An Evidence-Based Approach To The Evaluation And Treatment Of Croup In Children

Abstract

Croup is a viral childhood infection characterized by the acute onset of barking cough and stridor that is a common cause of pediatric presentations to emergency departments and primary care centers. It is usually a mild, self-limited disease, but, in some rare cases, croup may lead to upper airway obstruction and respiratory failure. All children presenting with croup should be treated with oral dexamethasone to reduce the severity of symptoms and rate of revisits or admissions to the hospital. Children exhibiting signs of upper airway obstruction should be treated with nebulized epinephrine. There is no evidence, to date, to show that humidified air or heliox are of benefit when treating children with croup. Appropriate discharge instructions should be given to caregivers to prevent unnecessary or delayed visits to the emergency department. This review focuses on the clinical evaluation and treatment of children with croup by offering a thorough examination of the recent advances in treatment and recommendations on the necessity of appropriate disposition and follow-up.

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CME Objectives
Upon completion of this article, you should be able to:
1. Recognize the clinical presentation of viral croup.
2. Identify the common differential diagnoses of cough and stridor and how they differ from croup.
3. Treat and manage a child who presents with croup.
4. Identify the criteria for admission to the hospital or discharge home.

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Case Presentation

A previously healthy 2-year-old boy presents to your ED on an early winter evening after the sudden onset of a barking cough and trouble breathing. His parents are concerned because of a “whistling” sound he is making when he cries. He has had rhinorrhea and a low-grade fever for the past 36 hours. Upon arrival at triage, he is mildly tachypneic with a respiratory rate of 32 breaths per minute. His oxygen saturation is 94% on room air, his axillary temperature is 38.4°C, and his heart rate is 135 beats per minute. On examination, he is restless, fussy, and unable to settle down on his mother’s lap. You can clearly hear inspiratory stridor punctuated by a barking cough, and you notice moderate intercostal retractions. The rest of your physical exam is within normal limits. What are your first steps toward treating this child? What clinical criteria will you use to discharge this patient home? What discharge instructions will you give the parents?

Introduction

Croup is a common childhood viral illness. Clinically, it is manifested by the sudden onset of a barking cough, hoarseness, and inspiratory stridor which may lead to obstruction and, rarely, to respiratory failure. It typically affects young children between 6 months and 3 years of age and is seen predominantly in boys. It is the most prevalent cause of hoarseness, cough, and acute onset of stridor in the febrile child. While croup can be seen year-round, there is a clear seasonal pattern in North America, with affected children presenting most commonly between the months of November and February. This has been attributed to the biennial peak in human parainfluenza virus epidemics in November. Children may acutely become symptomatic at night and improve during daytime hours. This is often frightening for caretakers, as the distress can be quite dramatic. Although croup is typically a self-limited viral illness that normally resolves over 2 to 5 days, it can require admission to the hospital and, rarely, to the intensive care unit (ICU). The majority of children recover with no complications; however, in very rare instances, it can be life-threatening. The routine use of corticosteroid therapy in the last 30 years has revolutionized the treatment of croup, resulting in a dramatic decrease in the number of admissions to the ICU and the need for invasive therapy such as intubation and mechanical ventilation.  

This issue of Pediatric Emergency Medicine Practice focuses on the evaluation and treatment of children with croup by offering a thorough review of the recent advances in treatment. It will provide updated information to the emergency clinician and guidelines on management for primary care providers, who often see these patients early in their illness. Adequate first-line care and follow-up instructions may prevent unnecessary or delayed visits to emergency departments (EDs), alleviate burden on the healthcare system, and minimize stressful situations for caretakers.

Critical Appraisal Of The Literature

A literature review was carried out with PubMed and Ovid MEDLINE® for articles on croup, acute laryngotracheitis, and acute laryngotracheobronchitis with limits on all child: 0-18 years. Pertinent, well-designed randomized controlled trials were included as well as commonly referenced and older publications on the topic. A search in the Cochrane Database of Systematic Reviews yielded 3 important publications relating to the treatment of croup. One relevant review was not included in this issue as it had been withdrawn from the Cochrane Library because the authors were unable to update it. The website of the Canadian Pediatric Society (http://www.cps.ca/) and the American Academy of Pediatrics (AAP) (http://www.aap.org/) were consulted for guidelines, but none were found. The only document concerning croup from these organizations that was written for professionals is a position statement from the Canadian Pediatric Society dating back to 1992 on steroid administration for patients admitted to the hospital. The AAP website yielded several patient education sheets but no official guidelines or clinical decision algorithms. Additionally, the most often referenced guidelines on diagnosis and management of croup in the literature, published in 2007 by the Alberta Medical Association, were reviewed.

The literature on croup underwent a drastic update in the early 1990s with the introduction of corticosteroids, which were first used in hospitalized patients and then in ambulatory patients. The literature predating this introduction focused mostly on management of severe cases of upper airway obstruction from croup and on distinguishing this entity from other common childhood illnesses in the preimmunization period that cause upper airway obstruction (most notably, epiglottitis caused by Haemophilus influenzae type b). Several small underpowered studies demonstrated a small benefit in improvement of symptoms and a reduction in the rate of intubation with the treatment of hospitalized patients with upper airway obstruction using corticosteroids. These results were largely ignored by most of the pediatric medical community until 1989, when Kairys et al published a meta-analysis based on 10 randomized trials with a total of 1286 patients that supported the use of corticosteroids to lower the morbidity associated with croup. Based on these results, appropriately powered randomized controlled trials showing the effectiveness and safety of corticosteroids in croup were conducted.
Recently updated meta-analyses confirmed these results. More-recent studies have focused on determining the best administration modality and dosage to maximize effectiveness while minimizing harm to the patient. Multiple randomized controlled trials are currently trying to determine whether a lower corticosteroid dose is as effective as the one traditionally recommended. There are also several newer modalities, such as heliox, under investigation for the treatment of more-severe cases of croup. With the widespread use of corticosteroids, the rates of hospitalization and of admission to the ICU for croup have steadily decreased in the past 2 decades, limiting research in this area.²

### Epidemiology, Etiology, And Pathogenesis

The term *croup* encompasses a spectrum of disease involving the upper airway and sometimes (although rarely) extending into the lung parenchyma (laryngotraechitis, laryngotraceobronchitis, laryngotracheobronchopneumonitis). Acute laryngotraechitis is the most common presentation of these illnesses and is usually infectious in nature. In medical textbooks and review articles, differentiation is typically made between acute laryngotracheitis and recurrent croup that is associated with airway hyperreactivity (spasmodic croup).¹⁴⁻¹⁵ Both of these entities are usually caused by the same pathogens, and their clinical management is similar. Acute bacterial laryngotraceobronchitis is bacterial tracheitis, and it is commonly due to infection with *Staphylococcus aureus* or *H influenzae*.¹⁶

Males have a predominance over female patients on both visit and admission rates by a ratio of 3:2.¹⁷ Children aged 1 year old usually have the highest rate of visits to the ED and have the highest rate of admission to the hospital.¹⁷⁻¹⁸ Mortality quoted in a study from 1991 prior to the widespread use of corticosteroids was estimated to be less than 0.5%.¹⁹ More-recent extrapolations estimate the mortality rate now to be about 1 in 30,000 cases, which makes it an even more unlikely event.¹³,³³

According to a large Canadian population-based study, viral croup accounts for 3% to 5% of total visits to EDs.¹⁷ This study demonstrates that although the number of cases presenting to the ED increased over the 6 years studied (from April 1999 to May 2005), there has been a steady decrease in the number of patients needing admission to hospitals and ICUs. The authors hypothesize that this is due to the introduction of evidence-based treatment, such as corticosteroids.

