**Extrathoracic Upper Airway Obstruction**




**epiglottitis, laryngotracheobronchitis, foreign body aspiration**

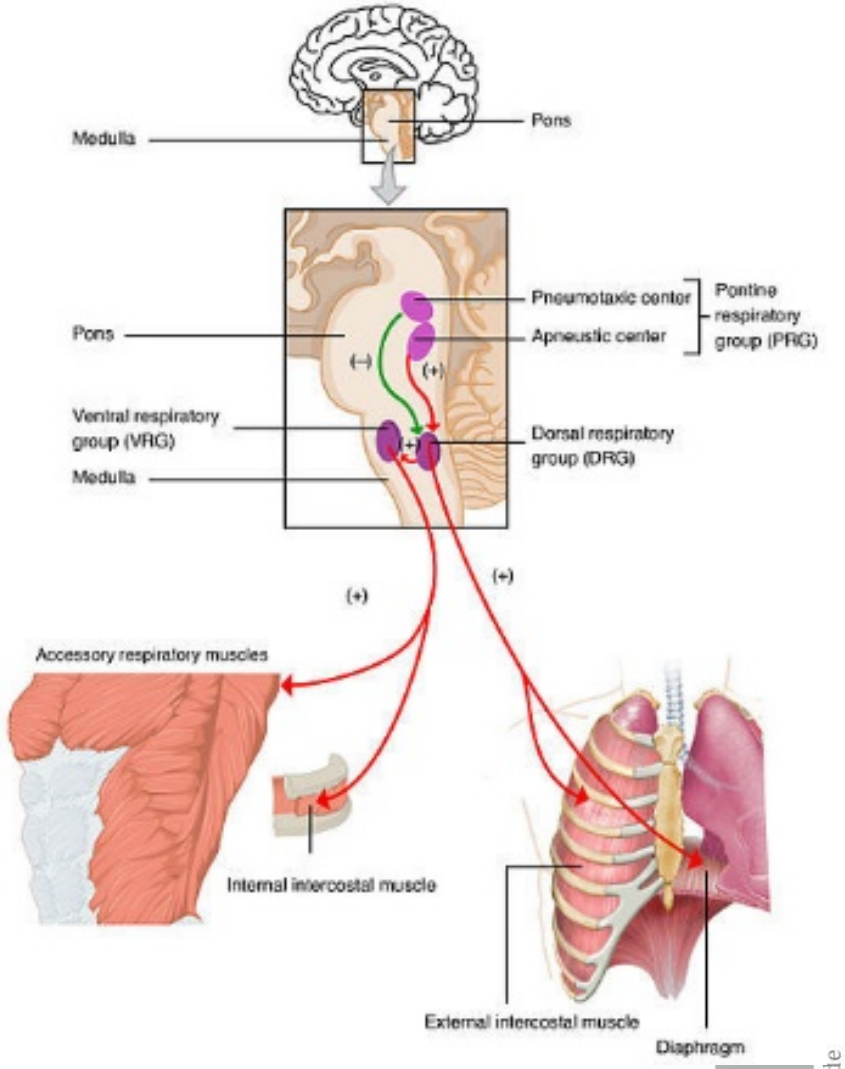
**Intrathoracic Upper Airway Obstruction**




**asthma, bronchiolitis**

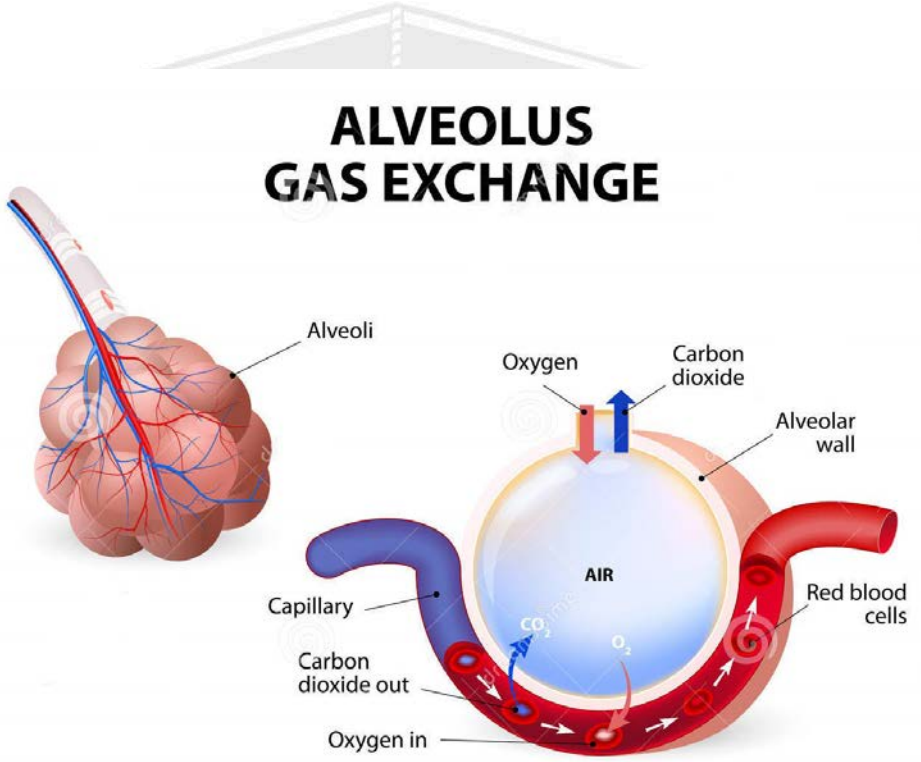
# Respiratory physiology

- The respiratory center in the brain controls respiration, sending impulses to the respiratory muscles to contract and relax.
- Breathing is usually automatic as the nervous system adjusts the ventilatory rate and volume to maintain normal gas exchange (Brashers, 2014).
- Chemoreceptors monitor the pH, PaCO2, and PaO2 in the arterial blood and send signals to the respiratory center to increase ventilation in cases of arterial hypoxemia.



# Respiratory physiology

- Effective gas exchange requires a near even distribution of ventilation and perfusion (oxygenated blood flow to all portions of the lungs).
- As oxygen diffuses across the alveolocapillary membrane, it dissolves in the plasma and the resulting increased partial pressure of oxygen (PaO2) helps bind the oxygen to the hemoglobin molecules for transport to the cells for metabolism.




- Carbon dioxide produced by cellular metabolism is dissolved in the plasma (PCO2) and/or as bicarbonate and travels back to the lungs where it diffuses across the alveolocapillary membrane.

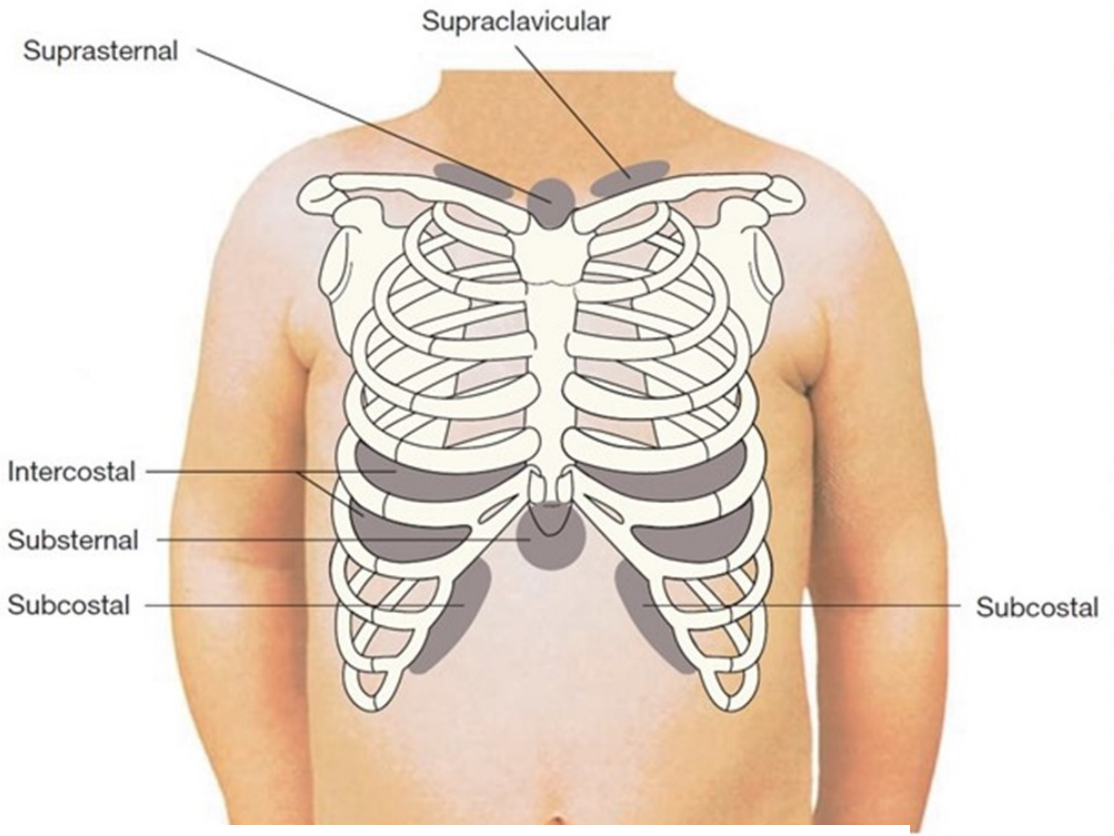
# Peculiarities of the respiratory system in children

- Newborns are obligatory nose breathers. The only time newborns breathe through the mouth is when they are crying.
- The coordination of mouth breathing is controlled by maturing neurologic pathways, and infants up to 2 to 3 months of age do not automatically open the mouth to breathe when the nose is obstructed.

**It is important to keep the newborn's nose patent for breathing and eating!**

# Peculiarities of the respiratory system in children

- The bronchi and bronchioles are lined with smooth muscle that develops after birth.
- Children under 6 years of age use the diaphragm to breathe because the intercostal muscles are immature.
- By 6 years of age the child uses the intercostal muscles more effectively.




The ribs are primarily cartilage and very flexible. In cases of respiratory distress, the negative pressure caused by the diaphragm movement causes the chest wall to be drawn inward, causing **retractions**.

# Airway Evaluation in Children

# Introduction

- Respiratory disease is one of the most common reasons that pediatric patients seek medical attention.

- Signs and symptoms can be subtle, and a careful history and physical examination are always useful in assessment of pediatric patients with respiratory complaints.

