Clinical features, evaluation, and diagnosis of croup

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INTRODUCTION — Croup is a respiratory illness characterized by inspiratory stridor, cough, and hoarseness. These symptoms result from inflammation in the larynx and subglottic airway. A barking cough is the hallmark of croup among infants and young children, whereas hoarseness predominates in older children and adults. Although croup usually is a mild and self-limited illness, significant upper airway obstruction, respiratory distress, and, rarely, death, can occur.

The clinical features, evaluation, and diagnosis of croup will be discussed here. The management of croup is discussed separately. (See "Approach to the management of croup" and "Pharmacologic and supportive interventions for croup".)

DEFINITIONS — The term croup has been used to describe a variety of upper respiratory conditions in children, including laryngitis, laryngotracheitis, laryngotracheobronchitis, bacterial tracheitis, or spasmodic croup [1]. These terms are defined below. In the past, the term croup also has been applied to laryngeal diphtheria (diphtheritic or membranous croup) which is discussed separately. (See "Epidemiology and clinical features of diphtheria" and "Diagnosis and treatment of diphtheria".)

Throughout this review, the term croup will be used to refer to laryngotracheitis. Laryngotracheobronchitis, laryngotracheobronchopneumonitis, bacterial tracheitis, and spasmodic croup are designated specifically as such.

- Laryngitis refers to inflammation limited to the larynx and manifests itself as hoarseness [2]. It usually occurs in older children and adults and, similar to croup, is frequently caused by a viral infection. The etiology, management, and evaluation of other causes of hoarseness are discussed in detail separately. (See "Etiology and management of hoarseness in children" and "Evaluation of the child with hoarseness".)
- Laryngotracheitis (croup) refers to inflammation of the larynx and trachea. Although lower airway signs are absent, the typical barking cough will be present.
- Laryngotracheobronchitis (LTB) occurs when inflammation extends into the bronchi, resulting in lower airway signs (e.g., wheezing, rales, air trapping, increased tachypnea) and sometimes more severe illness than laryngotracheitis alone. This term commonly is used interchangeably with laryngotracheitis, and the entities are often indistinct clinically. Further extension of inflammation into the lower airways results in laryngotracheobronchopneumonitis, which sometimes can be complicated by bacterial superinfection. Bacterial superinfection can be manifest as pneumonia, bronchopneumonia, or bacterial tracheitis.
- Bacterial tracheitis (also called bacterial croup) describes bacterial infection of the subglottic trachea, resulting in a thick, purulent exudate, which causes symptoms of upper airway obstruction (picture 1). The bronchi and lungs are typically involved as well (i.e., bacterial tracheobronchitis). Bacterial tracheitis may occur as a complication of viral respiratory infections (usually those which manifest themselves as LTB or laryngotracheobronchopneumonitis) or as a primary bacterial infection. (See "Bacterial tracheitis in children: Clinical features and diagnosis").
- Spasmodic croup is characterized by the sudden onset of inspiratory stridor at night, short duration (several hours), and sudden cessation. This is often in the setting of a mild upper respiratory infection, but without fever or inflammation. A striking feature of spasmodic croup is its recurrent nature, thus the alternate descriptive term: "frequently recurrent croup." Because of some clinical overlap with atopic diseases, it is sometimes referred to as "allergic croup."

**ETIOLOGY** — Croup is usually caused by viruses. Bacterial infection may occur secondarily, as described above.

Parainfluenza virus type 1 is the most common cause of acute laryngotracheitis, especially the fall and winter epidemics [3-5]. Parainfluenza type 2 sometimes causes croup outbreaks, but usually with milder disease than type 1. Parainfluenza type 3 causes sporadic cases of croup that often are more severe than those due to types 1 and 2. The microbiology, pathogenesis, and epidemiology of parainfluenza infections are discussed separately. (See "Parainfluenza viruses in children").

A number of other viruses that typically cause lower respiratory tract disease also can cause upper respiratory tract symptoms, including croup, as described below [5].
• RSV and adenoviruses are relatively frequent causes of croup. The laryngotracheal component of disease is usually less significant than that of the lower airways. (See "Respiratory syncytial virus infection: Clinical features and diagnosis" and "Diagnosis and treatment of adenovirus infection in children").