Croup is most often caused by a variety of viruses. Human parainfluenza viruses, especially type I and III, are the most common infectious agents, accounting for close to 80% of cases.²⁰ In the Northern Hemisphere, croup follows a clear seasonal pattern, following the epidemics of human parainfluenza virus, and has biennial peaks in rates in November during odd years and February in even years.¹⁷⁻¹⁸ Although less frequent, croup may also occur with infection by influenza A and B, respiratory syncytial virus, adenovirus, coronavirus, human metapneumovirus, and *Mycoplasma pneumoniae*.²¹,²² Sporadic cases have also been identified with infectious agents such as enterovirus and mumps, and croup is known complication of measles.²³ Fungi and mycobacteria are extremely rare primary causes of laryngotracheobronchitis, and, when identified, should raise the suspicion of underlying immunodeficiency and prompt appropriate investigations. Immunosuppression may also occur with repeated treatments of corticosteroids or prophylaxis with antibiotics and may lead to opportunistic infections such as *Candida* or herpes simplex virus.²⁴

The symptoms of croup are caused by infiltration of the subglottic region of the larynx by an infectious pathogen. This infiltration causes erythema, edema, and glandular hypersecretion of the subglottic mucosa. Because this narrowest part of the pediatric airway is bound by a complete ring of cartilage and cannot expand outward to accommodate for narrowing of the airway, obstruction may occur quickly with even the smallest amount of swelling. Poiselle’s law states that the increase in airway resistance is inversely proportional to the fourth power of the radius. This phenomenon explains why even a minimal amount of airway edema may lead to an exponential rise in airway obstruction, especially in the young infant or toddler. In bacterial croup, pseudomembranes and fibrinous exudates may accumulate within the airway and cause further obstruction. The characteristic stridor of croup is caused by the passage of turbulent air through the narrowed airway at the level of the supraglottis, glottis, subglottis, or trachea and—depending on its timing with the respiratory cycle—may be inspiratory, expiratory, or biphasic.²⁵

### Differential Diagnosis

Most children presenting with the classic “barky” cough and stridor have croup. Nonetheless, other potentially more serious entities may manifest as stridor and present similarly to croup. Emergency clinicians need to stay vigilant to identify and treat these children appropriately. (See Table 1, page 4.) Common causes of acute febrile stridor are bacterial tracheitis, epiglottitis, and retropharyngeal abscess. Acute afebrile stridor may be due to foreign body aspiration, spasmodic croup, thermal or caustic injury to the airway, or angioneurotic edema. Patients with accidental or intentional strangulation may also present with stridor. Emergency clinicians should inspect the neck for external signs of injury.
Table 1. Differential Diagnosis Of Stridor

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Clinical Presentation</th>
<th>Physical Examination</th>
<th>Diagnostic Investigations</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterial tracheitis</td>
<td>Prodromal upper respiratory viral illness, high fever, acute-onset stridor</td>
<td>Toxic appearance, varying degree of respiratory distress, poor response to epinephrine</td>
<td>Complete blood count, blood and tracheal secretion cultures</td>
<td>IV antibiotics; may require intubation and mechanical ventilation</td>
</tr>
<tr>
<td>Epiglottitis</td>
<td>High fever, dysphonia, refusal to eat, dysphagia, sore throat, vomiting, absence of cough</td>
<td>Toxic appearance, drooling, tripod stance; obtundation</td>
<td>Direct visualization of edematous epiglottis by laryngoscopy, “thumb print” sign on lateral neck x-ray</td>
<td>Airway management by highly skilled physicians (ENT, anesthesiologist); IV antibiotics</td>
</tr>
<tr>
<td>Viral croup (laryngotracheitis)</td>
<td>Low grade fever, +/- prodromal upper respiratory tract illness, barky “seal-like” cough, inspiratory stridor, onset during night</td>
<td>Respiratory distress, audible stridor, agitation</td>
<td>Clinical diagnosis; “steeple sign” on anteroposterior neck x-ray</td>
<td>Nebulized epinephrine, corticosteroids; may require intubation and mechanical ventilation</td>
</tr>
<tr>
<td>Retropharyngeal/peritonsillar abscess</td>
<td>Fever, odynophagia, neck pain or torticollis, drooling, general malaise</td>
<td>Enlarged cervical lymph nodes, tender neck to palpation, limitations of neck movements</td>
<td>Swelling of retropharyngeal space on lateral neck x-ray, CT scan</td>
<td>IV antibiotics, surgical management (drainage, tonsillectomy) by ENT specialist</td>
</tr>
<tr>
<td>Diphtheria</td>
<td>Low-grade fever, upper respiratory tract illness, sore throat, odynophagia, recent travel to endemic area</td>
<td>Pharyngeal pseudomembrane, enlarged cervical lymph nodes, swelling of neck (“bull neck”), skin lesions</td>
<td>Throat culture positive for Corynebacterium diphtheriae</td>
<td>Diphtheria antitoxin, antibiotics; may require intubation and mechanical ventilation</td>
</tr>
<tr>
<td>Foreign body aspiration</td>
<td>Sudden episode of choking on food or small object, cough, stridor/wheezing</td>
<td>Diminished air entry, stridor/wheezing</td>
<td>Lateral decubitus chest x-ray or inspiratory/expiratory chest x-ray, bronchoscopy (rigid or flexible)</td>
<td>Bronchoscopy and foreign body removal</td>
</tr>
<tr>
<td>Laryngomalacia</td>
<td>Progressively worsening stridor associated with crying/feeding or position (supine), possible feeding intolerance</td>
<td>Positional, inspiratory stridor; otherwise unremarkable physical examination</td>
<td>Laryngoscopy or bronchoscopy, chest x-ray +/- barium esophagography to rule out extrinsic compression of airway by structural anomalies</td>
<td>Conservative or surgical (laryngoplasty or epiglottotomy)</td>
</tr>
<tr>
<td>Angioneurotic edema</td>
<td>Positive family history; rapid-onset swelling of face, limbs, or larynx without discoloration; abdominal pain precipitated by trauma/emotional stress</td>
<td>Angioedema, stridor, shock, absence of urticaria and pruritus</td>
<td>C1 esterase inhibitor level and function, complement levels</td>
<td>Epinephrine (IV or IM), fluid resuscitation, C1 inhibitor concentrate (rarely available); may require intubation and mechanical ventilation</td>
</tr>
</tbody>
</table>

Abbreviations: CT, computed tomography; ENT, ear, nose, and throat; IM, intramuscular; IV, intravenous.
Patients should be immediately assessed for life-threatening conditions, especially airway obstruction. Do not agitate the child. Allow the child to remain in his position of comfort, even if this means being carried or lying in a parent’s lap. Avoid unnecessary procedures or examinations such as examination of the posterior pharynx. Oxygen may be administered if cyanosis is present. If nebulized epinephrine is available to specialized advanced life support teams and the child demonstrates audible stridor and respiratory distress, it may be administered on the way to the hospital to alleviate symptoms. Nonetheless, transport to the hospital must not be delayed for the administration of inhaled medications.

