PEDIATRIC INFECTIOUS DEISEASE

Seyed Bahador Mirrahimi
Pharmd, IBCPS.
Assistant Professor
Shahid Beheshti University of Medical Sciences

INTRODUCTION

Clinicians are concerned that an untreated minor infection may progress to a life-threatening illness if appropriate treatment is not given.

unnecessary treatment with antimicrobial agents may lead to a serious problem emergence of antimicrobial resistant organisms.

Accurate diagnosis of infectious and noninfectious diseases and providing specific treatment only as indicated reduce the unnecessary use of antibiotics.

LOCALIZING MANIFESTATIONS OF INFECTION

SITE	LOCALIZING SYMPTOMS	LOCALIZING SIGNS*
Eye	Eye pain, double vision, photophobia, conjunctival discharge	Periorbital erythema, periorbital edema, drainage, chemosis, limitation of extraocular movements
Ear	Ear pain, drainage	Red bulging tympanic membrane, drainage from ear canal
Upper respiratory tract	Rhinorrhea, sore throat, cough, drooling, stridor, trismus, sinus pain, tooth pain, hoarse voice	Nasal congestion, pharyngeal erythema, enlarged tonsils with exudate, swollen red epiglottis, regional lymphadenopathy
Lower respiratory tract	Cough, chest pain, dyspnea, sputum production, cyanosis	Tachypnea, crackles, wheezing, localized diminished breath sounds, intercostal retractions
Gastrointestinal tract	Nausea, vomiting, diarrhea, abdominal pain (focal or diffuse), anorexia, weight loss	Hypoactive or hyperactive bowel sounds, abdominal tenderness (focal or generalized), hematochezia
Liver	Anorexia, vomiting, dark urine, light stools	Jaundice, hepatomegaly, hepatic tenderness, bleeding diatheses, coma
Genitourinary tract	Dysuria, frequency, urgency, flank or suprapubic pain, vaginal discharge	Costovertebral angle or suprapubic tenderness, cervical motion and adnexal tenderness
Central nervous system	Lethargy, irritability, headache, neck stiffness, seizures	Nuchal rigidity, Kernig sign, Brudzinski sign, bulging fontanelle, focal neurologic deficits, altered mental status, coma
Cardiovascular	Dyspnea, palpitations, fatigue, exercise intolerance, chest pain	Tachycardia, hypotension, cardiomegaly, hepatomegaly, splenomegaly, crackles, petechiae, Osler nodes, Janeway lesions, Roth spots, new or change in murmur, distended neck veins, pericardial friction rub, muffled heart sounds
Musculoskeletal	Limp, bone pain, limited function (pseudoparalysis)	Local swelling, erythema, warmth, limited range of motion, point bone tenderness, joint line tenderness

FEVER

FEVER WITHOUT A FOCUS:

- Core body temperature is normally maintained within 1° C to 1.5° C in a range of 37° C to 38° C.

- **Fever of short duration**
  - accompanied by localizing signs and symptoms, in which a diagnosis can often be established by clinical history and physical examination

- **Fever without localizing signs (fever without a focus):**
  - frequently occurring in children younger than 3 years of age, in which a history and physical examination fail to establish a cause

- **Fever of unknown origin (FUO):**
  - defined as fever for >14 days without an identified etiology despite history, physical examination, and routine laboratory tests or after 1 week of hospitalization and evaluation

FEVER IN INFANTS YOUNGER THAN 3 MONTHS OF AGE

Fever or **temperature instability** in infants younger than 3 months of age is associated with a higher risk of **serious bacterial infections:**

- **Bacteremia**
- **Urinary tract infection (UTI)** *(E. coli)*,
- **pneumonia** *(S. pneumoniae,* GBS, or *Staphylococcus aureus*)
- **meningitis** (S. *pneumoniae, H. influenzae* type b, GBS, *N. meningitidis*, herpes simplex virus [HSV], enteroviruses),
- **bacterial diarrhea** *(Salmonella, Shigella, E. coli)*
- **Osteomyelitis**
- **septic arthritis**