• Measles is an important cause of croup in areas where measles remains prevalent. (See "Clinical presentation and diagnosis of measles").

• Influenza virus is a relatively uncommon cause of croup. However, children hospitalized with influenzal croup tend to have longer hospitalization and greater risk of readmission for relapse of laryngeal symptoms than those with parainfluenzal croup. (See "Clinical features and diagnosis of influenza in children").

• Rhinoviruses, enteroviruses (especially Coxsackie types A9, B4, and B5, and echovirus types 4, 11, and 21), and herpes simplex virus are occasional causes of sporadic cases of croup that are usually mild. (See appropriate topic reviews).

• Metapneumoviruses cause primarily lower respiratory tract disease similar to RSV, but upper respiratory tract symptoms have been described in some patients [6]. (See "Human metapneumovirus infections").

Croup also may be caused by bacteria. Mycoplasma pneumoniae has been associated with mild cases of croup. In addition, secondary bacterial infection may occur in children with laryngotracheitis, laryngotracheobronchitis, or laryngotracheobronchopneumonitis. The most common secondary bacterial pathogens include Staphylococcus aureus, Streptococcus pyogenes, and S. pneumoniae [1].

EPIDEMIOLOGY — Croup most commonly occurs in children 6 to 36 months of age. It is seen in younger infants (as young as three months) and in preschool children, but is rare beyond age six years [1,7]. It is more common in boys, with a male:female ratio of about 1.4:1 [1,7,8].

Most cases of croup occur in the fall or early winter, with the major incidence peaks coinciding with parainfluenza type 1 activity (often in October) and minor peaks occurring during periods of RSV or influenza virus activity.

Emergency department visits for croup are most frequent between 10:00 p.m. and 4:00 a.m. However, children seen for croup between noon and 6:00 p.m. are more likely to be admitted to the hospital [3,9].

Hospital admissions for croup have declined steadily since the late 1970s. In an analysis of data from the National Hospital Discharge Surveys from 1979 through 1997, the estimated number of annual hospitalizations for croup decreased from 48,900 to 33,500 [4]. Estimates of annual hospitalization rates for croup caused
by parainfluenza virus types 1 to 3 from 1994 to 1997 were 0.4 to 1.1 per 1000 children for children younger than one year and 0.24 to 0.61 per 1000 children for children between one and four years. Approximately one-half of these hospitalizations were attributed to parainfluenza type 1.

PATHOGENESIS — The viruses that cause croup typically infect the nasal and pharyngeal mucosal epithelia initially and then spread locally along the respiratory epithelium to the larynx and trachea.

The anatomic hallmark of croup is narrowing of the trachea in the subglottic region. This portion of the trachea is surrounded by a firm cartilaginous ring, such that any inflammation results in narrowing of the airway. In addition to this "fixed" obstruction, dynamic obstruction of the extrathoracic trachea below the cartilaginous ring may occur when the child struggles, cries, or becomes agitated. The dynamic obstruction occurs as a result of the combination of high negative pressure in the distal extrathoracic trachea and the floppiness of the tracheal wall in children.

Laryngoscopic evaluation of patients during acute laryngotracheitis shows redness and swelling of the lateral walls of the trachea. In severe cases, the subglottic airway may be reduced to a diameter of 1 to 2 mm. In addition to mucosal edema and swelling, fibrinous exudates and, occasionally, pseudomembranes, can build up on the tracheal surfaces and contribute to airway narrowing. The vocal cords and laryngeal tissues also can become swollen, and cord mobility may be impaired [2,10-12]. Autopsy studies in children with laryngotracheitis show infiltration of histiocytes, lymphocytes, plasma cells, and neutrophils into edematous lamina propria, submucosa, and adventitia of the larynx and trachea [13-15].

In spasmodic croup, findings on direct laryngoscopy demonstrate noninflammatory edema [10]. This suggests that there is no direct viral involvement of the tracheal epithelium.