Prehospital Care

Patients should be immediately assessed for life-threatening conditions, especially airway obstruction. Do not agitate the child. Allow the child to remain in his position of comfort, even if this means being carried or lying in a parent’s lap. Avoid unnecessary procedures or examinations such as examination of the posterior pharynx. Oxygen may be administered if cyanosis is present. If nebulized epinephrine is available to specialized advanced life support teams and the child demonstrates audible stridor and respiratory distress, it may be administered on the way to the hospital to alleviate symptoms. Nonetheless, transport to the hospital must not be delayed for the administration of inhaled medications.

Emergency Department Evaluation

History

Children with croup are typically between the age of 6 months and 3 years, but croup can be seen until adulthood. The illness typically starts with upper respiratory tract symptoms such as rhinorrhea and low-grade fever. Inspiratory stridor, hoarseness, and the classic barking “seal-like” cough appear abruptly within 12 to 48 hours of illness, most often in the overnight hours, for unknown reasons. Most symptoms tend to improve during the daytime period. The symptoms typically resolve progressively within 2 to 5 days.

The ED evaluation should focus on eliminating other life-threatening causes of stridor. Confirm the absence of drooling, nontoxic appearance or dysphagia, no neck pain or limitations of movements, and no history of choking on food or small object. Ask questions regarding immunization status. Review past medical history for previous episodes of croup, airway hyperactivity, previous endotracheal intubation, or subglottic manipulations, as these can lead to subglottic stenosis and precipitate upper airway obstruction.

Physical Examination

Vitals signs (heart rate, respiratory rate, temperature, oxygen saturation) should be obtained on all children with suspected croup; however, symptoms may worsen if the child is anxious or agitated. Observation is a key tool. The urgency and aggressiveness of interventions are driven by the appearance, breathing, and circulation status of the child. Moderate tachypnea and tachycardia may be seen as well as varying degrees of respiratory distress. Stridor may be audible at rest or on auscultation and may be inspiratory, expiratory, or biphasic depending on the severity of symptoms.

Scoring systems have been developed to attempt to grade the severity of viral croup. Although useful in clinical research, there is no consensus as to whether they improve clinical practice. The most widely used score is the Westley Croup score. Developed in 1978 by Westley et al, its validity and reliability has been well established. It consists of a maximum of 17 points, depending on the presence or absence of 5 clinical characteristics: (1) level of consciousness, (2) cyanosis, (3) stridor, (4) air entry, and (5) retractions. (See Table 2, page 6.)

The Alberta Clinical Practice Guideline Working Group categorizes croup according to its clinical signs into 4 categories that are more useful in a clinical setting. These categories include: (1) mild, (2) moderate, (3) severe, and (4) impending respiratory failure. (See Table 3, page 6.) According to these categories, over 85% of children presenting to EDs have mild croup, and < 1% fall into the severe croup category.
Diagnostic Studies

Croup is a clinical diagnosis, and laboratory and imaging studies are not necessary to make the diagnosis. Imaging studies may be useful in excluding other causes of stridor (such as foreign body aspiration) in situations where the history and physical examination are unclear or when the child’s symptoms do not respond to usual treatment.

The most common radiological sign of croup on anteroposterior chest radiograph is the “steeple sign.” This distinctive narrowing of the trachea in the shape of an inverted V is produced by the presence of edema in the trachea, which results in loss of the normal shoulder-like appearance of the subglottis. (See Figure 1.) Other causes of steepling on radiograph include epiglottitis, thermal injury, angioneurotic edema, and bacterial tracheitis. The majority of children with croup will have normal radiographs, and films should not be routinely obtained. If epiglottitis cannot be ruled out clinically, a lateral neck radiograph may be obtained, which may show the thickening of the epiglottis and aryepiglottic folds called the “thumb sign.” In croup, the radiological findings on lateral neck radiographs are variable and may be difficult to identify, as they are tied to the dynamics of the hypopharynx during inspiration and expiration. Patients with suspected epiglottitis or croup must always be accompanied and monitored during procurement of the radiographs, as upper airway obstruction may progress rapidly in children. If a child looks unwell or has signs of severe airway obstruction, emergent airway management should occur first and obtention of radiographs is contraindicated.

Laboratory studies such as complete cell count or blood culture are not useful when evaluating a child with croup, and viral cultures or rapid antigen testing are not routinely recommended. If intubation is attempted, trachea cultures should be obtained to rule out the presence of bacterial tracheitis and to guide antibiotic treatment.

Treatment

Humidified Air

Humidity has been used routinely to treat croup ever since steam produced by hot baths appeared to alleviate symptoms of croup during the 19th century. “Croup kettles” became popular to achieve relief “...by applying hot fomentations to the throat...and by steam inhalations.” Umbrellas and bed sheets were tied over a child’s crib in the fashion of a canopy, and boiling water from a kettle was administered through an opening in the sheets. Not unexpectedly, scald burns were a common adverse effect of this therapy. Croup kettles were progressively replaced by cool air mist after the observation that cool night air seemed to be more effective at

Table 2. Westley Croup Score Criteria

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level of Consciousness</strong></td>
<td></td>
</tr>
<tr>
<td>Normal (including sleep)</td>
<td>0</td>
</tr>
<tr>
<td>Disoriented</td>
<td>5</td>
</tr>
<tr>
<td><strong>Cyanosis</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Cyanosis with agitation</td>
<td>4</td>
</tr>
<tr>
<td>Cyanosis at rest</td>
<td>5</td>
</tr>
<tr>
<td><strong>Stridor</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>When agitated</td>
<td>1</td>
</tr>
<tr>
<td>At rest</td>
<td>2</td>
</tr>
<tr>
<td><strong>Air Entry</strong></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>0</td>
</tr>
<tr>
<td>Decreased</td>
<td>1</td>
</tr>
<tr>
<td>Markedly decreased</td>
<td>2</td>
</tr>
<tr>
<td><strong>Retractions</strong></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Mild</td>
<td>1</td>
</tr>
<tr>
<td>Moderate</td>
<td>2</td>
</tr>
<tr>
<td>Severe</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
</tr>
</tbody>
</table>

Mild croup, ≤ 2; Moderate, 3-5; Severe, 6-11; Impending respiratory failure, ≥ 12.