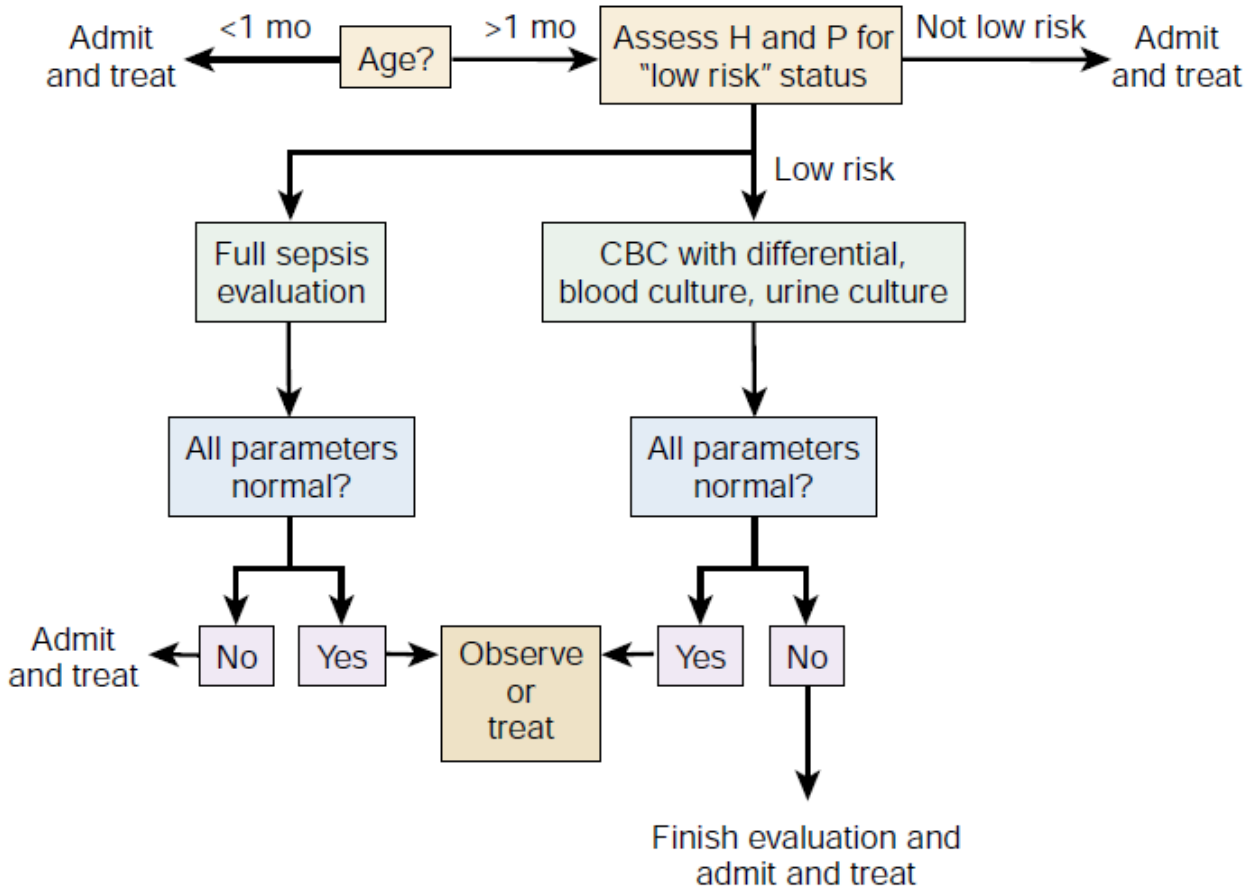
Febrile infants **<3 months** of age who appear **ill**, especially if follow-up is uncertain, and **all febrile infants <4 weeks** of age should be admitted to the hospital for empirical antibiotics pending culture results.

FEVER IN CHILDREN 3 MONTHS TO 3 YEARS OF AGE

Children between 2 months and 3 years of age are at increased risk for infection with organisms with polysaccharide capsules:

- *S. pneumoniae,*
- *H. influenzae,*
- *N. meningitides*
- nontyphoidal *Salmonella*

FEVER IN CHILDREN 3 MONTHS TO 3 YEARS OF AGE



ENCEPHALITIS

an inflammatory process of the brain parenchyma leading to cerebral dysfunction.

It is usually an acute process but may be a post infectious encephalomyelitis, a chronic degenerative disease, or a slow viral infection.

mechanisms: (1) direct infection of the brain parenchyma or (2) an apparent immune-mediated response several days after the infection.

Acute disseminated encephalomyelitis (ADEM) is the abrupt development of multiple neurologic signs related to an inflammatory, demyelinating disorder of the brain and spinal cord.

- follows childhood viral infections (such as measles and chickenpox) or vaccinations and resembles multiple sclerosis clinically.

EPIDEMIOLOGY

AGENT	FREQUENCY
Enterovirus and parechovirus	+++
Herpes simplex viruses (HSV 1, 6, 7)	++
Arthropod-borne viruses (especially West Nile virus, St. Louis, California, LaCrosse, and equine encephalitis viruses)	++
Epstein-Barr virus	+
Adenovirus	+
Human immunodeficiency virus	+
Borrelia burgdorferi (Lyme disease)	+
Bartonella henselae (cat-scratch disease)	+
Mycoplasma pneumoniae	+
Rickettsia rickettsii	+

CLINICAL MANIFESTATIONS

Prodrome of several days of nonspecific symptoms:

- Sore throat, fever, headache, and abdominal complaints

Followed by the characteristic symptoms of:

- progressive lethargy,
- Behavioral changes,
- neurologic deficits.
- Seizures are common at presentation.

TREATMENT

With the exception of HSV, varicella-zoster virus, cytomegalovirus, and HIV, there is no specific therapy for viral encephalitis.

Management is supportive:

- aggressive therapy for seizures,
- timely detection of electrolyte abnormalities
- airway monitoring and protection
- Reduction of increased intracranial pressure
- maintenance of adequate cerebral perfusion pressure.