Patients with bacterial tracheitis have a bacterial superinfection that causes thick pus to develop within the lumen of the subglottic trachea (picture 1). Ulcerations, pseudomembranes, and microabscesses of the mucosal surface occur. The supraglottic tissues usually are normal. (See "Bacterial tracheitis in children: Clinical features and diagnosis".)

Host factors — Only a small fraction of children with parainfluenza virus infections develop overt croup. This suggests that host (or genetic) factors play a role in the pathogenesis. Host factors that may contribute to the development of croup include functional or anatomic susceptibility to upper airway narrowing and variations in immune response.
Underlying host factors that predispose to clinically significant narrowing of the upper airway include:

- Anatomic narrowing of the airway, such as subglottic stenosis or laryngeal web
- Hyperactive airways, perhaps aggravated by atopy, as suggested in some children with spasmodic croup or recurrent croup \[16,17\]
- Acquired airway narrowing from respiratory tract papillomas (human papillomavirus) or post intubation scarring

The potential role of the immune response was demonstrated in studies that demonstrated increased production of parainfluenza virus-specific IgE and increased lymphoproliferative response to parainfluenza virus antigen, and diminished histamine-induced suppression of lymphocyte transformation responses to parainfluenza virus in children with parainfluenza virus and croup compared to those with parainfluenza virus without croup \[18,19\].

**CLINICAL PRESENTATION** — The clinical presentation of croup depends upon the specific croup syndrome and the degree of upper airway obstruction. Although croup usually is a mild and self-limited illness, specific features of the history and physical examination identify children who are seriously ill or at risk for rapid progression of disease. (See 'Evaluation' below.)

**Laryngotracheitis** — Laryngotracheitis typically occurs in children three months to three years of age \[2\]. The onset of symptoms is usually gradual, beginning with nasal irritation, congestion, and coryza. Symptoms generally progress over 12 to 48 hours to include fever, hoarseness, barking cough, and stridor. Respiratory distress increases as upper airway obstruction becomes more severe. Rapid progression or signs of lower airway involvement suggests a more serious illness. Symptoms typically persist for three to seven days with a gradual return to normal \[2\]. Deviations from this expected course should prompt consideration of diagnoses other than laryngotracheitis. (See 'Differential diagnosis' below.)

The degree of upper airway obstruction is evident on physical examination, as described below. In mild cases, the child is hoarse and has nasal congestion. There is minimal, if any, pharyngitis. As airway obstruction progresses, stridor develops, and there may be mild tachypnea with a prolonged inspiratory phase. The presence of stridor is a key element in the assessment of severity. Stridor at rest is a sign of significant upper airway obstruction. As upper airway obstruction progresses, the child may become restless or anxious. (See 'Severity assessment' below.)
When airway obstruction becomes severe, suprasternal, subcostal, and intercostal retractions may be seen. Breath sounds can be diminished. Agitation, which generally is accompanied by increased inspiratory effort, exacerbates the subglottic narrowing by creating negative pressure in the airway. This can lead to further respiratory distress and agitation.

Hypoxia and cyanosis can develop, as can respiratory fatigue from sustained increased respiratory effort. High respiratory rates also tend to correlate with the presence of hypoxia. Without intervention, the hypoxia or fatigue can sometimes lead to death.

**Spasmodic croup** — Spasmodic croup also occurs in children three months to three years of age [2]. In contrast to laryngotracheitis, spasmodic croup always occurs at night; the duration of symptoms is short, often with symptoms subsiding by the time of presentation for medical attention; and the onset and cessation of symptoms are abrupt. Fever is typically absent, but mild upper respiratory tract symptoms (eg, coryza) may be present. Episodes can recur within the same night and for two to four successive evenings [20]. A striking feature of spasmodic croup is its recurrent nature, thus the alternate descriptive term: "frequently recurrent croup." There may be a familial predisposition to spasmodic croup, and it may be more common in children with a family history of allergies [16].

Early in the clinical course, spasmodic croup may be difficult to distinguish from laryngotracheitis. As the course progresses, the episodic nature of spasmodic croup and relative wellness of the child between attacks differentiate it from classic croup, in which the symptoms are continuous.