- Diseases of the chest can be divided into two major categories: **acquired** and **congenital**.

# Introduction

- **Congenital** chest diseases are often **symptomatic at all times** rather than episodically.
  - a child who has chronic noisy breathing from a congenital vascular ring, for example, is not as likely as the patient with asthma to have intermittent periods of wheezing with long intervals of normal breathing.

- The spectrum of diseases involving the pediatric respiratory system is primarily dependent on the age of the patient; therefore, **age must be a primary consideration** in the differential diagnosis.

# Medical History

- **Upper Respiratory Infection** predisposes to coughing, laryngospasm, bronchospasm, desat during anesthesia
- **Snoring or noisy breathing** (adenoidal hypertrophy, upper airway obstruction, OSA)
- **Chronic cough** (subglottic stenosis, previous tracheoesohageal fistula repair)
- **Productive cough** (bronchitis, pneumonia)
- **Sudden onset of new cough** (foreign body aspiration)
- **Inspiratory stridor** (macroglossia, laryngeal web, laryngomalacia, extrathoracic foreign body)
- **Hoarse voice** (laryngitis, vocal cord palsy, papillomatosis)

# Medical History

- **Asthma and bronchodilator therapy** (bronchospasm)
- **Repeated pneumonias** (GERD, Cystic Fibrosis, bronchiectasis, tracheoesophageal fistula, immune suppression, congenital heart disease)
- History of **foreign body aspiration**
- **Previous anesthetic problems** (difficulty intubation/extubation or difficulty with mask ventilation)
- **Atopy, allergy** (increased airway reactivity)
- **History of congenital syndrome** (Pierre Robin Sequence, Treacher Collins, Klippel-Feil, Down's Syndrome, Choanal atresia)
- **Environmental**: smokers

# History

- Each pediatric history should include the **perinatal history**:
  - ex. respiratory distress at birth or intubation

- **Prematurity** with prolonged need for supplemental oxygen may **suggest bronchopulmonary dysplasia** with associated structural lung abnormalities.

- **Noisy breathing starting early in life** suggests **congenital airway obstruction** and should be evaluated.

# History

- Regardless of cause, **failure to thrive** is a worrisome finding, whereas excellent weight gain in a child with noisy breathing is reassuring.

- **Distinguishing between constant and intermittent symptoms** can be one of the most important means of diagnosing diseases of the pediatric chest.

- A good "**cough history**" and "**wheeze history**" are important and have similar elements.

# History

- The clinician should inquire about the
  - chronicity of the symptoms
  - association with feeding
  - upper respiratory infections
  - exposures (pets, dust, and especially cigarette smoking are important), and
  - fevers

# History

The nature of the cough is important:

- ***wet*** or ***dry***
- ***paroxysmal*** or ***continuous,*** and
- ***staccato*** (as seen in neonatal chlamydial pneumonia)
- **posttussive emesis** is a "red flag" to the clinician.
- a **persistent cough that disappears in sleep** strongly suggests the diagnosis of **habit** (psychogenic) **cough**.
- the **cough that awakens the child at night** or keeps the child up much of the night is another worrisome historical finding.

# History

- In evaluating the infant with frequent episodes of cough and/or wheeze, the clinician should inquire about symptoms and signs of **gastroesophageal reflux** (GER):

Because reflux is worse when the patient is lying down, **symptoms** tend to be more **prominent at night and during naps**.

- food refusal
- arching
- pain behaviors
- frequent spitting

- milk or formula found on the bed next to the infant's head in the morning
- recurrent croup
- hoarseness
- laryngomalacia

# History

- A **family history of atopy** including eczema and environmental allergies should be investigated.
- In inquiring about **cystic fibrosis**, an autosomal recessive trait, an **extended family medical history** including grandparents and cousins should be taken.
- **Frequent infections** in parents or siblings, particularly those requiring hospitalization, suggest **possible immunodeficiency** in the family.
- **Immunization history** is essential in identifying patients at risk for pertussis.

# Physical examination

- The infant or toddler is best examined with his or her shirt off while being held upright in the arms of a parent.
- The patient should face the parent; this maximizes contact with the parent and allows the patient to feel safe.
- The room should be at a comfortable temperature.
- The stethoscope head should be warmed in the clinician's hand or pocket for several minutes before use.

# Physical examination

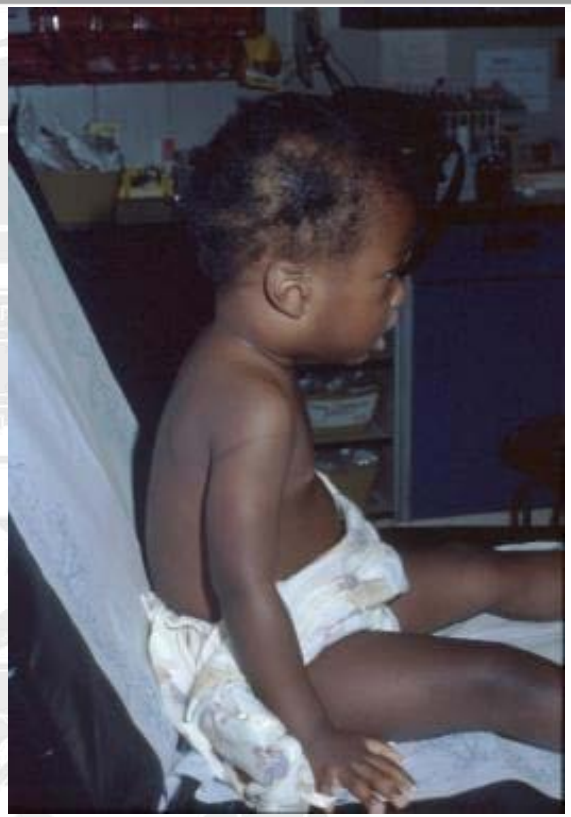
**Table: Normal respiratory rate ranges in children**

| Age group | Age | Normal respiratory rate range |
|---|---|---|
| Infant | 0–12 months | 30–60/min |
| Toddler | 1–3 years | 24–40/min |
| Preschooler | 4–5 years | 22–34/min |
| School age | 6–12 years | 18–30/min |
| Adolescent and adult | 13 years and older | 12–16/min |

# Physical examination

**Tripod position**:

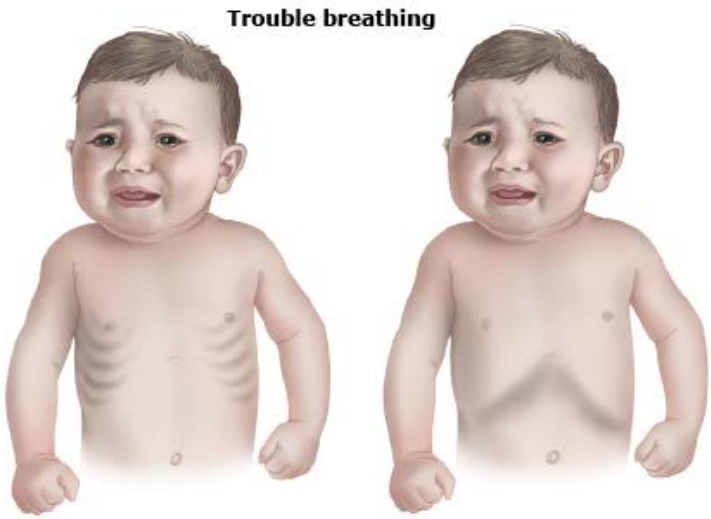
- Lean forward while sitting and rest the hands on the knees
- Seen in patients with asthma and respiratory distress in airways obstruction



# Inspection

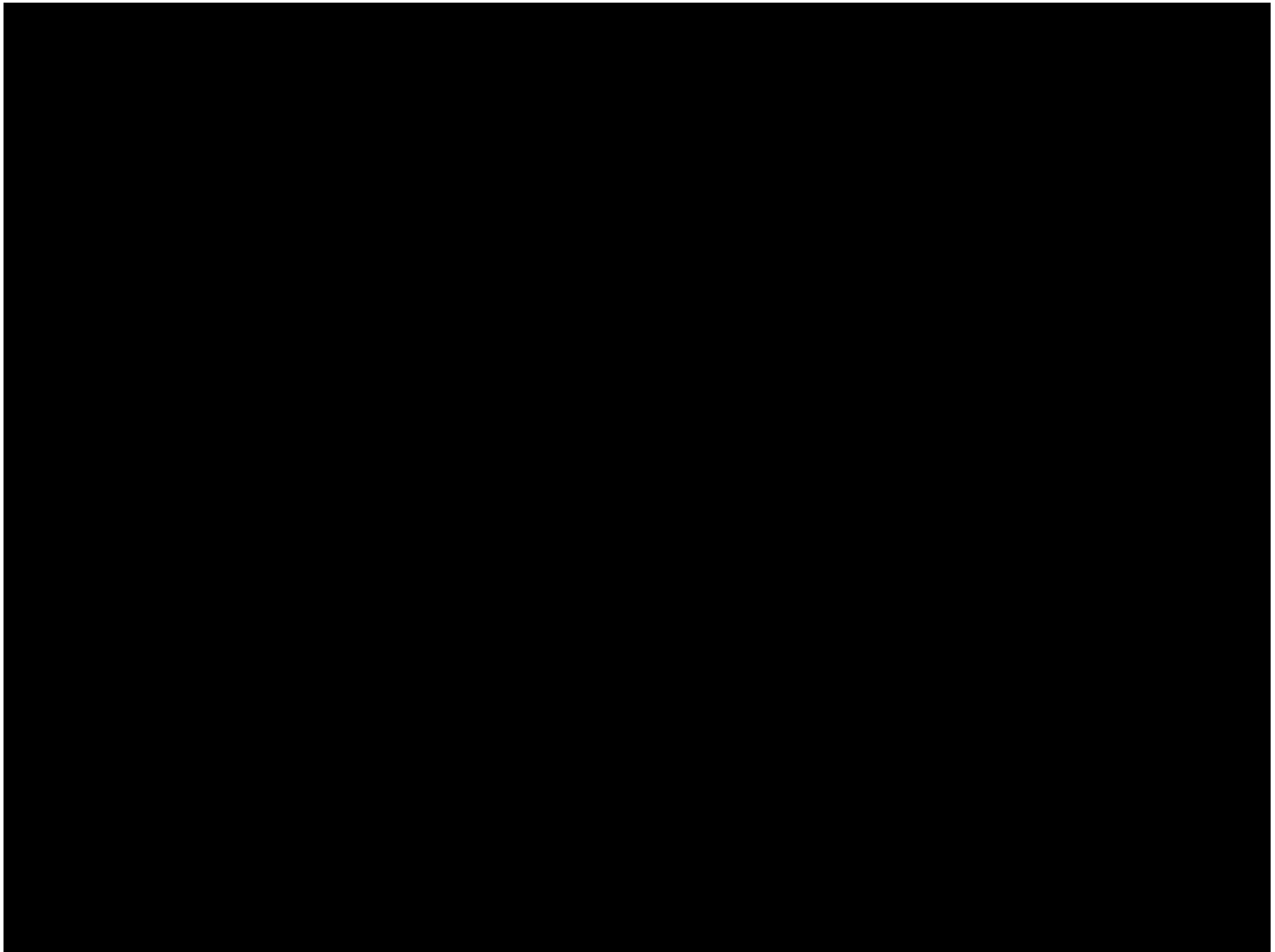
- **Decreased subcutaneous adipose tissue** as seen in a cystic fibrosis patient should be noted.
- The **pattern of breathing** should always be evaluated with the child disrobed.
- **Suprasternal** and **intercostal retractions** reflect excessive negative pleural pressure and can be seen in normal children with thin chest walls after vigorous exercise.
- In infants with **obstructive lung disease**, the **lower ribs** can be felt to **pull inwards on inspiration**. This is the palpable aspect of a subcostal retraction.