THE COMMON COLD

The common cold is a viral infection with prominent symptoms of rhinorrhea and nasal obstruction, absent or mild fever, and no systemic manifestations.

The viruses primarily associated with colds are rhinoviruses and, less commonly, coronaviruses.

Viral infection of nasal epithelium causes an acute inflammatory response with mucosal infiltration by inflammatory cells and release of cytokines. The inflammatory response is partly responsible for many of the symptoms.

EPIDEMIOLOGY

Colds occur throughout the year with peak incidence from early fall through late spring

Young children have an average of 6 to 7 colds each year, and 10% to 15% of children have at least 12 colds each year.

The annual number of colds decreases with age, to two to three colds each year by adulthood.

Children in out-of-home day care during the first year of life have 50% more colds than children cared for at home only.

- This difference diminishes during subsequent years in day care.

CLINICAL MANIFESTATIONS

develop 1 to 3 days after viral infection and include nasal obstruction, rhinorrhea, sore or scratchy throat, and occasional nonproductive cough

Colds usually persist about 1 week, although 10% last 2 weeks.

There is often a change in the color or consistency of nasal secretions, which is no indicative of sinusitis or bacterial superinfection.

TREATMENT

There is no specific therapy for the common cold.

Antibacterial therapy is not beneficial.

Management consists of symptomatic therapies.

Antihistamines, decongestants, and combination antihistamine-decongestants are **not recommended for children younger than 6 years of age** because of adverse effects and lack of benefits.

Low-grade fever is seen with colds, particularly in the first few days of illness and can be treated with antipyretic medications.

Cough suppressants and **expectorants** have not been shown to be beneficial.

VitaminC and inhalation of warm, humidified air are no more effective than placebo.

The benefit of zinc lozenges or sprays has been inconsistent.

COMPLICATIONS AND PROGNOSIS

Otitis media is the most common complication

- in 5% to 20% of children with a cold

bacterial sinusitis:

- if rhinorrhea or daytime cough persists without improvement for at least 10 to 14 days
- if severe signs of sinus involvement develop, such as fever, facial pain, or facial swelling

Colds may lead to exacerbation of asthma

may result in inappropriate antibiotic treatment.

PREVENTION

There are no proven methods for prevention of colds other than good hand washing and avoiding contact with infected persons.

No significant effect of vitamin C or Echinacea for prevention of the common cold has been confirmed.

PHARYNGITIS-ETIOLOGY

AGENT	SYNDROME OR DISEASE	ESTIMATED PROPORTION OF ALL PHARYNGITIS (%)
	BACTERIAL	
Group A streptococcus (*Streptococcus pyogenes*)	Pharyngitis, tonsillitis	15–30
Group C streptococcus	Pharyngitis, tonsillitis	1–5
Arcanobacterium haemolyticum	Pharyngitis (Scarlet fever-like syndrome)	0.5–3
Fusobacterium necrophorum	Lemierre syndrome	Unknown
Other (e.g., *Corynebacterium diphtheriae*)	Pharyngitis, laryngitis	<5
VIRAL		
Rhinoviruses (>100 types)	Common cold	20
Coronaviruses (>4 types)	Common cold	>5
Adenoviruses (types 3, 4, 7, 14, 21)	Pharyngoconjunctival fever, acute respiratory disease	5
Herpes simplex viruses (types 1 and 2)	Gingivitis, stomatitis, pharyngitis	4
Parainfluenza viruses (types 1–4)	Common cold, croup	2
Influenza viruses (types A and B)	Influenza	2
Epstein-Barr virus	Mononucleosis	Unknown
Coxsackie virus	Herpangina	Unknown

EPIDEMIOLOGY

Sore throat is the primary symptom in approximately one third of upper respiratory tract illnesses.

Streptococcal pharyngitis is relatively uncommon before 2 to 3 years of age.

Streptococcal pharyngitis occurs throughout the year in temperate climates, with a peak during the winter and early spring.

The illness often spreads to siblings and classmates.

Viral infections generally spread via close contact with an infected person and peak during winter and spring.

CLINICAL MANIFESTATIONS

Pharyngeal inflammation causes cough, sore throat, dysphagia, and fever.

If involvement of the tonsils is prominent, the term **tonsillitis** or **tonsillopharyngitis** is often used.

The onset of streptococcal pharyngitis is often **rapid** and associated with **prominent sore throat** and **moderate to high fever**.

Headache, nausea, vomiting, and abdominal pain are frequent.