Table 3. Assessment Of Severity Of Croup

<table>
<thead>
<tr>
<th>Level of Severity</th>
<th>Corresponding Westley Croup Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild</td>
<td>0-2</td>
</tr>
<tr>
<td>Occasionally barky cough</td>
<td></td>
</tr>
<tr>
<td>No audible stridor at rest</td>
<td></td>
</tr>
<tr>
<td>No mild suprasternal/intercostal retractions</td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>3-5</td>
</tr>
<tr>
<td>Frequently barky cough</td>
<td></td>
</tr>
<tr>
<td>Easily audible stridor at rest</td>
<td></td>
</tr>
<tr>
<td>Suprasternal and sternal wall retraction at rest</td>
<td></td>
</tr>
<tr>
<td>No or little distress or agitation</td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>6-11</td>
</tr>
<tr>
<td>Frequently barking cough</td>
<td></td>
</tr>
<tr>
<td>Prominent inspiratory and expiratory stridor</td>
<td></td>
</tr>
<tr>
<td>Marked sternal wall retractions</td>
<td></td>
</tr>
<tr>
<td>Significant distress and agitation</td>
<td></td>
</tr>
<tr>
<td>Impending Respiratory Failure</td>
<td>≥ 12</td>
</tr>
<tr>
<td>Barky cough (not prominent)</td>
<td></td>
</tr>
<tr>
<td>Audible stridor at rest (hard to hear)</td>
<td></td>
</tr>
<tr>
<td>Sternal wall retractions (may not be marked)</td>
<td></td>
</tr>
<tr>
<td>Lethargy or decreased level of consciousness</td>
<td></td>
</tr>
<tr>
<td>Dusky appearance</td>
<td></td>
</tr>
</tbody>
</table>
reducing the symptoms of upper airway obstruction.\textsuperscript{38} Croup tents were a common therapeutic modality in hospitals until the 1990s. They are now rarely used, as they isolate and separate the child from the caregiver, increasing the child’s anxiety, which then potentiates the symptoms of upper airway obstruction. Humidity, if used, is now delivered in the hospital setting by a “blow-by” flexible tubing hose, which is usually held by a caregiver and aimed towards the child’s face. Discharge instructions also routinely recommend that parents run hot water in the shower and sit with the child in the steam-filled bathroom or in front of a freezer or outdoors for a period of time, if living in a cooler climate.\textsuperscript{6,39} There are no studies, however, evaluating the effectiveness of this practice.

The postulated benefits of mist therapy include the decreased viscosity of tracheal secretions as well as mucosal cooling and a subsequent reduction in edema.\textsuperscript{40} Nonetheless, known adverse effects include bronchospasm in children who are prone to airway hyperreactivity, hyponatremia secondary to excessive moisture, and secondary infection by pathogens such as \textit{Pseudomonas aeruginosa} or fungi.\textsuperscript{38} Randomized controlled trials with small numbers of patients failed to show improvement after the administration of humidified air by croup tents and blow-by technique, respectively.\textsuperscript{41,42} One hypothesis to explain the failure to show positive results was that the water particles were not of the correct size to reach the larynx. Scolnik et al designed a randomized controlled trial with 140 patients to try to identify the ideal particle size for laryngeal deposition.\textsuperscript{43} As explained by the investigators, particles larger than 10 micrometers in diameter deposit in the nose and mouth, whereas particles smaller than 5 micrometers reach the lower airway where they may cause bronchospasm. Therefore, particles that are 5 to 10 micrometers in diameter have the greatest probability of reaching the larynx, making this particle size the most appropriate choice for croup therapy. Despite empirically testing this theory, the investigators were unable to demonstrate any improvement in Westley Croup Score with humidity as compared to placebo. A systematic review and meta-analysis by Moore and Little reviewed the aforementioned randomized controlled trials and concluded that there was insufficient evidence of therapeutic benefit to support the routine use of humidified air.\textsuperscript{40} When pooling the results to perform a meta-analysis, their results were not methodologically strong enough to rule in or out any beneficial effect of humidified air.

**Nebulized Epinephrine**

Nebulized epinephrine has been thoroughly studied for the treatment of croup.\textsuperscript{31,44,45} Epinephrine induces vasoconstriction in laryngeal mucosa by stimulating alpha-adrenergic receptors, thus decreasing the symptoms of upper airway narrowing. It also promotes bronchial smooth muscle relaxation and thinning of bronchial secretions by stimulation of beta-adrenergic receptors. Epinephrine comes under 2 different forms: racemic, which is composed of equal parts of L- and D-isomers, and L-epinephrine, which is the drug routinely used in acute situations in concentrations of 1:1000 and 1:10,000.

In 1971, Adair et al first reported the benefits of administration of nebulized epinephrine by intermittent positive-pressure breathing (IPPB) by observing a significant reduction in clinical croup score, although the beneficial effect lasted for less than 2 hours.\textsuperscript{46} Subsequent trials showed that similar benefits were achieved if racemic epinephrine was administered via IPPB or only nebulized without IPPB.\textsuperscript{47} Racemic epinephrine was initially used in the treatment of croup because it was thought to cause fewer cardiovascular effects than L-epinephrine. In a study of 66 patients, Waisman et al showed no difference in croup score at 30 minutes when comparing administration of 2.25% racemic epinephrine 0.5 mL diluted in 2.5 mL of saline versus L-epinephrine 1:1000 diluted in 5 mL of saline.\textsuperscript{48} In addition, L-epinephrine showed a statistically significant longer duration of benefit with
Clinical Pathway For Management Of Croup In The Emergency Department

**Diagnosis of croup**

- Dexamethasone 0.6 mg/kg orally to max dose of 10 mg (Class I)

**Mild (no stridor or chest wall retractions at rest)**

- Parental education:
  - Expected course of illness
  - Signs of respiratory distress
  - When to seek medical care
  - Discharge home without further observation
  - No specific follow-up required

**Moderate (stridor and chest wall retractions at rest without agitation)**

- Minimize intervention
- Keep child on caregiver’s lap in position of comfort

- Consider nebulized epinephrine; if given, observe for 2 h (Class I)

**Severe (stridor and retractions of the sternum associated with agitation or lethargy)**

- Minimize intervention as for moderate croup
- Provide blow-by oxygen only if cyanosis is present

- Nebulized epinephrine (Class I):
  - Racemic epinephrine 2.25% (0.5 mL in 2.5 mL saline)
  - L-epinephrine 1:1000 (5 mL)
- Observe for improvement for minimum of 2 h, if epinephrine given
- If vomiting, consider budesonide (2.5 mg) nebulized with epinephrine or dexamethasone 0.6 mg/kg IV or IM (Class I)

**Improvement?**

- **No or minimal improvement**
  - Repeat nebulized epinephrine; observe for 4 h

- **Patient improves and no longer has stridor at rest or chest wall retractions**
  - Educate parents (as per mild croup)
  - Discharge home

- **Poor response to nebulized epinephrine (signs of respiratory failure)**
  - Contact pediatric ICU for further management
  - Consider contacting anesthesia +/- ENT consult if airway management is required

**Note:** treatment based on severity at time of initial assessment.

Abbreviations: ENT, ear, nose, and throat; ICU, intensive care unit; IM, intramuscular; IV, intravenous.

For class of evidence definitions, see page 9.
a better croup score at 120 minutes as opposed to racemic epinephrine.\textsuperscript{1,48} Nebulized epinephrine has also been shown to decrease the rate of admission to the hospital and the need for intubation or tracheotomy.\textsuperscript{1} The rarity of adverse effects makes it a safe drug to give for otherwise healthy children with symptoms of croup.\textsuperscript{49,50} Butte et al reported 1 case of ventricular tachycardia and myocardial infarction in a child with severe croup who received 3 doses of epinephrine within 1 hour.\textsuperscript{51} Up to 2 doses of nebulized epinephrine administered every 15 to 20 minutes within the same hour is most likely safe in an otherwise healthy child. Consultation with a pediatric critical care unit for cardiac monitoring should be made if more doses are required.\textsuperscript{1} If a child continues to exhibit symptoms of stridor and altered level of consciousness after repeated doses of epinephrine, urgent consultation with the ICU, an ENT specialist, and an anesthesiologist is mandated to prepare for further airway management, as this clinical situation may quickly lead to respiratory failure.