**Any use of expiratory musculature is abnormal!**

# Inspection

**Subcostal retractions and nasal flaring**



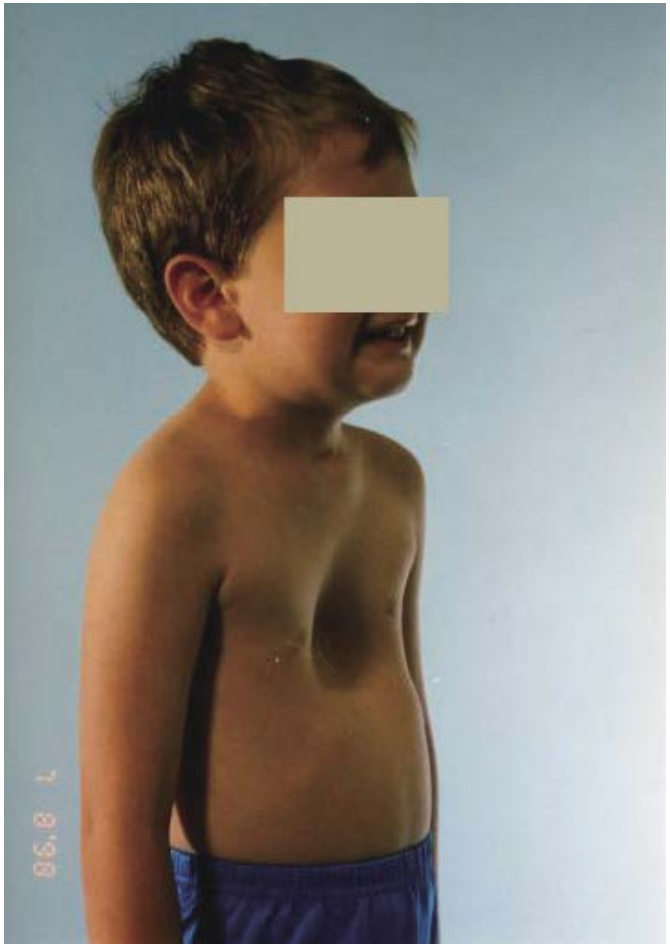
# Inspection

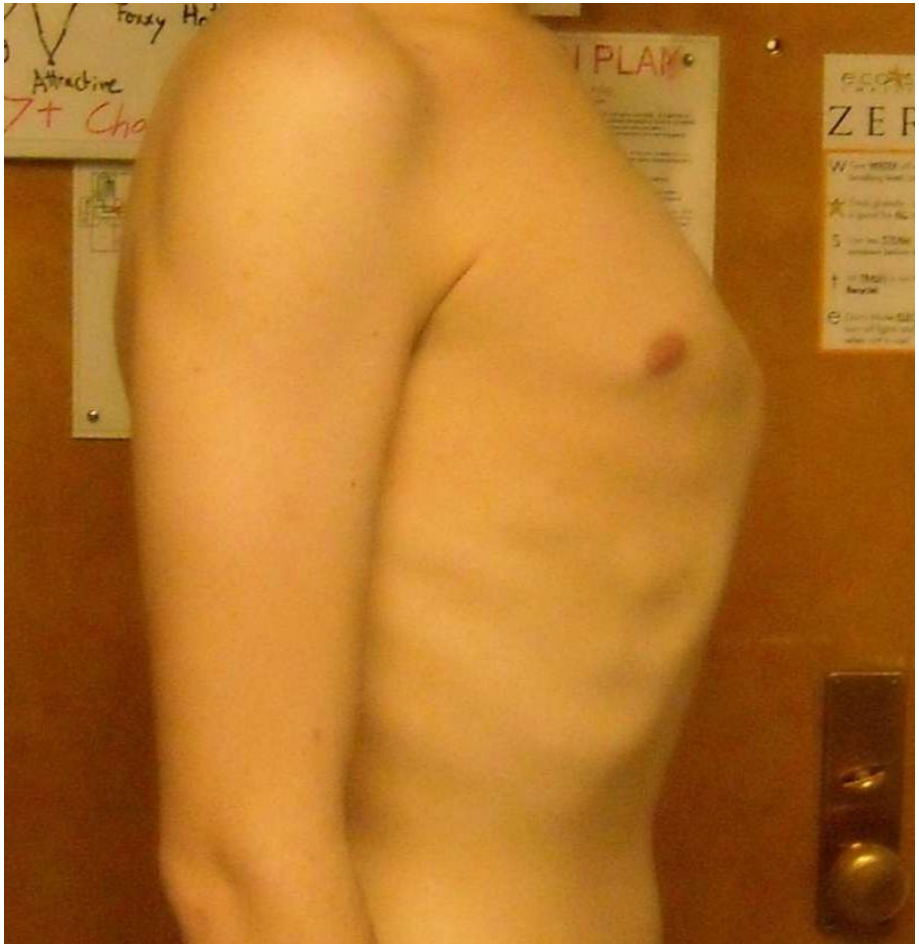
- **Subcostal retractions** are **always pathologic** and are the result of hyperinflated lungs and a flattened diaphragm pulling inward on the chest wall.

- In advanced lung disease, the use of accessory muscles of inspiration can be noted:
  - the sternocleidomastoid muscle, for example, helps lift the chest (in a "bucket handle" fashion) and increase its anteroposterior diameter, thereby increasing intrathoracic volume.

# Inspection

- Chest wall deformities such as **pectus excavatum** or **pectus carinatum (pigeon chest)** should be noted.





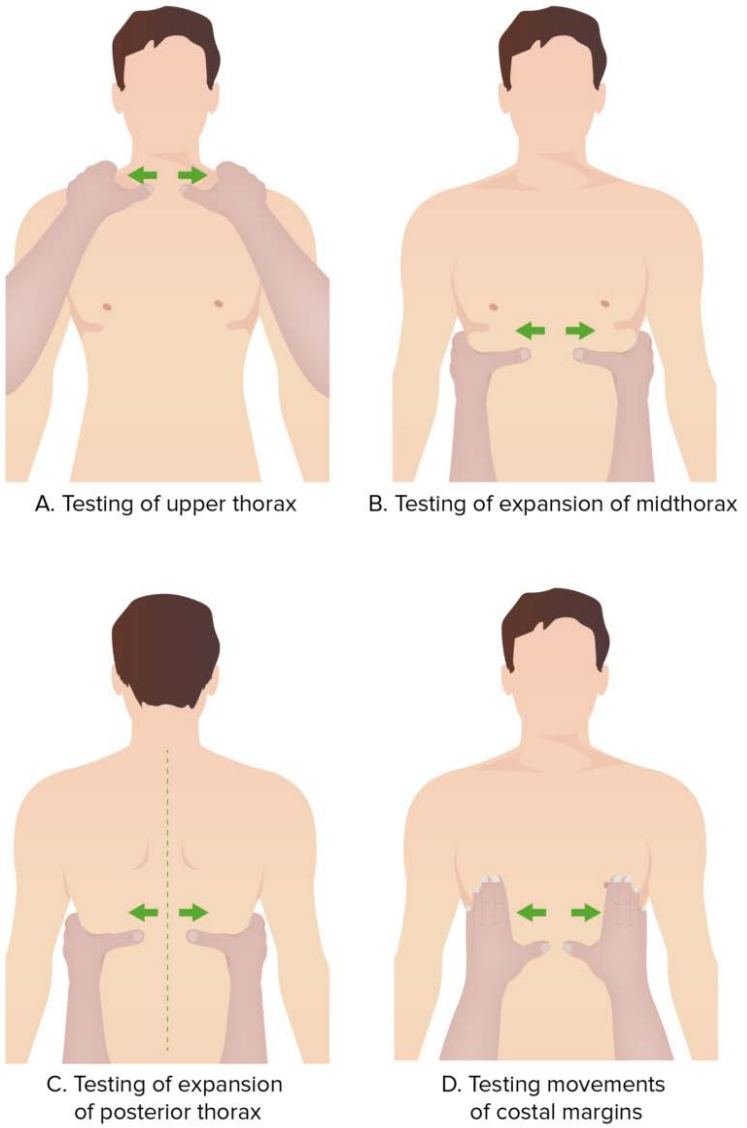
# Palpation

Palpation of the chest can reveal significant findings:

- The examiner places the hands on either side of the chest as the patient takes a deep breath.

- The chest should expand symmetrically;

- **asymmetry** can be seen in unilateral pulmonary hypoplasia, mainstem bronchial obstruction, and diaphragmatic paresis.



# Palpation

Palpation of the chest can reveal significant findings:

- Vocal fremitus should be assessed in patients with suspected pleural fluid accumulation
  - the vibrations transmitted from the larynx as the child says “99” are diminished when there is an accumulation of air or fluid in the pleural space.

- Infants and children with tracheomalacia and bronchomalacia often have a **palpable vibration in the back**.
  - palpable vibrations in only one hemithorax suggest a partial obstruction of the mainstem bronchus in that hemithorax as seen in bronchomalacia.