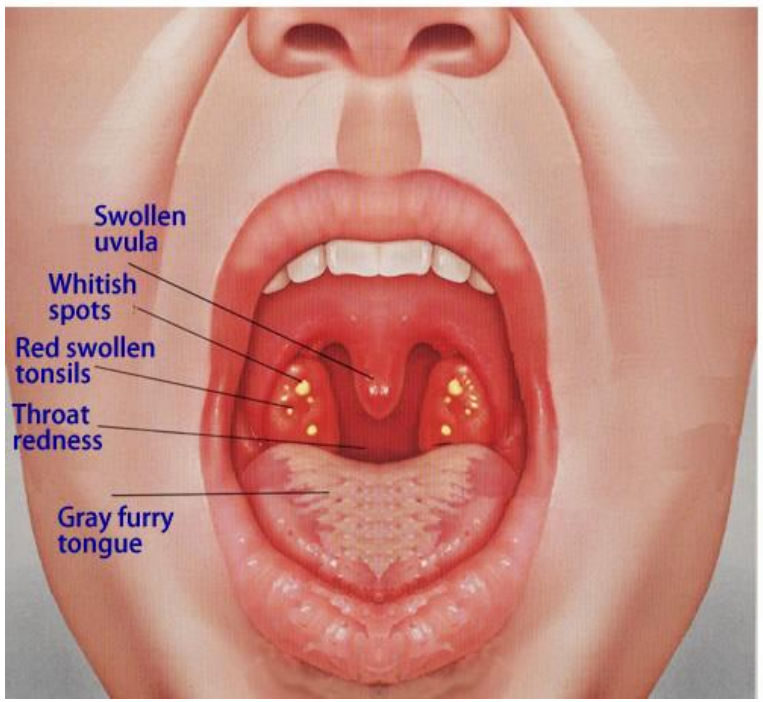
The tonsils are enlarged and covered with a yellow, blood tinged exudate.

Many children, present with only mild pharyngeal erythema without tonsillar exudate or cervical lymphadenitis.

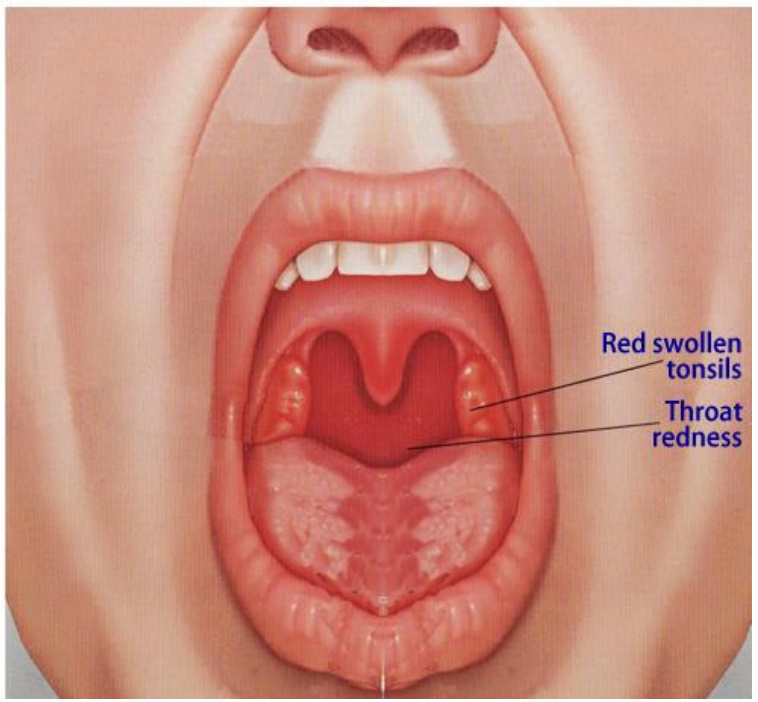
Conjunctivitis, cough, coryza, hoarseness, or ulcerations suggest a viral etiology.

The diagnosis of streptococcal pharyngitis **cannot be made on clinical features** alone.

Bacterial



Viral



TREATMENT

Even if untreated, most episodes of streptococcal pharyngitis resolve uneventfully over a few days.

Early antimicrobial therapy accelerates clinical recovery by 12 to 24 hours.

The major benefit of antimicrobial therapy is prevention of acute **rheumatic fever**

- the latent (incubation) period of acute rheumatic fever is relatively long (1 to 3 weeks), treatment instituted **within 9 days of illness** is virtually 100% successful in preventing rheumatic fever.

Cephalosporins have superior pharyngeal bacterial eradication rates compared to penicillins.

- staphylococci or anaerobes in the pharynx produce β-lactamase

TREATMENT

Table 103-2	Antimicrobial Treatment of Group A Streptococcal Pharyngitis
Penicillin	
Oral penicillin V (2–3 times daily for 10 days) 10 mg/kg/dose, maximum dose 250 mg/dose	
Intramuscular benzathine penicillin G (single dose)	
For children ≤27 kg: 600,000 U	
For larger children and adults: 1.2 million U	
For persons allergic to penicillin	
Cephalexin 20 mg/kg/dose BID, maximum dose 500 mg/dose × 10 days	
Cefadroxil 30 mg/kg OD maximum, maximum dose 1 g × 10 days	
Clindamycin 7 mg/kg/dose TID, maximum dose 300 mg/dose × 10 days	
For persons allergic to β-lactams	
Erythromycin	
Erythromycin ethyl succinate: 40–50 mg/kg/day (max 1 g/day) in 3–4 doses for 10 days	
Erythromycin estolate: 20–40 mg/kg/day in 2–4 doses (max 1 g/day) for 10 days	
Azithromycin, children: 12 mg/kg orally once daily for 5 days (to maximum adult dose); adults: 500 mg orally on day 1, then 250 mg orally on days 2–5	

SINUSITIS

ETIOLOGY:

Obstruction to mucociliary flow, such as mucosal edema resulting from the common cold, impedes sinus drainage and predisposes to bacterial proliferation.

