Pneumonia

A lower respiratory tract infection (LRI) develops in one in three children in the first year of life. Twenty nine percent of these children develop pneumonia, 15% develop croup, 34% tracheobronchitis, and 29% bronchiolitis. Pneumonia consists of an invasion of the lung by an infectious agent, resulting in an acute inflammatory response and consolidation of the affected lobe.

I. **Clinical Evaluation of Pneumonia**

A. **Cough**. Pneumonia usually causes cough that persists day and night. Patients who cough spontaneously throughout the office visit are likely to have lower respiratory tract disease. The cough often is productive.

B. **Grunting** occurs in 20% of infants who have bronchiolitis or pneumonia. Grunting is produced by approximation of the vocal cords, which prevents collapse of narrowed airways and improves oxygenation.

C. **Chest Pain**. Pneumonia causes chest pain when the infection develops near the pleura. Pneumonia that involves the diaphragmatic pleura may present as abdominal pain. Older children may complain of diffuse chest or abdominal pain, which is caused by persistent cough and repeated muscle contraction.

D. **Tachypnea**. Increased respiratory rate is one of the earliest and most consistent signs of lower respiratory tract disease.

Abnormal Respiratory Rates by Age	
Age	**Abnormal**
<2 months	>60 bpm
2-12 months old	>50 bpm
>1 year old	>40 bpm

E. **Retractions**

1. Retractions of the intercostal spaces are caused by decreased compliance or increased airway resistance.
2. Severe lung disease may cause retractions of the supraclavicular spaces, and contraction of the sternocleidomastoid muscles may cause "head-bobbing."

F. **Auscultation**

1. **Signs of consolidation** include dullness to percussion and increased transmission of the voice on auscultation.
2. **Crackles** are the fine popping sounds that occur when previously closed airways open suddenly. They indicate pulmonary parenchymal disease.
3. **Wheezing** is generated by narrowed airways. It can be caused by bronchiolitis, asthma, early pulmonary edema, subglottic stenosis, or tracheal compression. If the wheezing occurs only on expiration, it more likely is caused by intrathoracic small airway obstruction (asthma, bronchiolitis). If the wheezing is audible during both phases of respiration, it usually originates from extrathoracic airway narrowing (epiglottitis).

G. **Cyanosis** occurs at an oxygen saturation of 67%; however, cyanosis will not manifest in the presence of anemia. It is not a sensitive predictor of pneumonia because significantly hypoxemia may be present before cyanosis is visible.

H. The absence of respiratory distress, tachypnea, crackles, and decreased breath sounds accurately exclude the presence of pneumonia.

II. **Diagnostic Evaluation of Lower Respiratory Infections**

A. **Chest Radiograph**

1. Some children who have pneumonia may present with a normal chest radiograph. A radiograph is not required for well-appearing infants and children with mild pneumonia.
2. A chest radiograph should be obtained when pneumonia fails to improve on antibiotics, and when the child appears ill. The radiograph that demonstrates lobar consolidation should be repeated in 4 to 6 weeks in order to demonstrate resolution of the infection and to exclude any underlying anatomic abnormalities.

B. **Laboratory Tests**

1. **WBC count** should be obtained for children who have significant fever (>38°C in infants, >39°C in children), who appear ill, or who are hospitalized.
2. **Blood cultures** are rarely positive in children with pneumonia. They should be obtained in infants and children with high fever, ill appearance, or upon hospitalization. Nasopharyngeal and throat cultures are not routinely indicated because the bacteria isolated do not correlate with those present in the lower respiratory tree.
3. **Bacterial antigen assays** of urine by latex agglutination, or antibody tests of blood influence therapy only rarely with unusual infections or when pneumonia is unresponsive to therapy.
4. **Nasopharyngeal cultures for viruses** and immunofluorescence studies for viral antigens are obtained when therapy with antiviral agents are being considered.

III. **Pneumonia in Newborns**

A. Group B streptococcal disease is the most common cause of pneumonia in the newborn. The infection most likely is acquired in utero. Prenatal screening of expectant mothers and intrapartum prophylaxis of colonized mothers with IV ampicillin decreases the incidence. Affected infants frequently develop fulminant illness within hours of delivery.

B. Initial therapy of pneumonia in newborns consists of ampicillin (100 mg/kg IV initial dose, followed by 200 mg/kg/day divided QID) and gentamicin (2.5 mg/kg IV initial dose, followed by 7.5 mg/kg/day divided TID, adjusted according to serum levels).