# Percussion

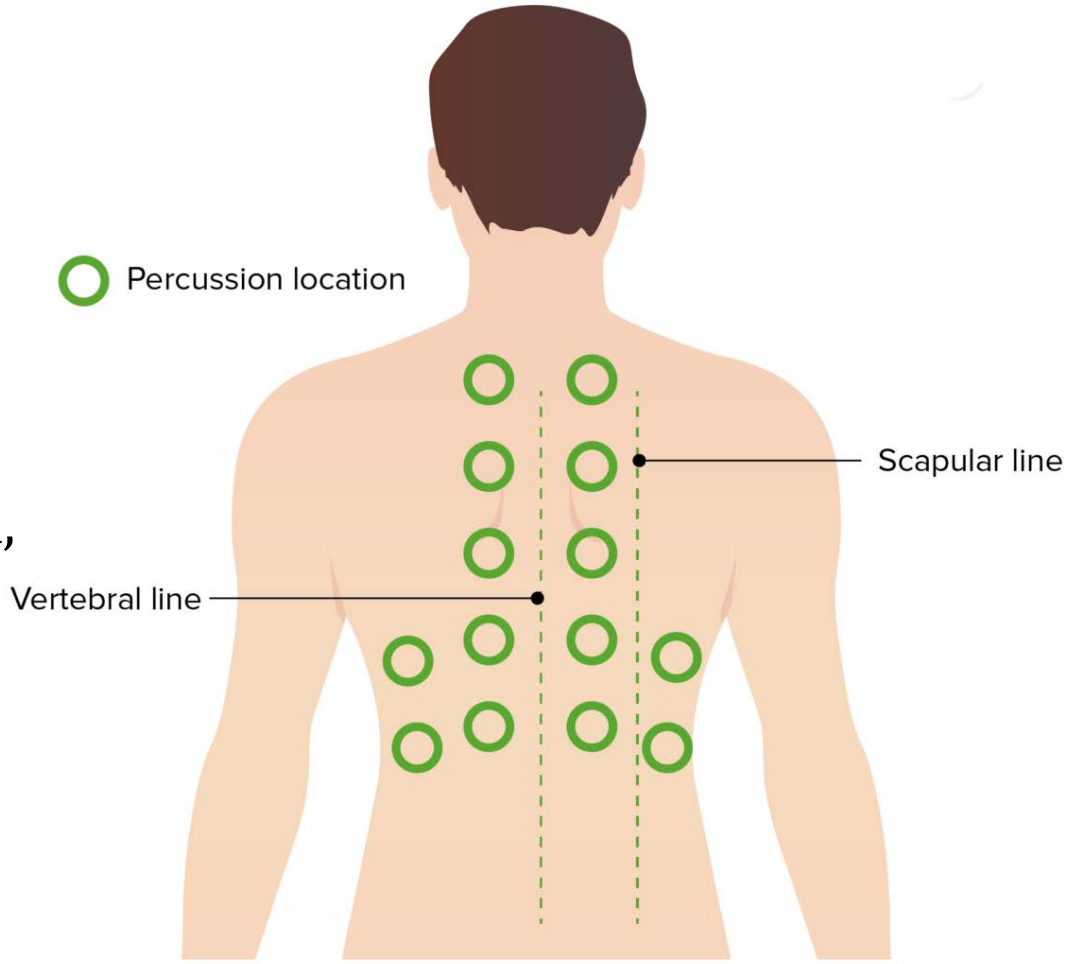
- Percussion of the chest can reveal much more than hyperresonance and dullness over an area of consolidation.

- **Air trapping** is the hallmark of small airway disease and results in a **depressed position of the diaphragm**:
  - ordinarily the diaphragm can be found just at or slightly below the tip of the scapula when the patient's arm is at his or her side in children 5 years old and younger.
  - In the patient with hyperinflation, the diaphragm is found several fingerbreadths below the scapular tips. This finding, even in the absence of wheezing on auscultation, suggests a lesion of the small airways.

# Percussion

- An **area of consolidation** or **pleural effusion** results in **dullness to percussion**.

- Another disorder causing **asymmetry of percussion** of the two hemithoraces is **diaphragmatic eventration**, which is a congenital lesion of the diaphragm in which the diaphragm is replaced with a thin fibrous membrane without contractile properties.



# Auscultation

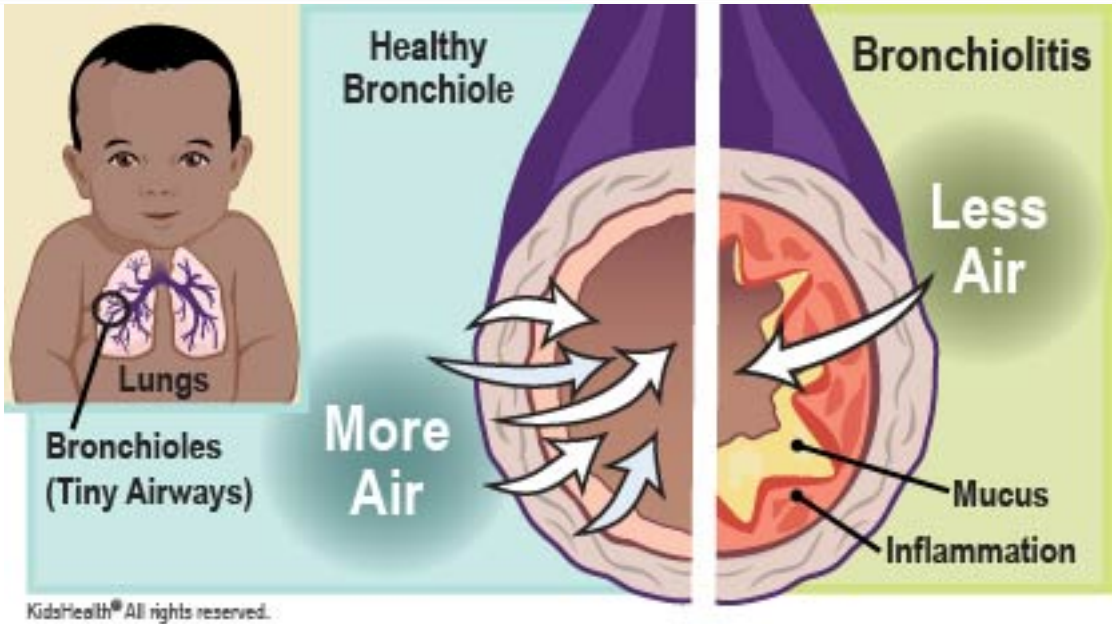
Abnormal ("adventitial") breath sounds include **crackles** and **wheezes**.

- **Wheezes** are *continuous* sounds, whereas crackles (formerly referred to as *rales*) are *discontinuous*.
- Wheezes and crackles can be inspiratory or expiratory, although crackles are more commonly heard on inspiration and wheezes are more commonly heard on expiration.
- Wheezes probably arise from the vibration within the walls of narrowed large and medium-sized airways.
- In a patient experiencing an acute exacerbation of asthma, the lungs have wheezes in a range of pitches (described as *polyphonic*) with substantial regional differences in auscultation.
- Patients with central airway obstruction such as tracheomalacia, on the other hand, have a single pitch of wheeze that sounds the same in all lung fields *(monophonic)* and is heard loudest over the central airway that is obstructed.

# Bronchiolitis

## Basics

- Respiratory infection of the bronchioles
- Occurs in early childhood (younger than 1 yr)
- Caused by viral infection




## Assessment/History

- Length of illness or fever
- Has infant been seen by a doctor
- Taking any medications
- Any previous asthma attacks or other allergy problems
- How much fluid has the child been drinking

# Bronchiolitis

## Signs & symptoms

- Acute respiratory distress
- Tachypnea
- May have intercostal and suprasternal retractions
- Cyanosis
- Fever & dry cough
- May have wheezes - inspiratory & expiratory
- Confused & anxious mental status
- Possible dehydration

## Management

- Assess & maintain airway
- When appropriate let child pick POC
- Clear nasal passages if necessary
- Prepare to assist with ventilations
- IV LR or NS TKO rate
- Intubate if airway management becomes difficult or fails

# Causes of Chronic or Recurrent Wheezing

- Asthma
  - Exercise-induced asthma
- GER
- Hypersensitivity reactions (e.g., ABPA)
- Cystic fibrosis
- Aspiration
  - Tracheoesophageal fistula
  - Foreign body
  - GER
  - Laryngeal cleft
  - Pharyngeal dysmotility
- Extrinsic masses
  - Vascular ring
  - Cystic adenomatoid malformation
  - Lymph nodes
  - Tumors
- Ciliary dyskinesia syndromes
- Tracheomalacia and/or bronchomalacia
- Congestive heart failure
- Bronchopulmonary hemosiderosis or Heiner syndrome
- Endobronchial lesions including localized stenosis
- Interstitial pneumonitides
- Bronchiolitis obliterans