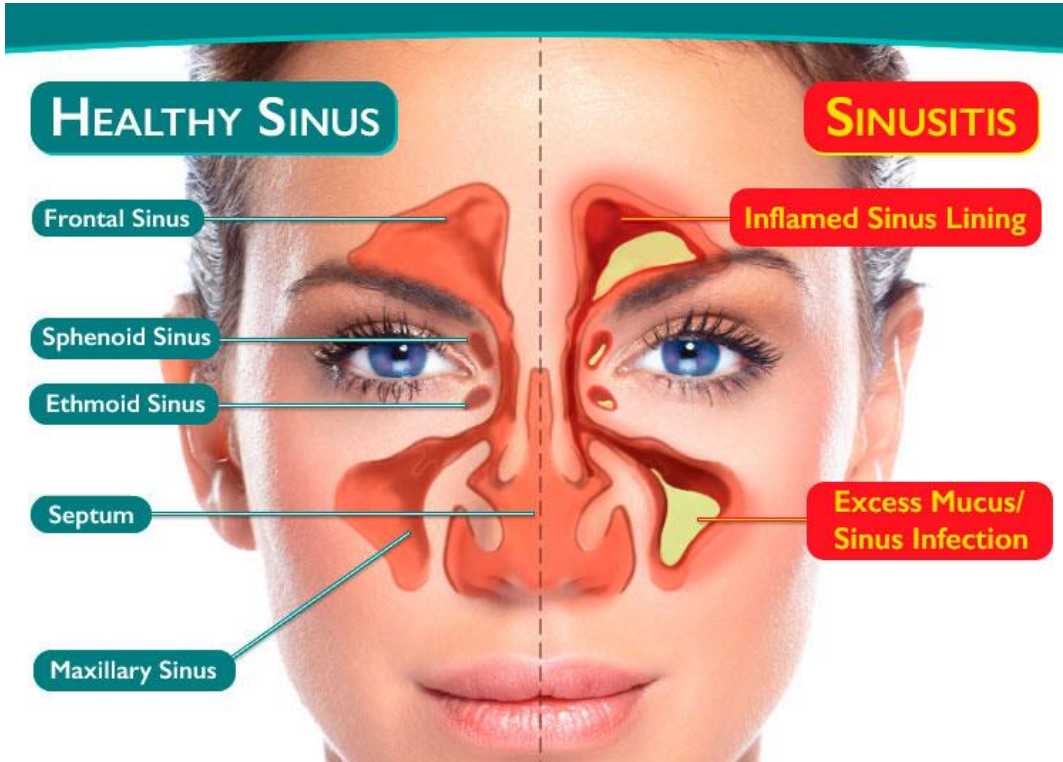
The bacterial causes are:

- *Streptococcus pneumoniae,*
- *Haemophilus influenzae,*
- *Moraxella catarrhalis,*
- *Staphylococcus aureus*
- group A streptococcus.

EPIDEMIOLOGY

The true incidence of sinusitis is unknown.

The common cold is the major predisposing factor for developing sinusitis at all ages.



CLINICAL MANIFESTATIONS

persistent,mucopurulent, unilateral or bilateral rhinorrhea,

nasal stuffiness,

cough, especially at night.

Less common symptoms:

- a nasal quality to the voice,
- halitosis,
- facial swelling,
- facial tenderness and pain,
- headache.
- Sinusitis may exacerbate asthma.

TREATMENT

Amoxicillin-clavulanate for 10 to 14 days is recommended as first-line therapy of sinusitis in children.

High-dose therapy is recommended for children at increased risk for resistant bacteria:

- antibiotic treatment in the preceding 1 to 3 months,
- day care attendance,
- age <2 years,
- high rates of antimicrobial resistance locally

Levofloxacin is recommended for children with type I hypersensitivity to penicillins. Clindamycin plus a third generation cephalosporin (cefixime, cefpodoxime) is recommended for children with non-type I hypersensitivity.