Although the initial presentation can be dramatic, the clinical course is usually benign. Symptoms are almost always relieved by comforting the anxious child and administering humidified air. Rarely, children may benefit from treatment with corticosteroids and/or nebulized epinephrine [21]. Other therapies generally are not indicated [2]. (See "Approach to the management of croup".)

**Bacterial tracheitis** — Bacterial tracheitis may present as a primary or secondary infection [22]. In primary infection, there is acute onset of symptoms of upper airway obstruction with fever and toxic appearance. In secondary infection, there is marked worsening during the clinical course of viral laryngotracheitis, with high fever, toxic appearance, and increasing respiratory distress secondary to tracheal obstruction from purulent secretions. In both of these presentations, signs of lower airway disease such as rales and wheezes may be present. However, the upper airway obstruction is the more clinically
significant manifestation [2,23]. (See "Bacterial tracheitis in children: Clinical features and diagnosis").

**Recurrent croup** — A child who has had recurrent episodes of classic viral croup may have an underlying condition that predisposes him or her to develop clinically significant narrowing of the upper airway. Such children may require radiographic evaluation. (See 'Host factors' above and 'Imaging' below.)

**EVALUATION**

**Overview** — The evaluation of children with suspected croup has several objectives, including prompt identification of patients with significant upper airway obstruction or at risk for rapid progression of upper airway obstruction. In addition, there are some conditions with presentations similar to that of croup that require specific evaluations and/or interventions; these too must be promptly identified. (See 'Differential diagnosis' below.)

During the evaluation, efforts should be made to make the child as comfortable as possible. The increased inspiratory effort that accompanies anxiety and fear in young children can exacerbate subglottic narrowing, further diminishing air exchange and oxygenation. (See 'Pathogenesis' above.)

**Rapid assessment and initial management** — Rapid assessment of general appearance (including the presence of stridor at rest), vital signs, pulse oximetry, airway stability, and mental status are necessary to identify children with severe respiratory distress and/or impending respiratory failure. (See "Approach to the management of croup", section on 'Intubation'.)

Endotracheal intubation is required in less than 1 percent of children with croup who are seen in the emergency department. However, the need for endotracheal intubation should be anticipated in children with progressive respiratory failure so that it can be performed in as controlled a setting as possible. Respiratory failure is heralded by the following signs [1,24,25]:

- Fatigue and listlessness
- Marked retractions (although retractions may decrease with increased obstruction and decreased air entry)
- Decreased or absent breath sounds
- Depressed level of consciousness
- Tachycardia out of proportion to fever
- Cyanosis or pallor
A tracheal tube that is 0.5 to 1 mm smaller than would typically be used may be required. (See "Emergent endotracheal intubation in children", section on 'Endotracheal tube'.)

In addition to establishment of an airway, children who have severe respiratory distress require immediate pharmacologic treatment, including administration of nebulized epinephrine and systemic or nebulized corticosteroids. (See "Approach to the management of croup", section on 'Moderate to severe croup'.)

Once control of the airway is established and pharmacologic treatment, if necessary, is under way, the remainder of the evaluation can proceed.

**History** — The history should include a description of the onset, duration, and progression of symptoms. Factors that are associated with increased severity of illness include:

- Sudden onset of symptoms
- Rapidly progressing symptoms (ie, symptoms of upper airway obstruction after fewer than 12 hours of illness)
  - Previous episodes of croup
  - Underlying abnormality of the upper airway
  - Medical conditions that predispose to respiratory failure (eg, neuromuscular disorders)

Aspects of the history that are helpful in distinguishing croup from other causes of acute upper airway obstruction include [1]:

- **Fever** — The absence of fever from onset of symptoms to the time of presentation is suggestive of spasmodic croup or a noninfectious etiology (eg, foreign body aspiration or ingestion, acute angioneurotic edema).
- **Hoarseness and barking cough** — Hoarseness and barking cough, characteristic findings in croup, are typically absent in children with acute epiglottitis, foreign body aspiration, and angioneurotic edema.
- **Difficulty swallowing** — Difficulty swallowing may occur in acute epiglottitis and foreign body aspiration. A large ingested foreign body may lodge in the upper esophagus, where it distorts and narrows the upper trachea, thus mimicking the croup syndrome (including barking cough and inspiratory stridor).
- **Drooling** — Drooling may occur in children with peritonsillar or retropharyngeal abscesses, retropharyngeal cellulitis, and epiglottitis.