Management of Pneumonia in Children

Patient	Chest Radio-graph	Blood Count	Blood Gas	Blood Culture	Antibiotics
Newborn	+	+	+	+	Ampicillin and gentamicin
Infant Febrile/Ill-appearing	+	+	+	+	Nafcillin and cefotaxime
Afebrile/Well-appearing	+	+	±	-	Erythromycin or clarithromycin PO
Toddler Febrile/ill-appearing	+	+	+	+	Amoxicillin or cefuroxime
Afebrile/Well-appearing	+	±	+	+	None (close follow-up)
Child Febrile/ill-appearing	+	+	±	±	Cefuroxime
Afebrile/Well-appearing	+				Erythromycin or clarithromycin PO

IV. **Pneumonia in Infants (2 weeks to 6 months)**

A. **Febrile/Ill Appearing Infants**

1. High fever in an infant is more likely to be the result of invasive bacterial disease.

2. Pathogens in this age group include Streptococcus pneumoniae and Haemophilus influenzae serotype B (HIB). HIB has all but disappeared because of vaccination. Staphylococcus aureus is also a potential pathogen, which frequently causes pleural effusion (55%) or pneumothorax (21%).
3. Evaluation of the ill-appearing, febrile infant for sepsis includes blood cultures, urine culture, chest radiograph, complete blood count, and a lumbar puncture.
4. Initial parenteral antibiotic therapy consists of nafcillin (100-150 mg/kg/day divided QID) to cover staphylococci, and cefotaxime (100-150 mg/kg/day divided TID) for Gram-negative pathogens. Alternative therapy is cefuroxime (100-150 mg/kg/day divided TID).

B. **Afebrile/Well-Appearing Infants**

1. In infants with afebrile pneumonia, the pathogens most commonly are Chlamydia trachomatis (25%), Ureaplasma urealyticum (21%), cytomegalovirus (20%), and Pneumocystis carinii (18%).
2. Chlamydia antigens can be detected by direct flourescent antibody and enzyme-linked immunoassay techniques.
3. RSV, adenovirus, and the parainfluenza viruses also can cause pneumonia in otherwise well infants. Viral antigen detection kits are available for these common viral pathogens.
4. Bordetella pertussis infection may cause paroxysms of cough in an otherwise well-appearing infant. The characteristic "whoop" cough is not always present.
5. Infants with afebrile pneumonia are treated as outpatients. Hospitalization is required for infants with inability to eat, respiratory distress, or hypoxemia. Erythromycin (50 mg/kg/day divided QID) or clarithromycin [(Biaxin) 15 mg/kg/day PO bid] are drugs of choice.

V. **Pneumonia in Toddlers and Preschoolers**

A. **Afebrile/Well-appearing Toddlers and Preschoolers**

1. The majority of pneumonia among in this age group is caused by viral infection with RSV, parainfluenza, adenovirus, or influenza, or by other viruses (enterovirus, rhinovirus), or with Mycoplasma pneumoniae.
2. A chest radiograph is usually not necessary.
3. This pneumonia and can usually be treated symptomatically, without antibiotic therapy.

B. **Febrile/Ill-appearing Toddlers and Preschoolers**

1. Pneumococcus is the most common bacterial pathogen causing febrile pneumonia in children and adults. The syndrome is characterized by acute onset of high, spiking fever, with chills, cough and sputum production. Crackles may be heard on auscultation, leukocytosis is frequent, and the chest radiograph will demonstrate lobar pneumonia. A small parapneumonic effusion is common.
2. Neisseria meningitidis infection also may present with the picture of febrile pneumonia; however, signs of meningococcemia, such as petechiae and sepsis syndrome, are usually present.
3. Outpatient therapy is appropriate for otherwise healthy, alert, cooperative children. Pneumococcus usually is sensitive to amoxicillin (40 mg/kg/day divided TID).
4. If the patient does not tolerate oral medication, intramuscular ceftriaxone (50 mg/kg with lidocaine) may be given initially.
5. Severely ill patients (ie, hypoxemia, respiratory insufficiency) require parenteral therapy. Intravenous ampicillin (100 mg/kg/day divided QID) is initiated while blood cultures, sputum Gram stain and culture, and blood count are obtained. Cefuroxime (150 mg/kg/day divided TID) is an acceptable alternative.
6. If hypoxemia is present, oxygen is given by nasal cannula. Chest physiotherapy is not helpful in routine lobar pneumonia.

VI. **Pneumonia in Children and Adolescents**

A. Atypical bacteria, Mycoplasma pneumoniae and C pneumoniae, are responsible for a significant proportion of afebrile lower respiratory tract disease in adolescents and school-age children.

B. Atypical pneumonia may be associated with a prodrome of headache and abdominal symptoms. Onset usually is insidious with low grade fever. Specific serologic studies for Mycoplasma and Chlamydia are available, but they are usually not helpful in choosing an initial treatment.

C. These bacteria are susceptible to erythromycin. Erythromycin base and erythromycin stearate often cause gastric upset. The estolate form (Ilosone) often is tolerated better than the ethylsuccinate form (EES). The recommended dose of the estolate form (Ilosone) is 30-40 mg/kg/day divided q 8-12 hours. If GI upset occurs, a lower dose can be used or the drug can be administered after clear liquids or crackers.

D. Clarithromycin (Biaxin), 15 mg/kg/day PO bid, is also effective against these pathogens.

E. Tetracycline (25-50 mg/kg/day divided QID) and doxycycline (2-4 mg/kg/day divided BID) also are effective against Mycoplasma and Chlamydia and can be used in children older than 8 years. §