OTITIS MEDIA

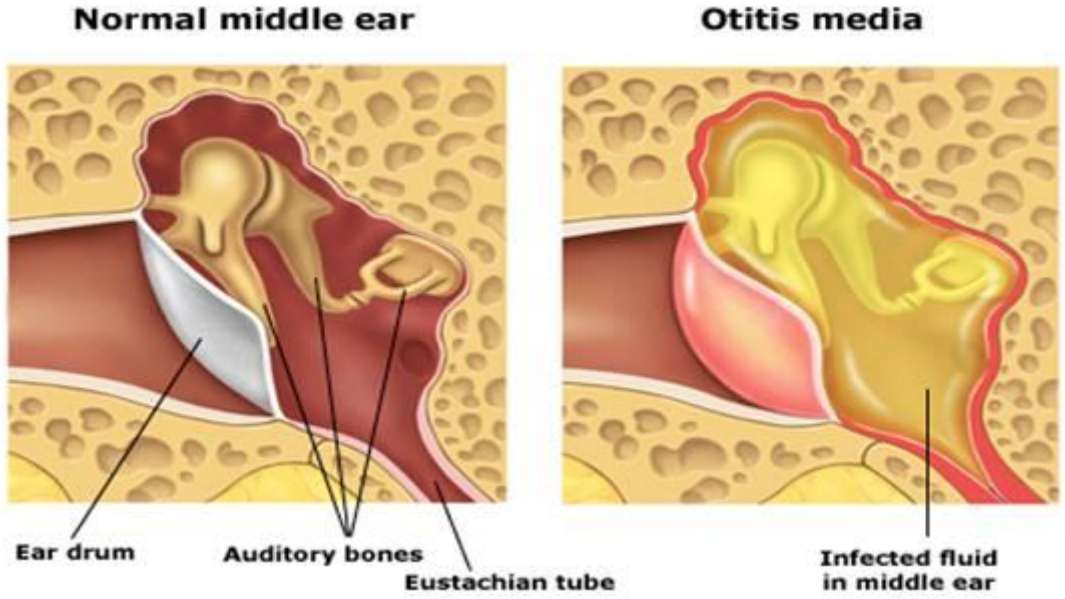
ETIOLOGY

Otitis media (OM) is a suppurative infection of the middle ear cavity. Bacteria gain access to the middle ear when the normal patency of the eustachian tube is blocked by upper airway infection or hypertrophied adenoids.

Both bacteria and viruses can cause OM.

- *Streptococcus pneumoniae*
- *Haemophilus influenzae,*
- *Moraxella catarrhalis,* and,
- group A streptococcus

S. pneumoniae is **resistant** to penicillin.



EPIDEMIOLOGY

Diseases of the middle ear account for approximately one third of office visits to pediatricians.

The peak incidence of acute OM is between **6 and 15 months** of life.

OM is more common in boys and in patients of lower socioeconomic status.

peak in January and February

The major risk factors for acute OM are:

- young age,
- lack of breastfeeding,
- passive exposure to tobacco smoke,
- increased exposure to infectious agents (day care).

presence of six or more acute OM episodes in the first 6 years of life, at least 12% of children in the general population have **recurrent OM** and would be considered **otitis-prone.**

CLINICAL MANIFESTATIONS

In infants:

- fever, irritability, and poor feeding.

In older children and adolescents:

- Fever
- **otalgia** (acute ear pain)
- **otorrhea** (ear drainage)

Table 105-1	Definition of Acute Otitis Media (AOM)
A diagnosis of AOM requires:	
History of acute onset of signs and symptoms	
Presence of middle ear effusion	
Signs and symptoms of middle ear inflammation	
The definition of AOM includes all of the following:	
Recent, usually abrupt, onset of signs and symptoms of middle ear inflammation and middle ear effusion	
The presence of middle ear effusion that is indicated by any of the following:	
Bulging of the tympanic membrane	
Limited or absent mobility of the tympanic membrane	
Air-fluid level behind the tympanic membrane	
Otorrhea	
Signs or symptoms of middle ear inflammation as indicated by either:	
Distinct erythema of the tympanic membrane	
Distinct otalgia (discomfort clearly referable to the ear that results in interference with or precludes normal activity or sleep)	

TREATMENT

The recommended first-line therapy is amoxicillin (80 to 90 mg/kg/day in two divided doses) for most children with:

- a certain diagnosis of acute OM
- uncertain diagnosis but who are younger than 2 years of
- fever greater than 39° C
- otalgia

Children with an uncertain diagnosis who are older than 2 years of age may be **observed if appropriate follow- up can be arranged.**

Failure of initial therapy with amoxicillin **at 3 days** suggests infection with β-lactamase-producing organism:

- high-dose amoxicillin-clavulanate (amoxicillin 80 to 90 mg/kg/day),
- Cefuroxime axetil,
- ceftriaxone (50 mg/kg intramuscularly in daily doses for 1 to 3 days).
  - Intramuscular ceftriaxone is especially appropriate for children younger than 3 years of age with vomiting that precludes oral treatment..

Acetaminophen and ibuprofen are recommended for fever.

Decongestants or antihistamines are not effective.

PREVENTION

continue exclusive breastfeeding as long as possible

risks of *bottle-propping* and of children taking a bottle to bed.

The home should be a smoke-free environment.