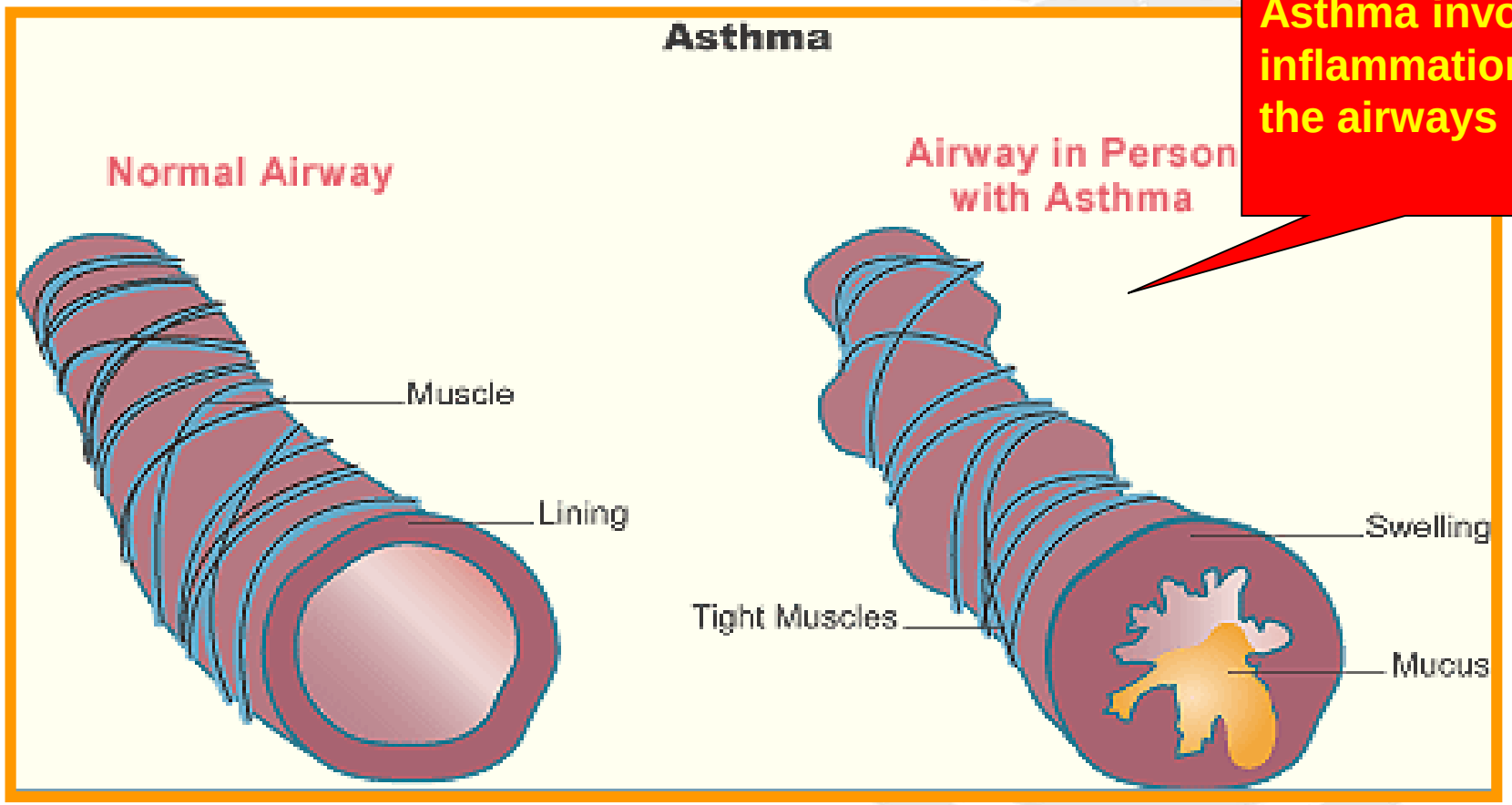
*ABPA,* Allergic bronchopulmonary aspergillosis; *GER,* gastroesophageal reflux.

# Asthma

- Chronic disease of the airways that may cause
  - Wheezing
  - Breathlessness
  - Chest tightness
  - Nighttime or early morning coughing

- Episodes are usually associated with widespread, but variable, airflow obstruction within the lung that is often reversible either spontaneously or with treatment.

# Pathology of Asthma




**Asthma involves inflammation of the airways**

# Indoor Air Exposures & Asthma Development

## Biological Agents

- Sufficient evidence of causal relationship
  - Cat
  - Cockroach
  - House dust mite
- Sufficient evidence of an association
  - Dog
  - Fungus/Molds
  - Rhinovirus
- Limited or suggestive evidence of association
  - Domestic birds
  - Chlamydia and Mycoplasma pneumonia
  - RSV

## Chemical Agents

- Sufficient evidence of causal relationship
  - Environmental tobacco smoke (among pre-school aged children)
- Sufficient evidence of association
  - $NO_2$, $NO_X$ (high levels)
- Limited or suggestive evidence of association
  - Environmental Tobacco Smoke (among school-aged, older children, and adults)
  - Formaldehyde
  - Fragrances

# Diagnosing Asthma: Medical History

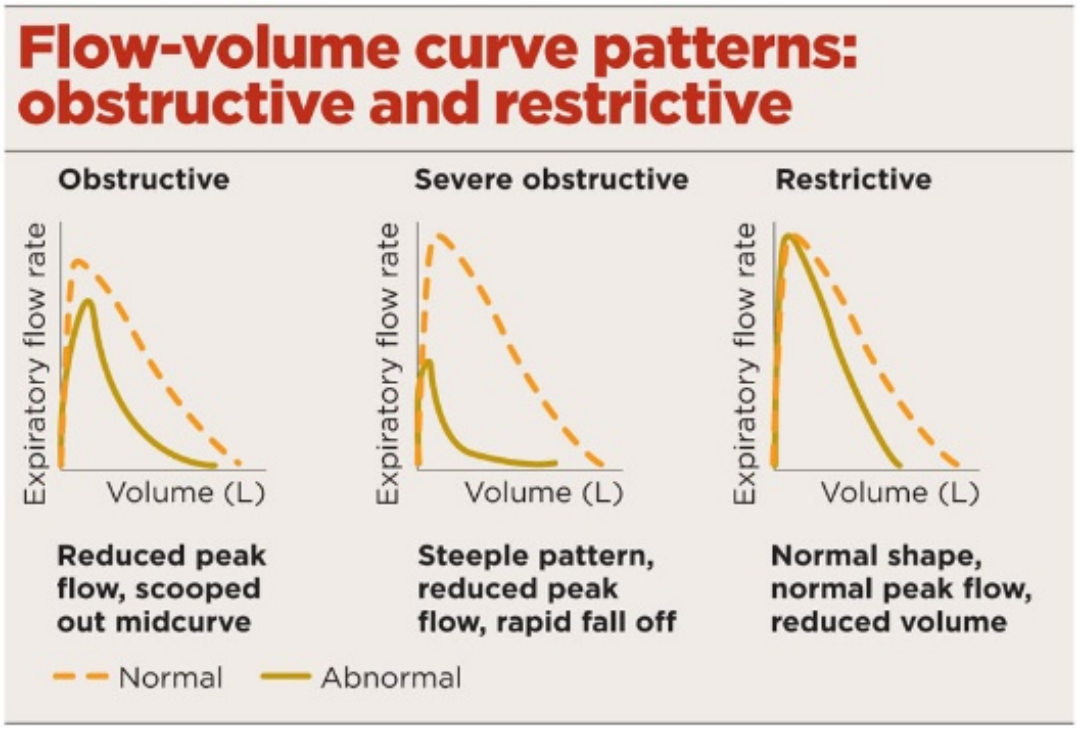
- Symptoms
  - Coughing
  - Wheezing
  - Shortness of breath
  - Chest tightness
- Symptom Patterns
- Severity
- Family History

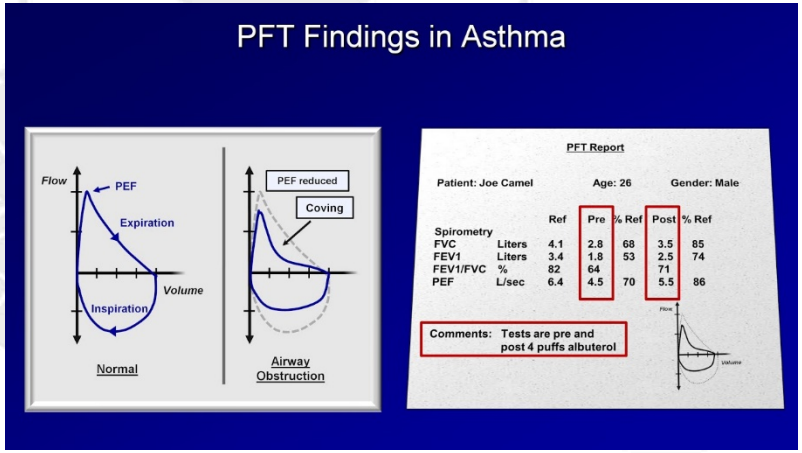
# Diagnosing Asthma

- Troublesome cough, particularly at night
- Awakened by coughing
- Coughing or wheezing after physical activity
- Breathing problems during particular seasons
- Coughing, wheezing, or chest tightness after allergen exposure
- Colds that last more than 10 days
- Relief when medication is used
- Wheezing sounds during normal breathing
- Hyperexpansion of the thorax
- Increased nasal secretions or nasal polyps
- Atopic dermatitis, eczema, or other allergic skin conditions

# Diagnosing Asthma: Spirometry

Test lung function when diagnosing asthma



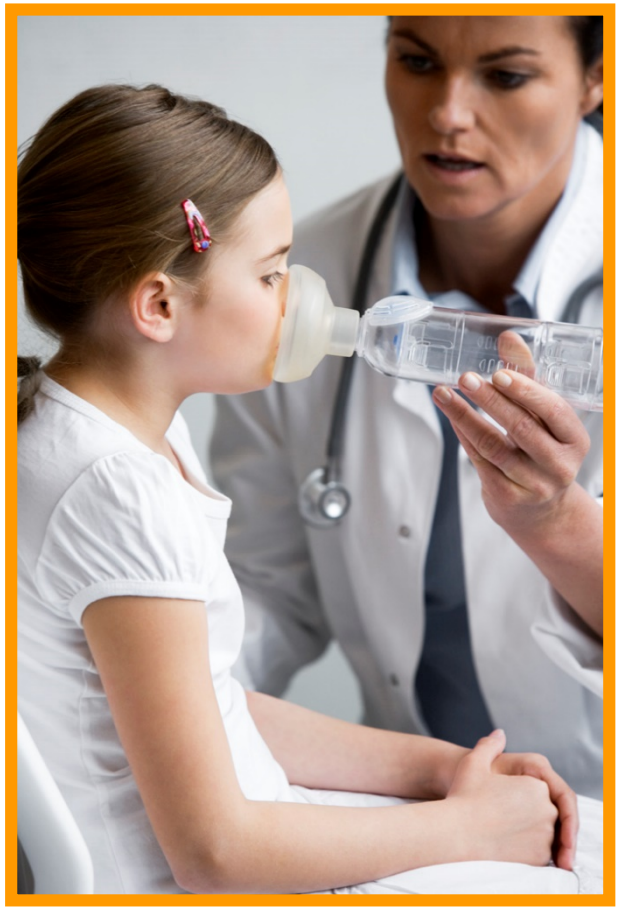



# Medications to Treat Asthma

- Medications come in several forms.
- Two major categories of medications are:
  - Long-term control
    - Taken daily over a long period of time
    - Used to reduce inflammation, relax airway muscles, and improve symptoms and lung function
      - Inhaled corticosteroids
      - Long-acting beta$_2$-agonists
      - Leukotriene modifiers
  - Quick relief
    - Used in acute episodes
    - Generally short-acting beta$_2$agonists

# Medications to Treat Asthma: How to Use a Spray Inhaler

**The health-care provider should evaluate inhaler technique at each visit.**



Remember to breathe in slowly.