A systematic review conducted by Bjornson et al looking at 8 studies (with a total of 225 participants) concluded that nebulized epinephrine may be used to alleviate symptoms of croup in patients with moderate-to-severe presentation and that these symptoms do not tend to worsen after the effect of epinephrine dissipates.\textsuperscript{1} In the early 1990s, standard ED practice was to hospitalize all patients with a presentation severe enough to require the use of nebulized epinephrine. Since then, several trials have demonstrated that patients treated with nebulized epinephrine and therapeutic doses of corticosteroids may be observed for 2 to 4 hours, and, if they remain stable, they may be safely discharged home.\textsuperscript{49,52,53}

Corticosteroids
The use of corticosteroids has truly revolutionized the management of croup in the last 30 years. The first trials addressing the role of corticosteroids in the 1950s were unable to show any effect on the severity or length of symptoms of acute viral croup.\textsuperscript{7,8} Further investigations conducted until the late 1980s consistently demonstrated significant improvement in patients treated with corticosteroids compared to placebo.\textsuperscript{9-12} The meta-analysis published by Kairys et al in 1989 included 10 studies with a total of 1286 patients and provided the most reliable estimate of the impact of steroid therapy on the morbidity associated with croup.\textsuperscript{13} Their results showed significant clinical improvement 12 hours and 24 hours posttreatment and a significantly reduced incidence of endotracheal intubation. Super et al confirmed these results in a well-designed randomized controlled trial looking at 29 hospitalized patients.\textsuperscript{34} The Canadian Pediatric Society published a position statement in 1992 recommending the use of steroid therapy as a single dose of dexamethasone (Decadron\textsuperscript{®}) 0.6 mg/kg IV or intramuscular (IM) in children admitted to hospital with severe croup.\textsuperscript{3}

The recently updated Cochrane review on glucocorticoids looked at 24 studies involving 2878 patients and found that treatment with glucocorticoids is effective in improving symptoms in children as early as 6 hours and up to 12 hours after treatment, and that it significantly reduces hospital admissions and return visits to EDs.\textsuperscript{2} When compared to children with croup who received placebo, children who received steroid therapy spent significantly less time in the ED or hospital.

The benefits of glucocorticoid therapy are not limited to children with moderate croup. A large multicenter randomized controlled trial involving 720 children demonstrated multiple benefits in treating children with mild symptoms of croup with 0.6 mg/kg of oral dexamethasone as compared to placebo.\textsuperscript{35} The treated children had half the rate of revisits to a healthcare practitioner and lost less sleep in 48 hours, and their parents experienced less stress in the 24 hours following treatment.

Class of Evidence Definitions

<table>
<thead>
<tr>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
<th>Indeterminate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always acceptable, safe</td>
<td>Safe, acceptable</td>
<td>May be acceptable</td>
<td>Continuing area of research</td>
</tr>
<tr>
<td>Definitely useful</td>
<td>Probably useful</td>
<td>Possibly useful</td>
<td>No recommendations until further research</td>
</tr>
<tr>
<td>Proven in both efficacy and effectiveness</td>
<td>Level of Evidence: Generally higher levels of evidence</td>
<td>Considered optional or alternative treatments</td>
<td>Level of Evidence: Evidence not available</td>
</tr>
<tr>
<td>Level of Evidence: One or more large prospective studies are present (with rare exceptions)</td>
<td>Level of Evidence: Non-randomized or retrospective studies: historic, cohort, or case control studies</td>
<td>Level of Evidence: Generally lower or intermediate levels of evidence</td>
<td>Higher studies in progress</td>
</tr>
<tr>
<td>High-quality meta-analyses</td>
<td>Less robust randomized controlled trials</td>
<td>Case series, animal studies, consensus panels</td>
<td>Results inconsistent, contradictory</td>
</tr>
<tr>
<td>Study results consistently positive and compelling</td>
<td>Results consistently positive</td>
<td>Occasionally positive results</td>
<td>Results not compelling</td>
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This clinical pathway is intended to supplement, rather than substitute for, professional judgment and may be changed depending upon a patient’s individual needs. Failure to comply with this pathway does not represent a breach of the standard of care.

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Trials comparing oral, parenteral, and nebulized corticosteroids have demonstrated similar efficacy and superiority of the different treatment groups to placebo. Oral dexamethasone has become the preferred choice of treatment because it is less expensive than budesonide (Pulmicort) and is easier to administer to children with croup. The parenteral-injectable preparation (which is more palatable and less diluted than the oral preparation) can be given in a smaller volume mixed with syrup, is rarely vomited, and is recommended for use in children. Nonetheless, budesonide 2.5 mg by nebulization may be safely substituted for dexamethasone if a child cannot tolerate the oral administration.

Combining inhaled corticosteroids with oral dexamethasone does not confer any added benefit when looking at length of hospital stay, croup score, revisit rate, or admission to the hospital. To the authors' knowledge, there is no study, to date, looking at the benefit of multiple doses of corticosteroids in children with croup.

While most of the larger studies on glucocorticoids in croup have been done using 0.6 mg/kg of oral dexamethasone, there is ongoing debate about the optimal dosing regimen, particularly in mild croup. A randomized controlled trial by Geelhoed with 120 enrolled patients tried to identify the minimum effective dose of dexamethasone. Initially, 60 patients were randomized to receive 0.6 versus 0.3 mg/kg dexamethasone. A second group of 60 patients was randomized to receive 0.3 versus 0.15 mg/kg of dexamethasone. There were no significant differences in outcome detected between the 3 treatment dosages; however, given the small number of subjects in the study (only 30 were treated with 0.15 mg/kg of dexamethasone), the study was underpowered to demonstrate the equivalence of the lower dose of dexamethasone with the more-studied 0.6 mg/kg dose. Another small study of 99 subjects with croup found similar outcomes in patients randomized to 1 of 3 orally administered treatment regimens: 0.15 mg/kg of dexamethasone, 0.6 mg/kg dexamethasone, and 1 mg/kg of prednisolone (a dose of 1 mg/kg of prednisolone is equivalent to 0.15 mg/kg of dexamethasone). A retrospective descriptive report by Dobrovoljac and Geelhoed describes the experience at their center in the 11 years since they adopted the 0.15 mg/kg oral dose of dexamethasone. While these studies demonstrate that the 0.15 mg/kg dose of dexamethasone is beneficial in reducing the symptoms and the admission rate in children with mild croup, there is not enough evidence to conclude that this dose is equivalent to the more rigorously studied dose of 0.6 mg/kg. A large randomized controlled trial is currently underway to answer the question of the optimal dose of dexamethasone in the treatment of croup.