Children identified at high-risk:

prolonged courses of antimicrobial prophylaxis:

- Amoxicillin (20 to 30 mg/kg/day)

CROUP (LARYNGOTRACHEOBRONCHITIS)

Croup, or laryngotracheobronchitis, is the most common infection of the middle respiratory tract

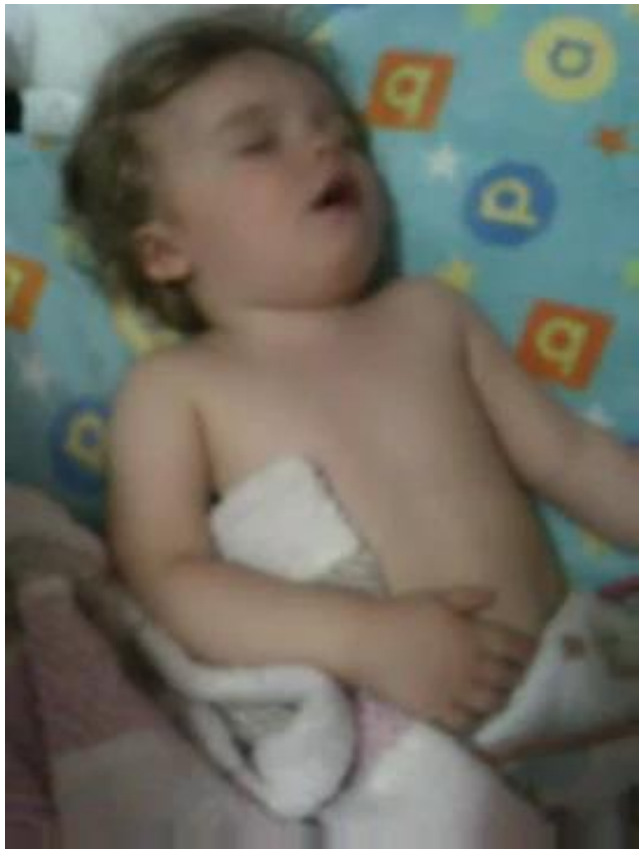
The most common causes of croup are parainfluenza viruses (types 1, 2, 3, and 4) and respiratory syncytial virus.

Croup is most common in children 6 months to 3 years of age, with a peak in fall and early winter.

CLINICAL MANIFESTATIONS

The manifestations of croup are a harsh cough described as **barking** or **brassy,** hoarseness, inspiratory stridor, low-grade fever, and respiratory distress that may develop slowly or quickly.

Stridor is a harsh, high-pitched respiratory sound produced by turbulent airflow



TREATMENT

Oral or intramuscular **dexamethasone** for children with mild, moderate, or severe croup reduces symptoms, the need for hospitalization, and shortens hospital stays.

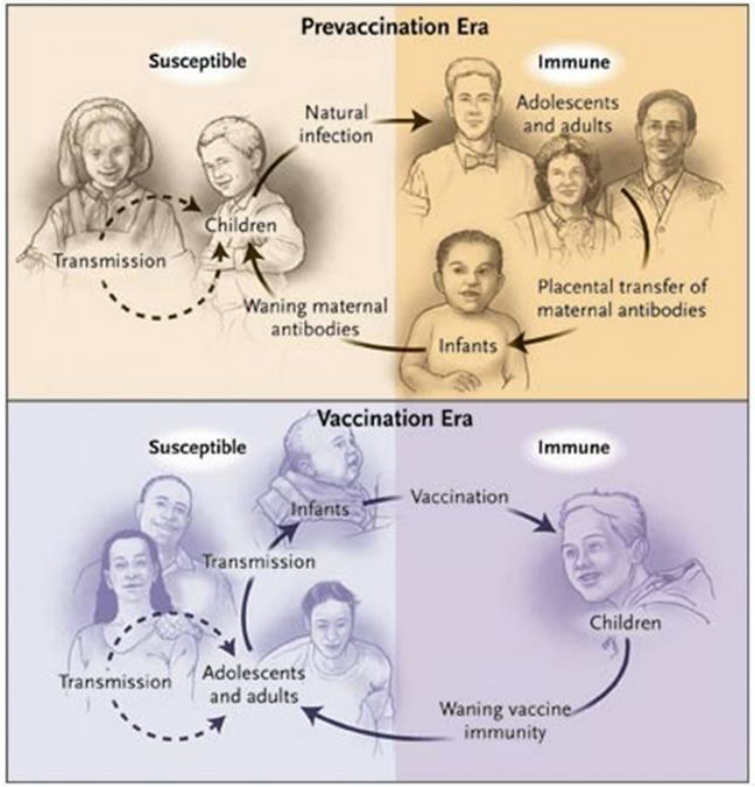
- Dexamethasone (0.6 to 1 mg/kg) may be given once intramuscularly
- Dexamethasone (0.6 to 1 mg/kg) once orally.
- prednisolone (2 mg/kg per day) may be given orally in two to three divided doses.

Hospitalization is often required for children with stridor at rest.

PERTUSSIS

Classic pertussis (whooping cough) is caused by Bordetella pertussis,

- a gram-negative pleomorphic bacillus with fastidious growth requirements.
- B. pertussis infects only humans and is transmitted person to person by coughing.



EPIDEMIOLOGY

The typical incubation period is 7-10 days but can range between 5 and 21 days.