The differential diagnosis of croup is discussed in greater detail below. (See 'Differential diagnosis' below.)
**Examination** — The objectives of the examination of the child with croup include assessment of severity of upper airway obstruction and exclusion of other infectious and non-infectious causes of acute upper airway obstruction, both of which are necessary in making management decisions.

The initial examination often can be accomplished by observing the child in a comfortable position with the caretaker. Every effort should be made to measure the child's weight and vital signs.

Aspects of the examination that are helpful in assessing the degree of upper airway obstruction and severity of illness include:

- **Overall appearance** — Is the child comfortable and interactive, anxious and quiet, or obtunded? Is there stridor at rest? Stridor at rest is a sign of significant upper airway obstruction. Children with significant upper airway obstruction may prefer to sit up and lean forward in a "sniffing" position (neck is mildly flexed and head is mildly extended). This position tends to improve the patency of the upper airway.

- **Quality of the voice** — Does the child have a hoarse or diminished cry? Is the voice muffled? A muffled "hot potato" voice is suggestive of epiglottitis, retropharyngeal abscess, or peritonsillar abscess.

- **Degree of respiratory distress** — Signs of respiratory distress include tachypnea, hypoxemia, and increased work of breathing (intercostal, subcostal, or suprasternal retractions; nasal flaring; grunting; use of accessory muscles)

- **Tidal volume** — Does there appear to be good chest expansion with inspiration, indicating adequate air entry?

- **Lung examination** — Are there abnormal respiratory sounds during inspiration or expiration? Inspiratory stridor indicates upper airway obstruction, whereas expiratory wheezing is a sign of lower airway obstruction. If there is stridor, is it present at rest or only with agitation? As discussed above, stridor at rest is a sign of significant upper airway obstruction. Stridor will be more obvious on auscultation, since the inspiratory noise is transmitted through the chest. The presence of rales (crackles) also suggests lower respiratory tract involvement (eg, laryngotracheobronchitis, laryngotracheobronchopneumonitis, or bacterial tracheitis).

- **Assessment of hydration status** — Decreased oral intake and increased insensible losses from fever and tachypnea may result in dehydration. (See "Clinical assessment and diagnosis of hypovolemia (dehydration) in children").

These aspects of the examination are often used in clinical scoring systems to evaluate the severity of illness and/or in making decisions regarding the need for
hospital admission. (See 'Severity assessment' below and "Approach to the management of croup", section on 'Hospitalization'.)

Components of the examination that are useful in distinguishing croup from other causes of acute upper airway obstruction include:

- Examination of the oropharynx for the following signs:
  - Cherry red, swollen epiglottis, suggestive of epiglottitis
  - Pharyngitis, typically minimal in laryngotracheitis, may be more pronounced in epiglottitis or laryngitis
  - Excessive salivation, suggestive of acute epiglottitis, peritonsillar abscess, or retropharyngeal abscess
  - Diphtheritic membrane
  - Tonsillar asymmetry or deviation of the uvula suggestive of peritonsillar abscess
  - Midline or unilateral swelling of the posterior pharyngeal wall suggestive of retropharyngeal abscess

Concerns have been raised about safety of examining the pharynx in children with upper airway obstruction and possible epiglottitis since such efforts have been reported to precipitate cardiorespiratory arrest. However, in two series, each including more than 200 patients with epiglottitis or viral croup, direct examination of the oropharynx was not associated with sudden clinical deterioration [22,26].