1. Take off the cap.
   Shake the inhaler.

2. Stand up.
   Breathe out.

3. Put the inhaler in your mouth or put it just in front of your mouth. As you start to breathe in, push down on the top of the inhaler and keep breathing in slowly.

4. Hold your breath for 10 seconds.
   Breathe out.

# Auscultation

- **Crackles** are believed to arise from the popping of fluid menisci within airways.
- Coarse crackles are often audible at the mouth and are a late finding in cystic fibrosis patients with advanced bronchiectasis.

- **Rhonchi** refers to the sound made by pooled secretions in the central airways, which can be categorized as harsh, low-pitched central wheezes or coarse, central crackles (depending on the nature of the sounds heard)

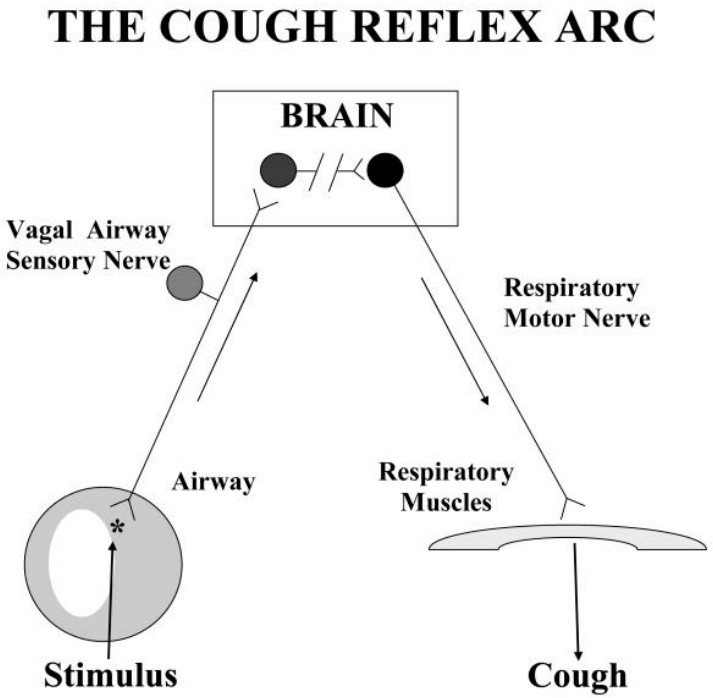
**Friction rubs** are creaking sounds heard during both phases of respiration as inflamed pleural surfaces rub over one another.

One of the most important abnormal findings in children is the **absence of breath sounds** over an area of **collapse** or **consolidation**.

# Signs and symptoms of respiratory diseases in children

# Cough

- Persistent or recurrent cough represents one of the most common and vexing problems in pediatrics.
- In most circumstances, the tracheobronchial tree is kept clean by airway macrophages and the mucociliary escalator.




- Cough becomes an important component of airway clearance when excessive or abnormal materials are present, or when mucociliary clearance is reduced, such as during a viral respiratory illness.

# Causes of Cough According to Age

## Infancy (Younger Than 1 Year Old)

**Congenital and Neonatal Infections**

*Chlamydia*
Viral (e.g., RSV, CMV, rubella)
Bacterial (e.g., pertussis)
*Pneumocystis jiroveci*

**Congenital Malformations**

Tracheoesophageal fistula
Vascular ring
Airway malformations (e.g., laryngeal cleft)
Pulmonary sequestration

**Other**

Cystic fibrosis
Asthma
Aspiration
Recurrent viral bronchiolitis/bronchitis
GER
Interstitial pneumonitides
Lymphoid interstitial pneumonitis
Diffuse interstitial pneumonitis

## Preschool

Inhaled foreign body
Asthma
Suppurative lung disease
    Cystic fibrosis
    Bronchiectasis
Right middle lobe syndrome
Ciliary dyskinesia syndromes
Upper respiratory tract disease
Recurrent viral infection/bronchitis
Passive smoke inhalation
GER
Interstitial pneumonitides
Pulmonary hemosiderosis

# Causes of Cough According to Age

## School Age to Adolescence

Asthma
Cystic fibrosis
*Mycoplasma pneumoniae* infection
Psychogenic or habit cough
Cigarette smoking
Pulmonary hemosiderosis
Interstitial pneumonitides
Ciliary dyskinesia syndromes

## All Ages

Recurrent viral illness
Asthma
Cystic fibrosis
Granulomatous lung disease
Foreign body aspiration
Pertussis infection

# Characteristics of Chronic Cough and Associated Conditions

| Characteristic | Associated Condition |
|---|---|
| Loose, productive | Cystic fibrosis, bronchiectasis, ciliary dyskinesia |
| Croupy | Laryngotracheobronchitis |
| Paroxysmal | Cystic fibrosis, pertussis syndrome, foreign body inhalation, *Mycoplasma, Chlamydia* |
| Brassy | Tracheitis, upper airway drainage, psychogenic cough |
| After feedings | Pharyngeal incoordination, pharyngeal mass, tracheoesophageal fistula, GER |
| Nocturnal | Upper respiratory tract disease, sinusitis, asthma, cystic fibrosis, GER |
| Most severe in morning | Cystic fibrosis, bronchiectasis |
| With exercise | Asthma (including exercise induced), cystic fibrosis, bronchiectasis |
| Loud, honking, or bizarre | Psychogenic cough |
| Disappears with sleep | Psychogenic cough |

*GER,* Gastroesophageal reflux.

# Diagnostic Approach to Cough

- Complete history and physical examination
- Chest and sinus radiographs
- CBC with differential
- Pulmonary function tests (including bronchoprovocation tests)
- Sweat test (pilocarpine iontophoresis method)
- Trial of bronchodilators
- Sputum for Gram stain, AFB (Acid-fast bacillus), bacterial, viral, and fungal cultures
- Quantitative immunoglobulins
- Tuberculin skin test/anergy panel
- Serologic tests or PCR for *Mycoplasma pneumoniae*
- Bronchoscopy with bronchoalveolar lavage
- Barium swallow

# Stridor

- Stridor is characteristically a harsh inspiratory noise created by obstruction of the larynx or the extrathoracic trachea.
- With a mild degree of airway narrowing, breath sounds may be normal when the infant or child is at rest, but with any activity that increases tidal breathing (e.g., crying, feeding, agitation), inspiratory stridor may become noticeable.

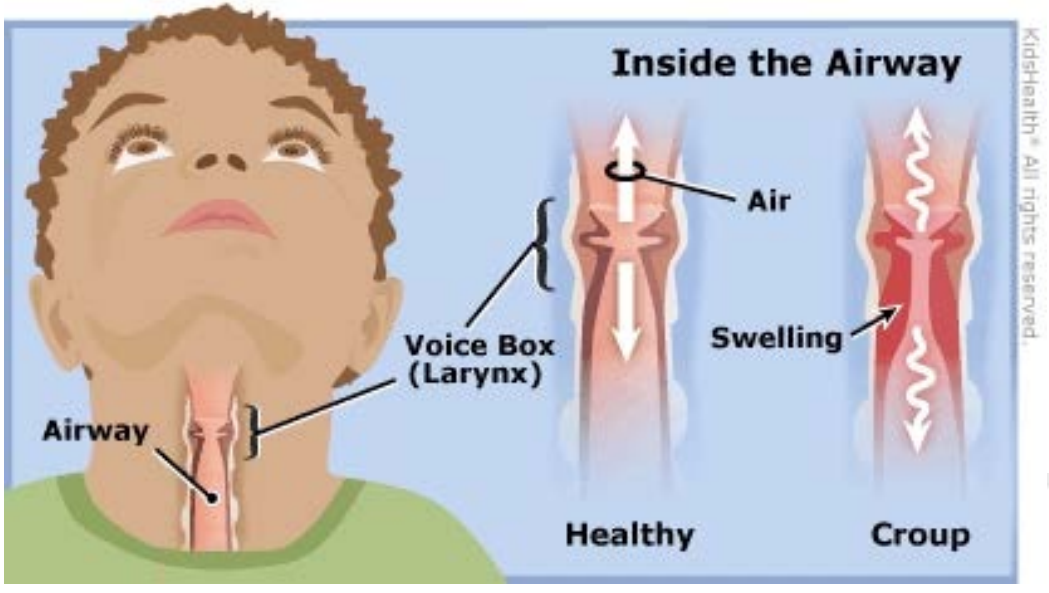
**Causes of Recurrent or Chronic Stridor**

| | |
|---|---|
| Croup | Foreign body in esophagus |
| Infectious | Thyromegaly |
| Allergic/angioneurotic edema, GER | Pharyngeal or laryngeal masses |
| Laryngomalacia | Papilloma |
| Tracheomalacia | Hemangioma |
| Subglottic stenosis | Laryngocele |
| Extrinsic airway compression | Web |
| Vascular ring | Foreign body |
| Mediastinal mass | Tracheoesophageal fistula |
| Lobar emphysema | Vocal cord paralysis |
| Bronchogenic cyst | Psychogenic |

*GER*, Gastroesophageal reflux.

