Croup

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Viral croup is the most common form of upper airway obstruction in children 6 months to 6 years of age. It typically presents in the late fall or early winter, is often preceded by an upper respiratory infection, and is characterized by a low-grade fever, barking cough, and inspiratory stridor. Diagnosis is made on clinical grounds with no specific confirmatory test. The differential diagnosis of croup, including epiglottitis and retropharyngeal abscess, must always be considered in evaluating children with inspiratory stridor.

Three therapeutic modalities are available for the treatment of croup: humidified air, racemic epinephrine, and adrenal corticosteroids. Maintaining at least 50% relative humidity in the child's room is recommended. If there is evidence of hypoxemia, a mist tent with supplemental oxygen may be helpful.

Racemic epinephrine administered by nebulizer can quickly reverse airway obstruction in children with croup. The patient needs to be monitored for rebound airway obstruction for at least 2 hours after administration. The mainstay of treatment for severe croup is dexamethasone, administered 0.6 mg/kg, intramuscularly (IM). Dexamethasone is effective at decreasing the obstructive symptoms of croup, but its onset of action is approximately 6 hours after administration. Therefore, administration of racemic epinephrine is often helpful until the steroids begin to take effect. The correct dosage of dexamethasone is important, as lower steroid dosages have proven to be ineffective in treating croup. Dexamethasone IM, or an equivalent dose of oral prednisone, may be considered in children with moderately severe croup who do not require hospitalization.

Key words. Croup; respiratory sounds; dexamethasone; epinephrine; steroids. (*J Fam Pract 1993; 37:165-170*)

Viral croup, or laryngotracheitis, is the most common form of airway obstruction in children 6 months to 6 years of age. Croup has an annual incidence of approximately 1.5 cases per 100 children under 6 years of age.[1] Between 1.5% and 15% of children with croup require hospitalization. As one of the more common inpatient pediatric illnesses, croup accounts for approximately 20,000 hospital admissions per year in the United States.[1–3]

Pathophysiology

Croup is a syndrome of laryngeal obstruction that occurs when the subglottic region of the larynx, held rigidly within the ring of the cricoid cartilage, becomes inflamed and edematous. This is most commonly caused by a viral infection. Because an infant's larynx is narrow, even a small decrease in the radius of the airway causes a large decrease in the area available for air flow, leading to clinical symptoms of airway obstruction including stridor and shortness of breath. The most common virus causing croup is parainfluenza virus type 1. Less common viral causes of croup include parainfluenza virus types 2 and 3, influenza virus type A, respiratory syncytial virus, and the rhinoviruses.[1–5]

Clinical Presentation

The mean age of children presenting with croup is 18 months, with age ranging from 3 months to 6 years. Peak incidence occurs in the second year of life. The male-to-female ratio of occurrence is 1.5:1. There is a seasonal

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correlation, with the number of cases rising dramatically in the early fall and tapering off through the winter.[1,2,4,6]

Viral croup is typically preceded by 1 to 2 days of an upper respiratory infection. As subglottic infection and edema progress, hoarseness, fever, and a characteristic "croupy" or barking cough develops. In many cases the illness progresses no further. If obstruction continues, inspiratory stridor, flaring of the ala nasi, suprasternal retractions, and intercostal retractions occur, at times leading to severe respiratory distress. The course of the illness is usually 3 to 7 days.

The syndrome of croup has traditionally been divided into spasmodic (recurrent) croup and laryngotracheitis. Spasmodic croup may not have preceding respiratory symptoms, can occur suddenly at night, and is usually milder than laryngotracheitis. Laryngotracheitis has a longer prodrome, and is often more severe than recurrent croup. A recent analysis has suggested that spasmodic croup may not be a separate illness, but rather one end of a broad spectrum of clinical manifestations of viral croup.[7]

Findings on physical examination vary depending upon when in the course of the illness a child is examined. Fever is present in about 80% of cases. The child may have only a "croupy" or "seal-like" cough, or may present in various degrees of respiratory distress with inspiratory stridor, flaring of the ala nasi, and intercostal or supracostal retractions. The lungs are usually clear to auscultation, though in about 5% of cases wheezing is heard.[1–4] Patients with croup may deteriorate rapidly. It is important therefore to monitor respiratory rate, skin color, degree of dyspnea, retractions, and level of consciousness.