- Examination of the cervical lymph nodes, which can be enlarged in patients with retropharyngeal or peritonsillar abscesses
- Other physical findings may be present, depending on the particular inciting virus. As an example, rash, conjunctivitis, exudative pharyngitis, and adenopathy are suggestive of adenovirus infection.
- Otitis media (acute or with effusion) may be present as a primary viral or secondary bacterial process.

The differential diagnosis croup is discussed in greater detail below. (See 'Differential diagnosis' below.)

**Severity assessment** — The severity of croup is often determined by the clinical scoring systems. Although there are a number of validated croup scoring systems, the Westley croup score [27] has been the most extensively studied; it is described below. No matter which system is used to assess severity, the presence of chest wall retractions and stridor at rest are the two critical clinical features.
The elements of the Westley croup score describe key features of the physical examination [27]. Each element is assigned a score, as illustrated below:

- Level of consciousness: Normal, including sleep = 0; disoriented = 5
- Cyanosis: None = 0; with agitation = 4; at rest = 5
- Stridor: None = 0; with agitation = 1; at rest = 2
- Air entry: Normal = 0; decreased = 1; markedly decreased = 2
- Retractions: None = 0; mild = 1; moderate = 2; severe = 3

- Mild croup is defined by a Westley croup score of ≤2. Typically, these children have a barking cough, hoarse cry, but no stridor at rest. Children with mild croup may have stridor when upset or crying (ie, agitated) and either no, or only mild, chest wall/subcostal retractions [1,24].
- Moderate croup is defined by a Westley croup score of 3 to 7. Children with moderate croup have stridor at rest, at least mild retractions, and may have other symptoms or signs of respiratory distress, but little or no agitation [1,24].
- Severe croup is defined by a Westley croup score of ≥8. Children with severe croup have significant stridor at rest, although stridor may decrease with worsening upper airway obstruction and decreased air entry [1,24]. Retractions are severe (including indrawing of the sternum) and the child may appear anxious, agitated, or fatigued. Prompt recognition and treatment of children with severe croup are paramount.

Imaging

Indications — Radiographic confirmation of acute laryngotracheitis is not required in the vast majority of children with croup. Radiographic evaluation of the chest and/or upper trachea is indicated if the diagnosis is in question, the course is atypical, an inhaled or swallowed foreign body is suspected (although the majority are not radio-opaque), croup is recurrent, and/or there is a failure to respond as expected to therapeutic interventions. (See 'Differential diagnosis' below and "Approach to the management of croup".)

Findings — In children with croup, a posterior-anterior chest radiograph demonstrates subglottic narrowing, commonly called the "steeple sign" (picture 2). The lateral view may demonstrate overdistention of the hypopharynx during inspiration [28] and subglottic haziness (picture 3). The epiglottis should have a normal appearance.

In contrast, the lateral radiograph in virtually all children with epiglottitis demonstrates swelling of the epiglottis, sometimes called the "thumb sign" (picture 4). (See "Epiglottitis (supraglottitis): Clinical features and diagnosis".)
The lateral radiograph in children with bacterial tracheitis may demonstrate only nonspecific edema or intraluminal membranes and irregularities of the tracheal wall (picture 5) [29].

**Laboratory studies** — Laboratory studies, which are rarely indicated in children with croup, are of limited diagnostic utility, but may help guide management in more severe cases.

**Blood tests** — The white blood cell (WBC) count can be low, normal, or elevated; WBC counts >10,000 cells/microL are common. Neutrophil or lymphocyte predominance may be present on the differential [30,31]. The presence of a large number of band-form neutrophils is suggestive of primary or secondary bacterial infection. Croup is not associated with any specific alterations in serum chemistries.

**Microbiology** — Confirmation of etiologic diagnosis is not necessary for most children with croup, since croup is a self-limited illness that usually requires only symptomatic therapy. When an etiologic diagnosis is necessary, viral culture and/or rapid diagnostic tests that detect viral antigens are performed on secretions from the nasopharynx or throat. (See 'Etiologic diagnosis' below.)

**DIAGNOSIS**

**Clinical diagnosis** — The diagnosis of croup is clinical, based on the presence of a barking cough and stridor, especially during a typical community epidemic of one of the causative viruses. (See 'Etiology' above.)