**Heliox**

Heliox, a mixture of helium and oxygen, is a gas with similar viscosity and a sevenfold lower density than air. It was successfully pioneered in the 1930s for the treatment of asthma and upper airway obstruction in adults and children. It is thought to reduce flow resistance by creating a less turbulent flow, thus decreasing the work of breathing and improving gas exchange by delivering an increased tidal volume. Several trials have demonstrated beneficial effect in children with croup, but they are mostly anecdotal case reports or small case series. A systematic review conducted by the Cochrane Collaboration identified 2 small studies that both found a greater improvement in croup score in the helium-oxygen group, but this change did not reach statistical significance. Thus, they concluded that there is a lack of evidence to determine whether heliox inhalation is beneficial in the treatment of croup. An ongoing randomized controlled trial that aims to enroll 142 participants plans to compare changes in croup score as well as need for additional therapy, admission to hospital, intubation rate, length of stay, and use of subsequent health services between patients treated with heliox and patients breathing room air.

**Analgesics, Antipyretics, Antitussives, And Antibiotics**

While the authors were not able to identify any controlled trials that specifically addressed the use of antipyretics or analgesics in children with croup, there are no known contraindications to their use for relief of fever and pain. Anecdotally, reducing pyrexia often has the added benefit of reducing the respiratory rate, and thus the work of breathing. There is, however, no rationale to support the use of antitussives in the treatment of croup. Furthermore, the average age of patients affected with croup is < 2 years, and both the United States Food and Drug Administration and Health Canada have issued strong recommendations stating that use of antitussive medication should be discouraged in children < 6 years of age.

As croup is most likely the result of viral infection, antibiotic therapy is generally not indicated. Antibiotics should be reserved for cases of suspected bacterial tracheitis or laryngotracheobronchopneumonitis. Since the rate of secondary bacterial infection in croup is estimated to be < 1 case in 1000, there is no rationale for using antibiotics for prophylaxis in viral croup.

**Special Circumstances**

Children with known congenital anomalies of their upper airway may present with more-severe symptoms of croup. These children should be observed...
in the hospital setting, as they are at risk for rapid progression of airway obstruction and respiratory failure. These anomalies may include, but are not limited to, laryngomalacia, acquired or congenital subglottic stenosis, vocal fold paralysis, juvenile laryngeal papillomatosis, and subglottic heman-gioma. Special attention should also be given to patients with craniofacial anomalies (eg, Pierre Robin sequence, Treacher Collins syndrome, Gold-enhar syndrome, or Crouzon syndrome) if they present with severe symptoms that may require airway management. Urgent consultation with an otolaryngologist or anesthesiologist for potential difficult intubation should be made in these cases.

Recurrent episodes of croup in the same year (more than 2), especially if not accompanied by the classic prodrome of upper respiratory tract symptoms, should prompt a referral to an otolaryngologist for assessment of the airway by direct laryngoscopy/bronchoscopy. Retrospective studies have shown that these children are often found to have various degrees of acquired or congenital subglottic stenosis. Gastroesophageal reflux is emerging as a possible cause of these recurrent episodes. Patients with laryngoscopic findings of gastroesophageal reflux should be adequately treated with antireflux medications to reduce the progression of airway narrowing secondary to inflammatory mucosal edema. There is some suggestion that there may be a correlation between recurrent croup and family history of atopy. Children with recurrent croup should be monitored for development of symptoms of airway hyperreactivity. A chest radiograph may be considered to rule out the possibility of occult foreign body.

**Disposition**

Patients presenting with mild croup without stridor or chest wall retractions should be treated with oral dexamethasone. These children can then be safely discharged home without further observation if parents appear reliable and adequate key information is provided to them. Parents should be educated on the anticipated course of illness, signs of respiratory distress and, most importantly, when to seek medical care. (See Figure 2, page 12.)

Children with moderate croup who are experiencing stridor and signs of respiratory distress (such as chest wall retractions) but who do not have any alteration in their level of consciousness should also be treated with oral dexamethasone and nebulized epinephrine. These children should be observed for a minimum of 2 to 4 hours following the treatment with epinephrine. If the child has improved and no longer shows signs of upper airway obstruction at the end of the observation period, he or she may be safely discharged home, provided the caregivers are reliable and able to return to the hospital should the symptoms recur.

Hospital admission should be considered in cases of moderate to severe croup where patients have not improved after 4 hours of observation or who have a poor response to epinephrine. Consultation with a pediatric ICU or anesthesia is critical if a child exhibits signs of impending respiratory failure or recurrent episodes of agitation or lethargy that are not improving with nebulized epinephrine. Children with croup do not need specific follow-up. If stridor persists for over a week without any signs of respiratory distress, parents should see their primary care provider who can decide to further refer to an otolaryngologist to rule out other causes of stridor.

**Summary**

Children with acute viral croup commonly present to EDs or primary care providers. The vast majority of patients will present with mild croup without showing any signs of upper airway obstruction. The diagnosis of croup should be made on clinical history with a pediatric ICU or anesthesia is critical if a child exhibits signs of impending respiratory failure or recurrent episodes of agitation or lethargy that are not improving with nebulized epinephrine. Children with croup do not need specific follow-up. If stridor persists for over a week without any signs of respiratory distress, parents should see their primary care provider who can decide to further refer to an otolaryngologist to rule out other causes of stridor.

You determined that your patient had viral croup with moderate symptoms. The nurse moved him into a quiet room with the lights dimmed. He remained seated on his mother’s lap, and, with her help, he was given a nebulized dose of racemic epinephrine 0.5 mL of 2.25% solution diluted in 2.5 mL of saline, for a total volume of 3 mL. An oral dose of dexamethasone 0.6 mg/kg was given to him as soon as possible. He responded quickly to the nebulized epinephrine, with resolution of his stridor and retractions. He remained in the ED for 2 hours of observation. At the 2-hour mark, he showed no signs of respiratory distress, although he continued to have an intermittent, barky cough. His parents received written instructions regarding home treatment of croup and signs of respiratory distress, and the family was discharged home.
What is croup?
- Croup is a viral infection that causes swelling of the windpipe near the voice box.
- The symptoms of croup can appear quite frightening, but the illness is rarely serious.
- Croup is more common in the fall and winter.
- Croup is contagious and can be spread through sneezing and coughing, like a cold.
- Croup often occurs in small children between the ages of 6 months and 4 years.

What are the symptoms of croup?
- The swelling of the windpipe may cause a typical cough that sounds like a barking dog. You may also notice a raspy voice or cry, and a “whistling” sound as your child breathes in that is called “stridor.”
- Your child may have symptoms of a cold illness, like a low-grade fever, runny nose, and a decrease in energy and appetite.
- The symptoms of croup usually appear in the middle of the night and get better during the daytime. These symptoms usually last 2 to 5 days and, in most children, are mild and disappear quite quickly.
- Children eventually outgrow the tendency to develop croup symptoms. Older family members affected by the same virus usually only get sore throat, raspy voice, and cold-like symptoms (cough, runny nose).