A patient with croup will have a normal or mildly elevated white blood count, with a WBC greater than 15,000/mm^3 in about 20% of patients.[6] Hypoxemia may occur. A classic finding on lateral radiographs of the neck is a widening of the hypopharynx. Posteroanterior radiographs may demonstrate a narrowed subglottic region, called the "steeple" sign, indicating subglottic edema and narrowing. Classic signs of croup appear on the radiograph in only 40% to 50% of cases.[3,6,8] Lateral radiographs of the neck are most helpful in making the diagnosis of epiglottitis or a retropharyngeal abscess. In epiglottitis, a lateral radiograph of the neck can reveal a swollen epiglottis and thickened aryepiglottic folds. In retropharyngeal abscesses, a lateral radiograph of the neck can reveal a widened retropharyngeal space. However, lateral radiographs of the neck may be less than 70% sensitive for detecting epiglottitis, and the findings on almost one fourth of lateral neck radiographs taken of children with croup may be indeterminate in ruling out epiglottitis.[9]

Table 1. Differential Diagnosis of Croup

Croup
Epiglottitis
Retropharyngeal abscess
Peritonsillar abscess
Foreign body
Extrinsic laryngeal compression (tumor, cyst, hematoma)
Angioedema
Laryngeal web
Vascular ring
Caustic ingestion
Bacterial tracheitis
Acquired or congenital subglottic stenosis
Paraquat poisoning
Laryngomalacia

It is important to consider a differential diagnosis in all children presenting with stridor, as not every child who has stridor has croup (Table 1). The most important condition that needs to be distinguished from croup is epiglottitis, a bacterial infection of the epiglottis usually caused by *Hemophilus influenzae*, type b (Table 2). Epiglottitis can rapidly lead to complete airway obstruction and death, and typically presents with a rapid course in which a child develops a high fever and a toxic appearance over the course of several hours. The child usually sits, leaning forward with his neck extended and chin thrust forward, drooling because of his inability to swallow his secretions. This is in contrast to the child with croup, who usually has a slower onset of illness, preceded by several days of an upper respiratory infection, a lower fever, a more dramatic cough, and a less toxic appearance. Also, the average age of children with epiglottitis is

Table 2. Differentiating Croup from Epiglottitis

Characteristic	Croup	Epiglottitis
Age	3 mo–6 y	3 y–7 y
History		
Preceding URI	Yes	No
Onset	Gradual or sudden	Sudden
Clinical findings		
Inspiratory stridor	Yes	Yes
Fever	Low grade	Medium to high
Drooling	No	Yes
Toxic appearance	No	Yes
Cough	Yes	No
Position	Lying or sitting	Sitting leaned forward, neck extended, drooling
Diagnostic findings		
Radiograph	Subglottic edema and narrowing ("steeple" sign)	Lateral neck: swollen Epiglottis

URI denotes upper respiratory infection.

older (3 to 7 years) than that for croup, though the overlap in ages is considerable.

A child who is leaning over drooling, but not coughing, should alert the physician to the possibility of epiglottitis. In one study this combination of physical signs was found to be 67% sensitive and 100% specific for epiglottitis. In the same study, 2% of patients initially suspected of having croup had epiglottitis as their final diagnosis.[10] In a child who is suspected of having croup, a lateral neck radiograph can raise the otherwise unsuspected possibility of epiglottitis or retropharyngeal abscess. Because of the lack of sensitivity and specificity of the test, however, lateral neck radiographs must be used and interpreted with caution. Examination of the throat of a child with suspected epiglottitis is contraindicated, as doing so can lead to spasm of the airway and complete airway obstruction. If the clinical presentation of a child suggests epiglottitis, the physician should not waste time getting a lateral neck radiograph. Visualization of the epiglottis should be performed as soon as possible in a controlled setting with facilities available for intubation and tracheotomy.[1,3,4,5,8] Epiglottitis is confirmed by visualizing the classic "cherry red" epiglottis.

Treatment

Airway obstruction can progress rapidly in children hospitalized for croup, so careful observation and monitoring for deterioration is an important part of inpatient management. This monitoring is best accomplished through frequent clinical assessment. The decision to hospitalize a child with croup is determined by the child's degree of stridor, severity of retractions, pulse rate, respiratory rate, and evidence of cyanosis. Many physicians feel that stridor at rest is an indication for hospital admission. Pulse oximetry may be a useful adjunct to clinical evaluation, but its use in croup has not been carefully evaluated. Furthermore, one study has shown a poor correlation between pulse oximetry and respiratory rate, raising questions as to the specificity of pulse oximetry in croup, with falsely low readings occurring secondary to movement artifact.[11]

The three treatments for croup, humidified air, racemic epinephrine, and adrenal corticosteroids, are discussed in the sections that follow (Table 3). All published studies of the treatment of croup have looked at children who required hospitalization. There are no data available from controlled studies on the ambulatory care treatment of children with croup. It must be understood that extension of inpatient-tested therapy to the ambulatory setting is based on clinical judgment, a generalization of studies of hospitalized patients, and two uncontrolled case series describing outpatient management.