Neither radiographs nor laboratory tests are necessary to make the diagnosis. However, radiographs may be helpful in excluding other causes if the diagnosis is in question. (See 'Differential diagnosis' below.)

**Etiologic diagnosis** — Although not typically required in most cases of croup, identification of a specific viral etiology may be necessary to make decisions regarding isolation for patients requiring hospitalization, for initiation of antiviral therapy (particularly when influenza is a consideration), or for public health/epidemiologic monitoring purposes.

Diagnosis of a specific viral etiology can be made by viral culture of secretions from the nasopharynx or throat. Rapid tests that detect viral antigens in these secretions are commercially available for many respiratory viruses. The diagnosis of specific viral infections is discussed in detail in individual topic reviews:

- Parainfluenza (see "Parainfluenza viruses in children", section on 'Diagnosis')
• Influenza (see "Clinical features and diagnosis of influenza in children", section on 'Diagnosis').
• RSV (see "Respiratory syncytial virus infection: Clinical features and diagnosis", section on 'Laboratory diagnosis').
• Adenovirus (see "Diagnosis and treatment of adenovirus infection in children", section on 'Upper respiratory illness').
• Measles (see "Clinical presentation and diagnosis of measles", section on 'Diagnosis').
• Enteroviruses (see "Clinical manifestations and diagnosis of enterovirus infections", section on 'Laboratory diagnosis').
• Metapneumovirus (see "Human metapneumovirus infections", section on 'Diagnosis').

In addition, multiplex tests, which assess the presence of multiple agents at the same time, and PCR-based tests are becoming more widely available [32].

DIFFERENTIAL DIAGNOSIS — The differential diagnosis of croup includes other causes of stridor and/or respiratory distress. The primary considerations are those with acute onset, particularly those that may rapidly progress to complete upper airway obstruction, and those that require specific therapy. Underlying anatomic anomalies of the upper airway also must be considered, since they may contribute to more severe disease. (See 'Host factors' above.)

Important considerations include [1,7]:

• Acute epiglottitis
• Peritonsillar and retropharyngeal abscesses
• Foreign body aspiration or ingestion
• Allergic reaction
• Acute angioneurotic edema
• Upper airway injury
• Congenital anomalies of the upper airway

• Laryngeal diphtheria (see "Diagnosis and treatment of diphtheria")

• Acute epiglottitis — Epiglottitis, which is rare in the era of vaccination against Haemophilus influenzae type b, is distinguished from croup by the absence of barking cough and the presence of anxiety that is out of proportion to the degree of respiratory distress. Onset of symptoms is rapid, and because of the associated bacteremia, the child is highly febrile, pale, toxic, and ill-appearing. Because of the swollen epiglottis, the child will have difficulty swallowing and is often drooling. Epiglottitis occurs infrequently, and there is no
predominant etiologic pathogen. (See "Epiglottitis (supraglottitis): Clinical features and diagnosis").

- Peritonsillar or retropharyngeal abscesses — Children with deep neck space abscesses, cellulitis of the cervical prevertebral tissues, or other painful infections of the oropharynx may present with drooling and neck extension and varying degrees of toxicity. Barking cough is usually absent. (See "Retropharyngeal infections in children").
- Foreign body — In foreign body aspiration, there often is a history of the sudden onset of choking and symptoms of upper airway obstruction in a previously healthy child. If an inhaled foreign body lodges in the larynx, it will produce hoarseness and stridor. If a large foreign body is swallowed, it may lodge in the upper esophagus, resulting in distortion of the adjacent soft extrathoracic trachea, producing a barking cough and inspiratory stridor. (See "Airway foreign bodies in children" and "Foreign bodies of the esophagus and gastrointestinal tract in children").
- Allergic reaction or acute angioneurotic edema — Allergic reaction or acute angioneurotic edema has rapid onset without antecedent cold symptoms or fever. The primary manifestations are swelling of the lips and tongue, urticarial rash, dysphagia without hoarseness, and sometimes inspiratory stridor [1,7]. There may be a history of allergy or a previous attack.
- Upper airway injury — Injury to the airway from smoke or thermal or chemical burns should be evident from the history. The child typically does not have fever or a viral prodrome.
- Anomalies of the upper airway — Hoarseness and stridor caused by anomalies of the upper airway (eg, laryngeal webs, laryngomalacia, vocal cord paralysis, congenital subglottic stenosis, and subglottic hemangioma) and laryngeal papillomas have a more chronic course with absence of fever and symptoms of upper respiratory tract illness, unless the presentation is due to exacerbation of airway narrowing from the impact of a concomitant viral infection. (See "Assessment of stridor in children" and "Etiology and management of hoarseness in children" and "Congenital anomalies of the larynx").