What can I do at home?
- If you believe your child has symptoms of croup, stay calm and make your child comfortable. Being upset makes the breathing even harder for children with swelling in the windpipe.
- If your child has fever or complains of a sore throat, you may give him or her acetaminophen (Tempra® or Tylenol®) or ibuprofen (Advil® or Motrin®).
- Over-the-counter cough and cold medicines should NOT be given to children under the age of 6 years under any circumstances.
- Cold air sometimes helps with “croupy” sounds. If the weather is cool, make sure your child is dressed appropriately and go outside with him or her for 5 to 10 minutes. In warmer weather, you can also open the freezer door and let him or her breathe in the cold air.
- You should keep an eye on your child or stay within hearing range to assess for your child’s breathing:
  - If you hear a “whistling” sound, note if you hear it all the time even when your child is calm or only when he/she is upset/crying.
  - Look at your child’s chest wall when he/she is sleeping to see if you can see his/her ribs appearing when breathing (retractions) or if the notch above their breastplate is sucking in.
  - See if you can get your child to calm down or if he/she remains fussy and restless even when you try to soothe them.
  - Try to notice the color of your child’s lip and face in a good light, checking for a bluish-gray color.

When should I go to the hospital?
- You should seek medical care if:
  - Your child makes a constant “whistling” sound OR the chest wall is “caving in” or “sucking in” as he/she breathes, especially when calm.
  - You are unable to calm your child down and feel that he/she is unusually fussy or restless.
- You should call 9-1-1 if:
  - Your child’s face is bluish-gray for more than 5-10 seconds OR
  - Your child becomes unusually sleepy and you have difficulty seeing their chest wall moving when he/she breathes OR
  - Your child is struggling to breathe in and you are unable to calm them within a few minutes.
- If your child has severe symptoms, ambulance paramedics may start some treatment right away, and it is safer to call 9-1-1 than to drive yourself to the hospital, especially if you are nervous and panicked.

How is croup diagnosed and treated in the hospital?
- Croup is a viral infection; therefore, antibiotics that are used to treat bacterial infections will not help. Blood tests or x-rays do not help in making the diagnosis of croup and doctors are usually able to recognize it by the symptoms you describe.
- The most effective treatment for croup is dexamethasone, an oral corticosteroid that is given with syrup. This medication helps to reduce the swelling in your child’s windpipe. It is safe, starts to work within 2 or 3 hours, and lasts for a few days.
- Your child may need a breathing mask if he or she has “stridor” or chest wall retractions. The medication given by mask is adrenaline (sometimes called epinephrine) and very quickly reduces the swelling in the windpipe. Its effects last only 1 to 2 hours. If your child receives adrenaline by mask, he/she will need to be observed in the Emergency Department for at least 2 hours.
- Very few children with croup need to stay in the hospital for more than a few hours of observation. Even children with the most severe symptoms who require hospital admission usually get completely better after a couple of days without any residual problems.

Used courtesy of Jasmine Allaire, MD.
1. “But I needed to document his blood pressure.”
Avoid causing further agitation in a child with stridor. Observation of the child on the parent’s lap and an oxygen saturation monitor is all you need to do.

2. “He’ll be fine. His saturations came right up with oxygen.”
If a child requires oxygen to maintain adequate oxygen saturation, consider serious upper airway obstruction with impending respiratory failure or lower respiratory tract parenchymal involvement, such as laryngotracheobronchopneumonitis, or pneumonia.

3. “This kid just had a barky cough yesterday. Why did his parents bring him back today?”
Evidence shows that treating even mild croup with oral dexamethasone prevents repeat ED and other healthcare visits and improves sleep.

4. “The child vomited the dexamethasone. What do I do now?”
Pay attention to the form of oral dexamethasone that is administered or dispensed in your practice setting. Many of the commercially available oral solutions of dexamethasone are quite dilute. This means that a child will have to take a large volume of medication. For example, a 10-kg child who is prescribed 0.6 mg/kg of the 0.5 mg/5 mL oral dexamethasone solution would have to ingest 60 mL of the solution to get his dose. Most of the studies on oral dexamethasone in croup have used the much more concentrated parenteral-injectable form of the drug given orally. The small volume is absorbed rapidly and is well tolerated, with vomiting in fewer than 5% of patients. In children with persistent vomiting, dexamethasone can be given IM or IV. Nebulized budesonide is another option when a child cannot tolerate oral medications.

5. “Antibiotics can’t hurt…”
Antibiotics should be reserved for suspected cases of bacterial tracheitis (high fever, toxic appearance, acute onset of stridor, poor response to epinephrine) or pneumonia (focal findings on auscultation such as crackles, wheezing, or infiltrate on chest radiograph). There is no role for antibiotic prophylaxis in croup.

6. “This is the third time this kid has had croup this winter.”
It is important to consider other causes of stridor in children with recurrent symptoms or who present with stridor in the absence of a viral prodrome or who do not improve with treatment with epinephrine.

7. “She looked so good after that dose of epinephrine that I let her go…”
Physicians should observe children who have been treated with epinephrine for at least 2 hours before discharging them home. The effects of epinephrine typically wear off after about 2 hours, and the child may develop recurrence of symptoms similar to the ones exhibited prior to treatment with epinephrine.

8. “He still had symptoms 4 days later, so I gave him more dexamethasone.”
There is no evidence to support the use of multiple doses of dexamethasone in the treatment of croup. Croup generally lasts 2 to 5 days. If a child is still having moderate symptoms days after receiving a dose of dexamethasone, other diagnoses must be considered, such as bacterial tracheitis or anatomic abnormalities of the airway.

9. “They’re calling a code blue in radiology!”
Children with signs of worsening upper airway obstruction should not leave the ED for diagnostic imaging. They may decompensate rapidly if they become upset or are laid down for radiographs.

10. “What size endotracheal tube should I use?”
If a child with signs of severe croup does not improve with nebulized epinephrine and/or if they show signs of increasing agitation or lethargy, they should be referred to a pediatric critical care unit. If intubation is necessary, it should be done under controlled circumstances by someone with expertise in managing difficult pediatric airways. It is advisable to start with a cuffed endotracheal tube a half-size smaller than would be predicted for the child’s age. It may be necessary to size down even more, depending on the degree of subglottic edema.
Key Points

- Croup is a common viral childhood illness occurring most often in the late autumn and winter in children between the age of 6 months and 3 years.
- Croup symptoms usually worsen during the night, making it a frequent chief complaint in the ED.
- Most cases presenting to EDs are assessed as mild, and mortality due to croup is very low.
- Symptoms of croup are a low-grade fever with or without an upper respiratory infection-like prodrome, a characteristic “seal-like” barking cough, and inspiratory stridor, accompanied by varying degrees of respiratory distress.
- A toxic-looking child presenting with drooling, tripod stance, and stridor with the absence of a barky cough should prompt quick assessment for epiglottitis, with airway management handled by highly skilled specialist physicians (ENT and/or anesthesiologist).
- Diagnosis of croup should be made clinically. If imaging studies are obtained to rule out another diagnosis, patients should be closely monitored because of the risk of rapidly progressive upper airway obstruction.
- Treatment of croup consists of oxygen by blow-by technique, oral corticosteroids (dexamethasone 0.15-0.6 mg/kg/dose) even for mild cases, and nebulized epinephrine for children with signs of upper airway obstruction (audible stridor or marked chest wall retractions). L-epinephrine 1:1000 has been shown to be as effective as racemic epinephrine 2.25%, and institutional preference may guide management.
- Signs of impending respiratory failure include a change in mental status, less respiratory effort, disappearance of stridor accompanied by a pale, dusky appearance, and decreasing oxygen saturation.
- Children with significant respiratory symptoms 4 hours after the administration of corticosteroids or repeated doses of epinephrine should be admitted to the hospital.
- Children with recurrent episodes of croup should be referred to an otolaryngologist for assessment of their upper airway to rule out anatomical anomalies such as subglottic stenosis or gastroesophageal reflux.