Table 3. Medication for the Treatment of Croup

Humidified air with or without oxygen
Racemic epinephrine 0.25 mL of 2.25% solution in 3 mL normal saline (L-epinephrine [1:1000] administered by nebulizer may be used if racemic epinephrine is not available.)
Dexamethasone 0.6 mg/kg IM

IM denotes intramuscularly.

Humidified Air

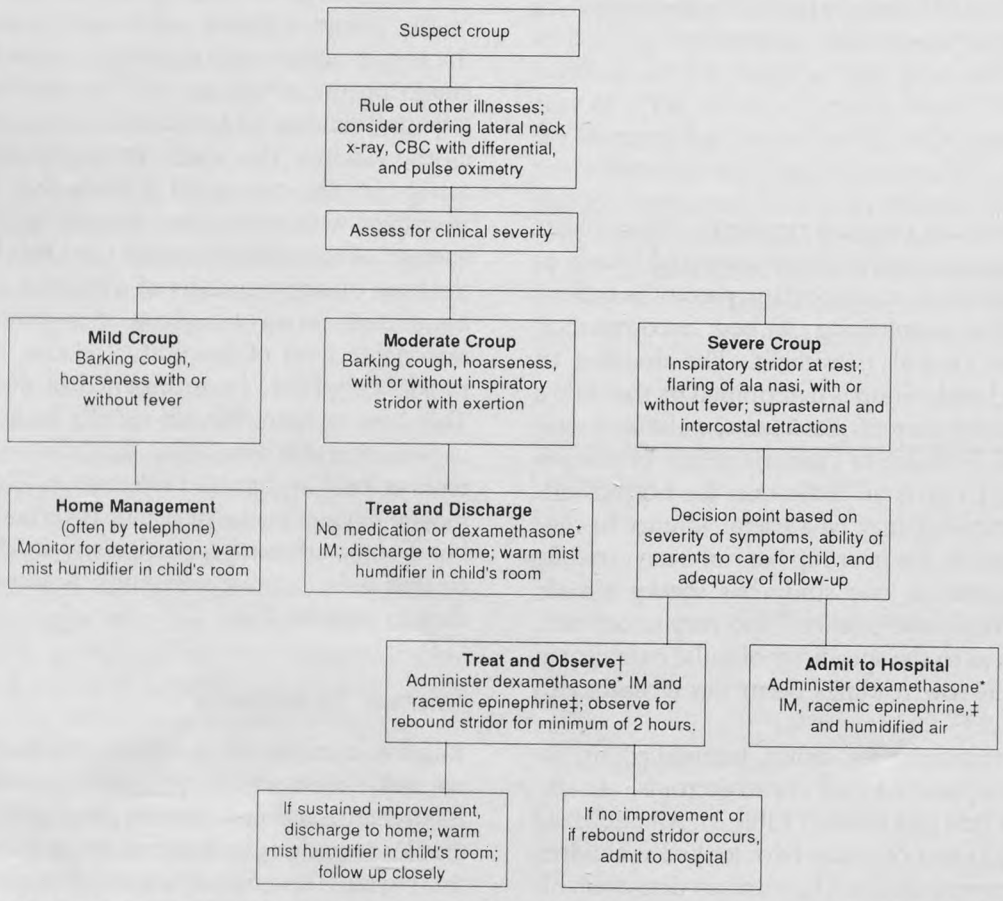
The provision of humidified air, usually by placing a mist tent over the patient, is routine treatment for all children hospitalized with croup. This treatment originated in the late 19th century, when it was observed that steam from tea kettles or hot tubs seemed to alleviate the spasm of croup. This led to the use of "croup kettles" in hospitals, and eventually mist tents to deliver higher levels of humidity.[3] Humidified air presumably works by moistening the throat and larynx, making it easier for the child to cough up the secretions, and by soothing the inflamed laryngeal mucosa.[7] Humidified air has no effect on subglottic edema, the main pathophysiologic defect in croup. In the two small studies that have looked at treatment with humidified air, neither showed any advantage of humidified air over placebo.[12,13] Primarily on the basis of large numbers of anecdotal observations that humidified air was beneficial, it is recommended that a reasonable level of humidity (relative humidity of approximately 50%) be maintained in the hospital room. This level of humidity can usually be achieved with the use of a portable humidifier. It is reasonable to use a mist tent, as long as the child tolerates it. The use of supplemental oxygen in the mist tent is certainly safe and may be of some advantage, particularly in children with decreased pulse oximetry readings; however, there are few data to support this.[7]