INFORMATION FOR PATIENTS — Educational materials on this topic are available for patients. (See "Patient information: Croup in infants and children"). We encourage you to print or e-mail this topic review or to refer parents to our public Web site, www.uptodate.com/patients, which includes this and other topics.

SUMMARY AND RECOMMENDATIONS

- The term croup has been used to describe a variety of upper respiratory conditions in children, including laryngitis, laryngotracheitis,
laryngotracheobronchitis, bacterial tracheitis, or spasmodic croup. (See 'Definitions' above.)

- Croup is usually caused by viruses. Bacterial infection may occur secondarily. Parainfluenza virus type 1 is the most common cause of croup; other causes include respiratory syncytial virus and influenza virus. (See 'Etiology' above.)

- Croup most commonly occurs in children 6 to 36 months of age. Most cases occur in the fall or early winter. (See 'Epidemiology' above.)

- Host factors that may contribute to the development of croup include functional or anatomic susceptibility to upper airway narrowing. (See 'Pathogenesis' above.)

- The clinical presentation of croup depends upon the specific croup syndrome and the degree of upper airway obstruction.

- The onset of symptoms in laryngotracheitis is gradual, beginning with nasal irritation, congestion, and coryza. Fever, hoarseness, barking cough, and stridor usually develop during the next 12 to 48 hours. Rapid progression or signs of lower airway involvement suggest a more serious illness. (See 'Laryngotracheitis' above.)

- The onset of symptoms in spasmodic croup is sudden and always occurs at night. Fever is typically absent, but mild upper respiratory tract symptoms may be present. (See 'Spasmodic croup' above.)

- Bacterial tracheitis (picture 1 and picture 5) may present acutely or as marked worsening during the course of an antecedent viral upper respiratory infection. Clinical manifestations of bacterial tracheitis include fever, toxic appearance, and severe respiratory distress. (See 'Bacterial tracheitis' above and "Bacterial tracheitis in children: Clinical features and diagnosis").

- The objectives of the evaluation of the child with croup include assessment of severity and exclusion of other causes of upper airway obstruction. (See 'Overview' above.)

- Rapid assessment of general appearance, vital signs, pulse oximetry, airway stability, and mental status are necessary to identify children with severe respiratory distress and/or impending respiratory failure. (See 'Rapid assessment and initial management' above.)

- The history should include a description of the onset, duration and progression of symptoms, and ascertain whether there are any underlying conditions that predispose to a more severe course. (See 'History' above.)

- Aspects of the examination that are useful in assessing the severity of upper airway obstruction include overall appearance (including the presence of stridor at rest or only with agitation), quality of voice, work of breathing, tidal volume and air entry, and the presence of wheezing. (See 'Examination' above.)
The diagnosis of croup is clinical, based upon the presence of a barking cough and stridor. Neither radiographs nor laboratory tests are necessary to make the diagnosis. However, radiographs may be helpful in excluding other causes if the diagnosis is in question. (See 'Diagnosis' above.)

The differential diagnosis of croup includes other causes of stridor and/or respiratory distress. The primary considerations are those with acute onset, particularly those that may rapidly progress to complete upper airway obstruction, and those that require specific therapy. Important considerations include acute epiglottitis, peritonsillar and retropharyngeal abscesses, foreign body aspiration, acute angioneurotic edema, upper airway injury, and congenital anomalies of the upper airway. (See 'Differential diagnosis' above.)

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