References

Evidence-based medicine requires a critical appraisal of the literature based upon study methodology and number of subjects. Not all references are equally robust. The findings of a large, prospective, randomized, and blinded trial should carry more weight than a case report.

To help the reader judge the strength of each reference, pertinent information about the study, such as the type of study and the number of patients in the study will be included in bold type following the references, where available. The most informative references cited in this paper, as determined by the author, will be noted by an asterisk (*) next to the number of the reference.


60. Geelhoed GC. Oral dexamethasone in the treatment of croup: 0.15 mg/kg versus 0.3 mg/kg versus 0.6 mg/kg. Ped Pulmonol. 1995;20(6):362-368. (Randomized controlled trial; 120 patients)


63. A comparison of oral prednisolone and oral dexamethasone in children with croup: a prospective, randomised, double blinded multicentre trial, Australian New Zealand Clini-
5. Which of the following is a radiographic sign of croup?
   a. Widening of the prevertebral space on lateral neck radiograph
   b. Thumb sign on the lateral neck radiograph
   c. Tracheal deviation on the chest radiograph
   d. Steeple sign on the chest radiograph

6. Which of the following tests are necessary in evaluating a child you suspect has croup?
   a. A chest x-ray
   b. A nasopharyngeal swab or washing for viral molecular testing
   c. A complete blood count
   d. No diagnostic tests are required

7. All of the following have been shown to be effective therapies for croup EXCEPT:
   a. Nebulized budesonide
   b. Humidified air
   c. Nebulized racemic epinephrine
   d. IM dexamethasone

8. Which of the following statements is true regarding treatment of mild croup with dexamethasone?
   a. Dexamethasone is only useful in children with a family history of atopy.
   b. Dexamethasone must be given within the first 24 hours of the onset of symptoms to be effective.
   c. Treatment of mild croup with dexamethasone reduces healthcare costs.
   d. Treatment of mild croup with dexamethasone reduces the infectiousness of the child.

9. A child with moderate to severe symptoms of croup treated with oral dexamethasone has improved with nebulized epinephrine. His symptoms recur 1 hour later. What is the most appropriate next step in management?
   a. Administer nebulized budesonide
   b. Prepare for intubation
   c. Repeat nebulized epinephrine dose
   d. Administer inhaled heliox

10. A child with moderate-to-severe symptoms of croup responds well to a dose of nebulized epinephrine. Provided she remains asymptomatic, when can she be safely discharged home?
    a. After 1 hour of observation
    b. After 2 to 4 hours of observation
    c. After 5 to 6 hours of observation
    d. All children requiring treatment with nebulized epinephrine should be hospitalized for at least 24 hours.
An Evidence-Based Approach To Pediatric Pain Management In The Emergency Department

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Analgesia is a critical part of the management of pediatric patients in the emergency department (ED). Pain is multifactorial and is influenced by its etiology, patient age, temperament, beliefs, and past experiences. Suboptimal treatment of pain can have deleterious effects in the short term, but it can also affect a patient's reaction to future painful experiences and development. Tools exist to reliably quantify a patient's pain level, regardless of age or developmental stage. Both pharmacologic and nonpharmacologic methods can be effective in the management of pediatric pain. Multiple modalities exist for the management of procedural pain, ranging from topical analgesia for IV placement to procedural sedation for more significant procedures. ED physicians must remain vigilant in the recognition and treatment of pediatric pain, as patients’ developmental level may limit their ability to adequately express their pain experience.

Evidence-Based Emergency Management Of The Pediatric Airway

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Pediatric airway emergencies are a relatively uncommon, yet anxiety-provoking, scenario seen in both pediatric and general emergency departments. Several new concepts regarding preoxygenation during rapid sequence intubation (RSI), anticipation and prevention of intubation-related complications, the utility of premedication agents, and the selection of induction and paralytic agents have gained popularity among emergency clinicians physicians for adult RSI. In this issue, we will outline the data behind these concepts, highlight any current pediatric literature related to these issues, and present conclusions based on the best available evidence. We present a review of the anatomic and physiologic differences during RSI commonly encountered in the pediatric patient, a systematic approach to the assessment of the pediatric patient in respiratory distress (ie, the pediatric assessment triangle), and a simple approach to pediatric RSI, starting with preparation and ending with postintubation management. We additionally highlight several alternative airway techniques and briefly review RSI in the obese pediatric patient and in the difficult airway patient.
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Credit Designation: EB Medicine designates this enduring material for a maximum of 4 AMA PRA Category 1 Credits™. Physicians should claim only credit commensurate with the extent of their participation in the activity.

ACEP Accreditation: Pediatric Emergency Medicine Practice is also approved by the American College of Emergency Physicians for 48 hours of ACEP Category I credit per annual subscription.

AAP Accreditation: This continuing medical education activity has been reviewed by the American Academy of Pediatrics and is acceptable for a maximum of 48 AAP credits per year. These credits can be applied toward the AAP CME/CPD Award available to Fellows and Candidate Fellows of the American Academy of Pediatrics.

AOA Accreditation: Pediatric Emergency Medicine Practice is eligible for up to 48 American Osteopathic Core Category 2A or 2B credits per hour.

Needs Assessment: The need for this educational activity was determined by a survey of medical staff, including the editorial board of this publication; review of morbidity and mortality data from the CDC, AHA, NCHS, and ACEP; and evaluation of prior activities for emergency physicians.

Target Audience: This enduring material is designed for emergency medicine physicians, physician assistants, nurse practitioners, and residents.

Goals: Upon reading Pediatric Emergency Medicine Practice, you should be able to: (1) demonstrate medical decision-making based on the strongest clinical evidence; (2) cost-effectively diagnose and treat the most critical ED presentations; and (3) describe the most common medicolegal pitfalls for each topic covered.

Discussion of Investigational Information: As part of the newsletter, faculty may be presenting investigational information about pharmaceutical products that are outside Food and Drug Administration approved labeling. Information presented as part of this activity is intended solely as continuing medical education and is not intended to promote off-label use of any pharmaceutical product.

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Method of Participation:

Print Subscription Semester Program: Paid subscribers who read all CME articles during each Pediatric Emergency Medicine Practice six-month testing period, complete the post-test and the CME Evaluation Form distributed with the June and December issues, and return it according to the published instructions are eligible for up to 4 hours of CME credit for each issue. You must complete both the post-test and CME Evaluation Form to receive credit. Results will be kept confidential.

Online Single-Issue Program: Current, paid subscribers who read this Pediatric Emergency Medicine Practice CME article and complete the online post-test and CME Evaluation Form at ebmedicine.net/CME are eligible for up to 4 hours of Category 1 credit toward the AMA Physician’s Recognition Award (PRA). You must complete both the post-test and CME Evaluation Form to receive credit. Results will be kept confidential.

Hardware/Software Requirements: You will need a Macintosh or PC with internet capabilities to access the website. Adobe Reader is required to download archived articles.

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