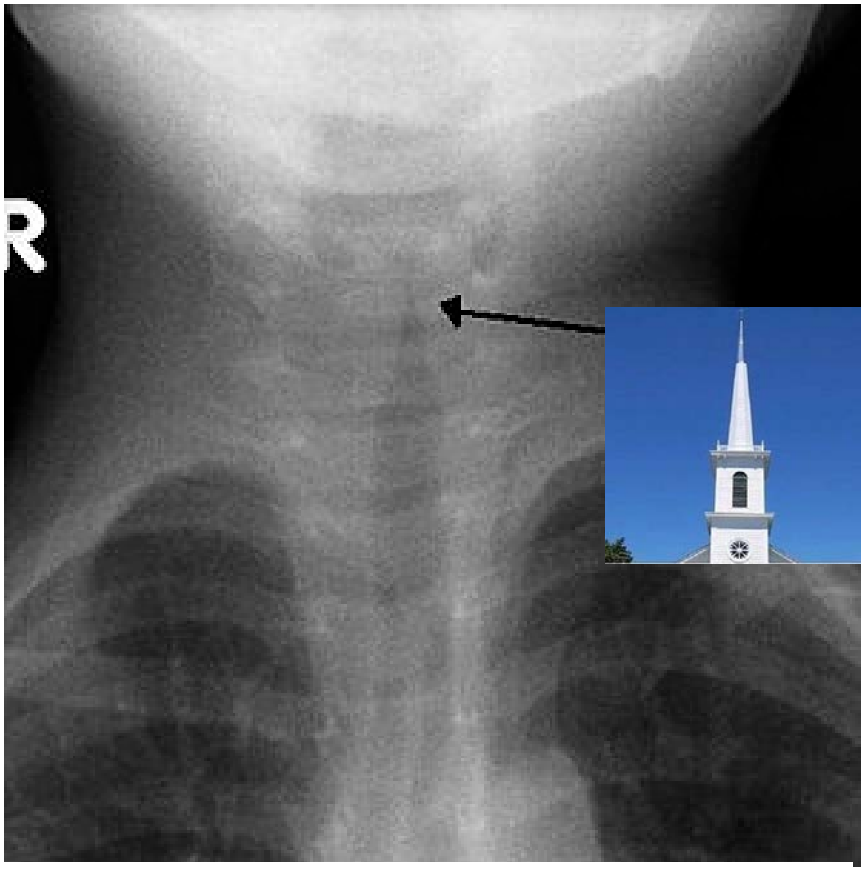
# Stridor

- The most common cause of inspiratory stridor in the pediatric population is **infectious croup** (acute laryngotracheobronchitis).
- This disease is most commonly caused by a respiratory virus (parainfluenza, respiratory syncytial, influenza, or rhinovirus), and the patient typically has coryza for 24 to 48 hours before the appearance of croupy cough, hoarseness, and stridor.



# Stridor

- Occasionally the inflammatory process may spread to the smaller airways and produce wheezing in addition to these symptoms.
- The “steeple sign” is a characteristic radiographic sign on anteroposterior projections that may be accompanied by marked dilation of supraglottic structures, particularly on lateral films.
- In the majority of patients, serious airway obstruction does not occur and the disease is self-limited.

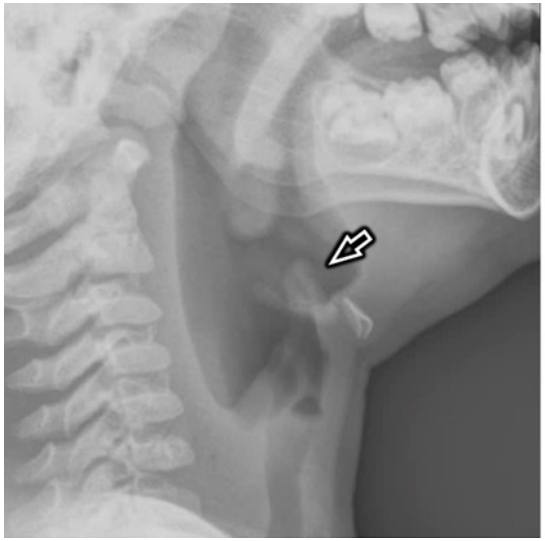


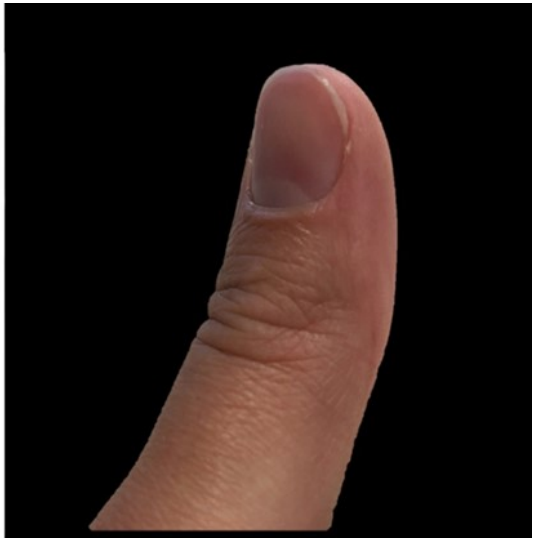

- Medically managed with oxygen and mist therapy, racemic epinephrine neb and IV dexamethasone (0.25-0.5mg/kg)
- Indications for intubation: progressive intercostal retraction, obvious respiratory fatigue, and central cyanosis

# Stridor

## Epiglottitis

- Etiology: Haemophilus influenzae type B; occurs in children ages 2-6 years
- Progresses rapidly from a sore throat to dysphagia and complete airway obstruction (within hours)
- Signs of obstruction: stridor, drooling, hoarseness, tachypnea, chest retraction, preference for upright position
- Lateral X-ray of the neck: "thumb sign" (a)





- OR intubation/ENT present for emergency surgical airway
- Do NOT perform laryngoscopy before induction of anesthesia to avoid laryngospasm
- Inhalational induction in sitting position to maintain spontaneous respiratory drive

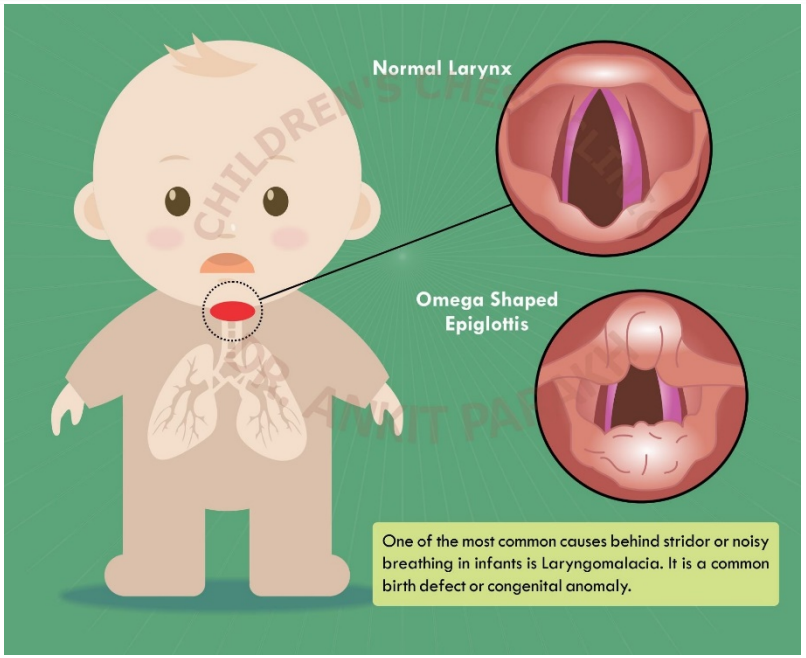
# Stridor

- **Acute angioneurotic edema** is a less common cause of stridor. In most cases, it results from an allergic reaction and is potentially fatal.

- **Gastro Esophageal Reflux**: some children with anatomically normal airways suffer recurrent bouts of stridor, usually in the middle of the night, in the absence of signs of viral infection.
  - Treatment for GER is often helpful in these patients, suggesting that for many, occult GER explains these bouts of recurrent airway obstruction.

# Stridor

- The stridor associated with **congenital laryngomalacia** generally begins within the first week of life, varies with activity, and is more noticeable in the supine position.




- Clinical symptoms may suggest the diagnosis; but if severe, bronchoscopic visualization of airway dynamics by flexible bronchoscopy is a safe and reliable method of excluding other causes of stridor.

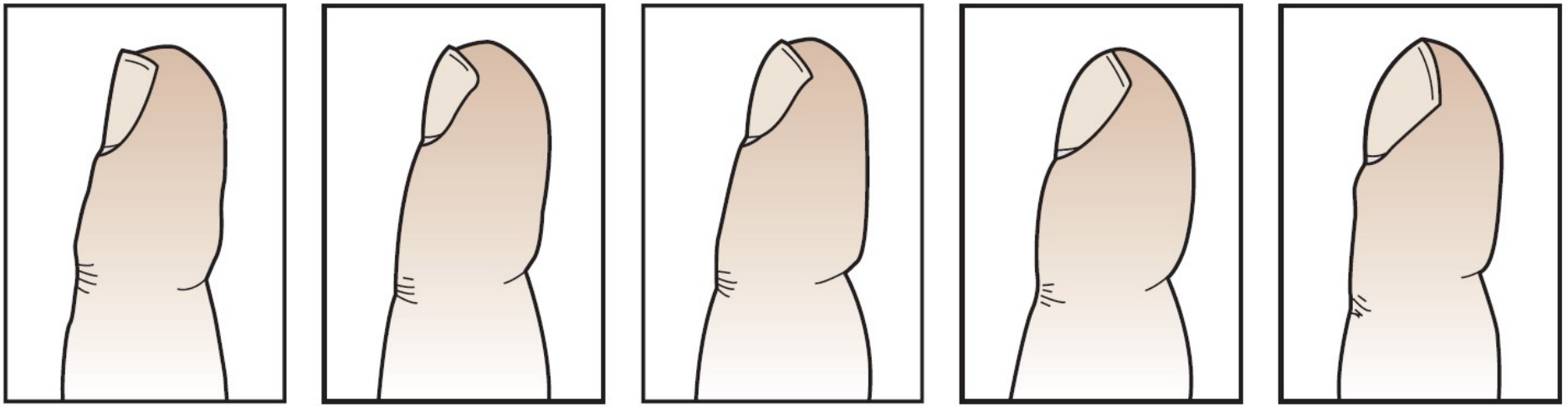
- Parents can be reassured that this entity is self-limited, becomes less marked after 6 to 10 months of age, and rarely causes serious problems.

# Clinical Manifestations of Respiratory Failure and Imminent Respiratory Arrest

| PHYSIOLOGIC CAUSE | CLINICAL MANIFESTATIONS |
|---|---|
| **INITIAL SIGNS OF RESPIRATORY FAILURE** | |
| The child is trying to compensate for oxygen deficit and airway blockage. Oxygen supply is inadequate; behavior and vital signs reflect compensation and beginning hypoxia. | Restlessness<br>Tachypnea<br>Tachycardia<br>Diaphoresis |
| **EARLY DECOMPENSATION** | |
| The child tries to use accessory muscles to assist oxygen intake; hypoxia persists and efforts now waste more oxygen than is obtained. | Nasal flaring<br>Retractions<br>Grunting<br>Wheezing<br>Anxiety, irritability<br>Mood changes<br>Headache<br>Hypertension<br>Confusion |
| **SEVERE HYPOXIA AND IMMINENT RESPIRATORY ARREST** | |
| The oxygen deficit is overwhelming and beyond spontaneous recovery. Cerebral oxygenation is dramatically affected; central nervous system changes are ominous. | Dyspnea<br>Bradycardia<br>Cyanosis<br>Stupor and coma |

# Digital clubbing

- Digital clubbing may point to the presence of lung disease. There are various stages of clubbing, from mild to severe:




Digital clubbing. The 0- to 4-point scale describes the spectrum of digital clubbing as follows:
1+, very mild; 2+, mild; 3+, moderate; and 4+, severe.