Pertussis incidence peaks among those less than 6 months of age

- too young to be completely immunized
- most likely to have severe complications
  - approximately 150 cases per 100,000

CLINICAL MANIFESTATIONS

The progression of the disease is divided into catarrhal, paroxysmal, and convalescent stages.

catarrhal stage:

- nonspecific signs (increased nasal secretions and low-grade fever) lasting 1-2 weeks

paroxysmal stage:

- Coughing occurs in **paroxysms** during expiration, causing young children to lose their breath. Posttussive emesis is common.
  - the most distinctive stage of pertussis and lasts 2-4 weeks.

convalescent stage:

- gradual resolution of symptoms over 1-2 weeks.

residual cough may persist for months, especially with physical stress or respiratory irritants.

TREATMENT

Macrolide antibiotics (azithromycin, clarithromycin, or erythromycin) are recommended for treatment.

Azithromycin is preferred in neonates due to the association between erythromycin

treatment and the development of pyloric stenosis.

- Treatment during the catarrhal phase eradicates nasopharyngeal carriage of organisms within 3-4 days and may lessen symptom severity.
- Treatment in the paroxysmal stage does not alter the course of illness but decreases the potential for spread to others.

PREVENTION

acellular pertussis components given as a vaccine in combination with the tetanus and diphtheria toxoids (DTaP).

Underimmunized close contacts under 7 years of age should receive a booster dose of DTaP (unless a booster dose has been given within the preceding 3 years), whereas those 7-10 years of age should receive Tdap.

All close contacts should receive prophylactic antibiotics for 5 days (azithromycin) or 7-14 days (clarithromycin or erythromycin, duration based on age).

URINARY TRACT INFECTION

Urinary tract infections (UTIs) include:

- **cystitis** (infection localized to the bladder),
- **pyelonephritis** (infection of the renal parenchyma, calyces, and renal pelvis)
- **renal abscess,** which may be intrarenal or perinephric.

Escherichia coli, ascending from bowel flora, accounts for 90% of first infections and *75%* of recurrent infections.

- *Klebsiella,*
- *Proteus,*
- *Enterococcus,*
- *Pseudomonas.*
- *Staphylococcus saprophyticus*

EPIDEMIOLOGY

Approximately 8% of girls and 2% of boys have a UTI by 11 years of age.

The lifetime incidence of UTI in females is about 30% compared to only 1% in males.

Approximately 75% of infants **younger than 3 months** of age with bacteriuria are **male** compared with only **10% between 3 and 8 months** of age. **After 12 months** of age, UTI in healthy children usually is seen **in girls.**

Vesicoureteral reflux, whether primary (70% of cases) or secondary to urinary tract obstruction, predisposes to chronic infection and renal scarring

CLINICAL MANIFESTATIONS

The symptoms and signs of UTI vary markedly with age:

- Failure to thrive
- feeding problems
- Fever

At 2 years of age, children begin to show the classic signs of UTI:

- urgency,
- dysuria,
- frequency,
- abdominal or back pain.

LABORATORY STUDIES

in infants and young children:

- the presence of **both pyuria** and at least 50,000 CFU/mL of a **single pathogenic organism**.
- Urinalysis showing **pyuria** (leukocyturia of >10 white blood cells [WBCs]/mm3) suggests infection in infants

older children and adolescents:

- >100,000 CFU/mL indicates infection

Urine obtained by midstream,clean-catch technique for older children and adolescents is an appropriate collection method,

transurethral **catheterization** is the appropriate method for younger children and infants in which antibiotics are being started.

Perineal bags for urine collection are prone to contamination and are not recommended for urine collection for culture.

- urine can be collected by the most convenient method for urinalysis and if suggestive of infection, collect urine by catheterization prior to starting antibiotics

TREATMENT

Empirical therapy should be initiated for symptomatic children and for all children with a urine culture confirming UTI.

For an older child who does not appear ill but has a positive urine culture, oral antibiotic therapy should be initiated.

For a child with suspected UTI who appears toxic, appears dehydrated, or is unable to retain oral fluids, initial antibiotic therapy should be administered parenterally.

Neonates with UTI are treated for 10 to 14 days with parenteral antibiotics because of the higher rate of bacteremia

Older children with UTI are treated for 7 to 14 days

Parenteral antibiotics should be continued until there is clinical improvement (typically 24 to 48 hours).

Specific antibiotic therapy should be guided by the local antimicrobial susceptibility patterns and the **results of the patient's urine cultures** because of increasing problems related to antimicrobial resistance.

TREATMENT

IV therapy options for empiric use:

- Ceftriaxone 75-100 mg/kg IV once daily
- Ceftazidime 50 mg/kg IV every 8 h
- Cefotaxime 50 mg/kg IV every 8 h

Oral options:

- Amoxicillin-Clavulanate 10-15 mg/kg po every 8 h
- Trimethoprim/Sulfamethoxazole 3-6 mg trimethoprim component po every 12 h
- Cephalexin 15-30 mg/kg po every 8 h
- Cefixime 8 mg/kg po once daily

PREVENTION

Primary prevention is achieved by promoting good hygiene and managing underlying risk factors for UTI:

- chronic constipation,
- Encopresis
- urinary incontinence.

Acidification of the urine with cranberry juice is not recommended as the sole means of preventing UTI in children at high risk.

THANK YOU!