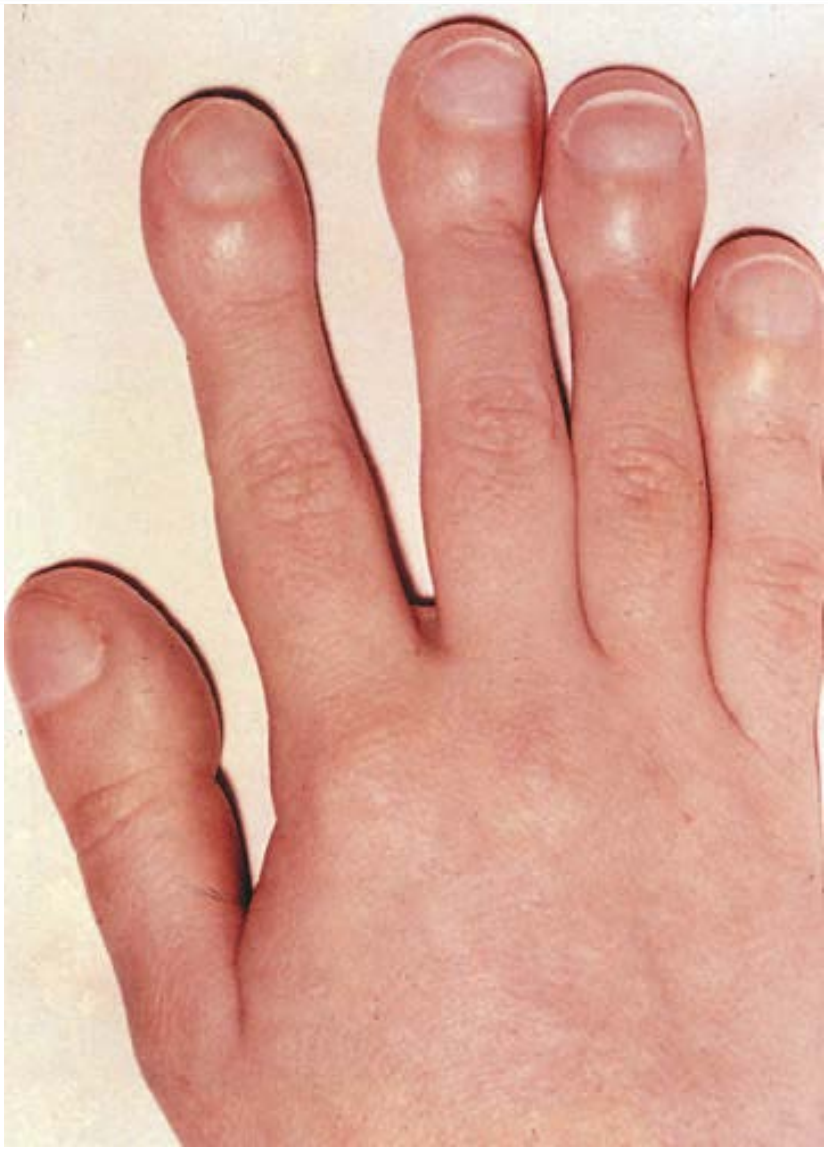
# Digital clubbing

## Causes of Clubbing

- Pulmonary
  - Cystic fibrosis
  - Other bronchiectasis
  - Pulmonary abscess
  - Empyema
  - Neoplasms
  - Interstitial fibrosis
  - Pulmonary alveolar proteinosis
  - Interstitial pneumonitis
  - Chronic pneumonia
- Cardiac
  - Cyanotic congenital heart disease
  - Subacute bacterial endocarditis
- Gastrointestinal or hepatic
  - Ulcerative colitis
  - Crohn disease
  - Polyposis
  - Biliary cirrhosis/atresia
- Familial
- Thyrotoxicosis

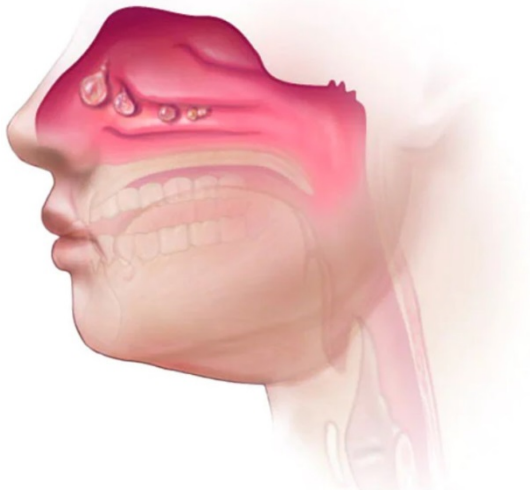
# Digital clubbing

- Bronchiectasis from **cystic fibrosis** or from other chronic infectious causes is the major cause of clubbing among all pulmonary diseases.

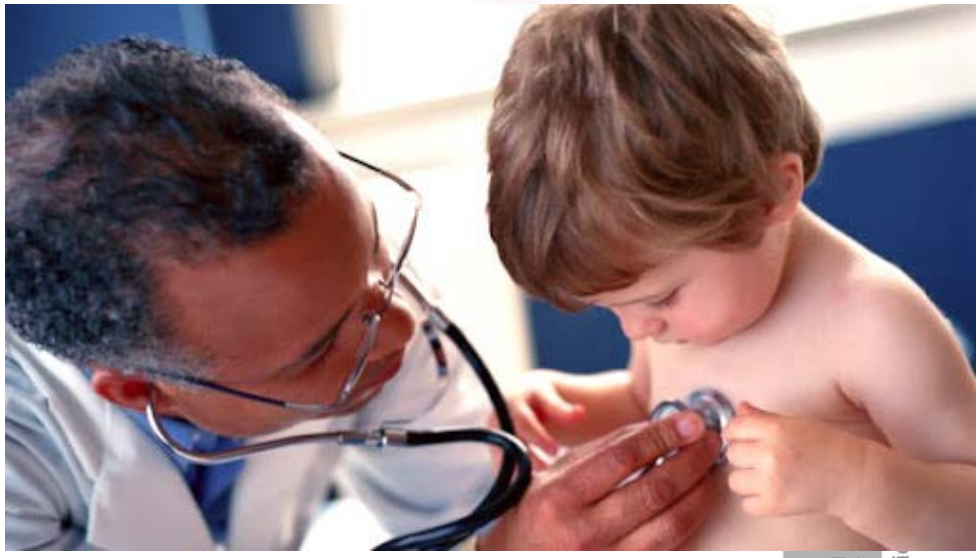


# The reminding of the physical examination

- **Nasal polyps** can be associated with cystic fibrosis, triad asthma, or significant atopy.



- An **increased second heart sound** on auscultation could suggest pulmonary hypertension.



## ASSESSMENT GUIDE | The Child in Respiratory Distress*

| Assessment Focus | Assessment Guideline |
|---|---|
| Position of comfort | • Is the child comfortable lying down?<br>• Does the child prefer to sit up or in the **tripod position** (sitting forward with arms on knees for support and extending the neck)? |
| Vital signs | • Assess the rate and depth of respirations. See Table 5–9 for age-related respiratory rates. Is **tachypnea** (abnormally rapid respiratory rate) present?<br>• Assess the pulse for rate and rhythm. See Table 5–11 for age-related heart rates. |
| Lung auscultation | • Are breath sounds bilateral, diminished, or absent?<br>• Are **adventitious sounds** (wheezes, crackles, or rhonchi) present? |
| Respiratory effort (work of breathing) | • Is **stridor** (audible crow-like inspiratory and expiratory breath sounds) or wheezing present? Is grunting heard on expiration?<br>• Is breathing easy or labored?<br>• Are retractions present or are accessory muscles used to breathe?<br>• Is nasal flaring present?<br>• Can the child say a full sentence or is a breath needed every few words? Is the cry strong or weak?<br>• Do the chest and abdomen rise simultaneously with inspiration or is **paradoxical breathing** present in which the chest and abdomen do not rise simultaneously? |
| Color | • What is the color of the mucous membranes, nail beds, or skin (pink, pale, cyanotic, or mottled)?<br>• Does crying improve or worsen the color? |
| Cough | • Is the cough dry (nonproductive), wet (productive, mucousy), brassy (noisy, musical), or croupy (barking, seal-like)?<br>• Is the coughing effort forceful or weak? |
| Behavior change | • Is irritability, restlessness, or change in level of responsiveness present? |

# Clinical Manifestations of Respiratory Failure and Imminent Respiratory Arrest

| PHYSIOLOGIC CAUSE | CLINICAL MANIFESTATIONS |
|---|---|
| **INITIAL SIGNS OF RESPIRATORY FAILURE** | |
| The child is trying to compensate for oxygen deficit and airway blockage. Oxygen supply is inadequate; behavior and vital signs reflect compensation and beginning hypoxia. | Restlessness<br>Tachypnea<br>Tachycardia<br>Diaphoresis |
| **EARLY DECOMPENSATION** | |
| The child tries to use accessory muscles to assist oxygen intake; hypoxia persists and efforts now waste more oxygen than is obtained. | Nasal flaring<br>Retractions<br>Grunting<br>Wheezing<br>Anxiety, irritability<br>Mood changes<br>Headache<br>Hypertension<br>Confusion |
| **SEVERE HYPOXIA AND IMMINENT RESPIRATORY ARREST** | |
| The oxygen deficit is overwhelming and beyond spontaneous recovery. Cerebral oxygenation is dramatically affected; central nervous system changes are ominous. | Dyspnea<br>Bradycardia<br>Cyanosis<br>Stupor and coma |

# Diagnostic and Laboratory Procedures/Tests for the Respiratory System

# Diagnostic and Laboratory Procedures/ Tests for the Respiratory System

| DIAGNOSTIC PROCEDURES | LABORATORY TESTS |
|---|---|
| Bronchoscopy | Arterial blood gas analysis |
| Chest radiograph | Cultures |
| Polysomnography (sleep study) | Neonatal screening for cystic fibrosis |
| Pulse oximetry | Protein-purified derivative (PPD), the Mantoux test |
| Spirometry (pulmonary function tests) | |
| Sweat chloride test | |

* See Appendices D and E for information about these diagnostic procedures and tests.