Racemic Epinephrine

Racemic epinephrine (a mixture of equal amounts of the D- and L-isomers of epinephrine) works through its α-adrenergic effects, causing mucosal vasoconstriction that leads to decreased edema in the subglottic region of the larynx.[3] Racemic epinephrine is given at a dose of 0.25 mL of 2.25% racemic epinephrine in 2 to 3 mL of normal saline solution and administered by nebulizer. Time until onset of action is less than 10 minutes and duration of action is less than 2 hours.[14–18] Treatment

may cause rebound upper airway obstruction, usually within 2 hours, with the degree of obstruction in some patients being greater 2 hours after treatment than before treatment.[15–17] Any patient who receives racemic epinephrine should be observed for at least 2 hours for signs of rebound stridor, should receive corticosteroid treatment, and should be considered for hospitalization. In a recent retrospective analysis in which 50 children were observed in the emergency room for a minimum of 2 hours after receiving racemic epinephrine and steroids and then discharged, only one child was brought back to the emergency room though not admitted to the hospital.[19] The two other children were lost to follow-up. All children were completely free of stridor at rest and intercostal retractions before being discharged. This study and one other descriptive report (the methodology of which is unclear and the data of limited reliability) of 1087 patients[20] raise the possibility that cautious use of racemic epinephrine, along with steroids, may be appropriate in selected patients with croup. In these patients, stridor and retractions should be completely resolved after treatment with racemic epinephrine. Patients should be observed for at least 2 hours post-treatment to see that their condition does not deteriorate before being discharged. Children who are considered for outpatient management must not appear toxic, must be well hydrated, have no stridor at rest 2 hours after receiving racemic epinephrine, and must be in the care of reliable adults who are able to bring the child back to the physician if further exacerbation of croup occurs. Further research is needed to confirm the safety of outpatient use of racemic epinephrine.

Because of problems in producing the chemical for the racemic form of epinephrine, it has become inconsistently available in the United States. L-epinephrine (1:1000), which is more readily available, can be administered by nebulizer and is as effective as racemic



An algorithm for the treatment of croup. *Dosage: 0.6 mg/kg. †Sending children home after treatment with racemic epinephrine is currently controversial. ‡Dosage: 0.25 mL of 2.25% solution in 3 mL normal saline by nebulizer (L-epinephrine 1:1000 may be used if racemic epinephrine is not available). IM denotes intramuscularly.

epinephrine in treating upper airway obstruction caused by croup.[21]

Adrenal Corticosteroids

Adrenal corticosteroid use in the treatment of croup has been debated for over 20 years.[7,22–24] Theoretically, corticosteroids decrease subglottic edema by suppressing the local inflammatory reaction, leading to decreased lymphoid tissue swelling and decreased capillary permeability.[3,25,26] Controversy over the use of steroids in the treatment of croup has occurred because, of the 14 studies since 1960 that have assessed their use, seven showed a positive effect and seven showed no effect.[6,8,14,27–37] Two recent articles, one a critical comprehensive overview of the literature and one a meta-analysis, concluded independently that the inconsistency in the results of the studies was caused by inadequate doses of steroids (<0.3 mg/kg of dexamethasone) in some of the studies.[7,24] These two analyses concluded that when adequate doses of corticosteroids are used, they are effective in decreasing obstructive symptoms of croup within 12 to 24 hours after administration. In addition, steroids significantly decreased the need for endotracheal intubation (80% decrease in the pooled steroid treated group) and may decrease the length of hospital stay. No study has shown any adverse effects from the use of a single dose of corticosteroid in the treatment of croup. Given the clear efficacy and safety of higher dose corticosteroid treatment, dexamethasone phosphate 0.6 mg/kg IM should be administered at the time of admission to the hospital of all children with croup.[7] Steroid use in ambulatory care treatment of croup has not been evaluated and remains an important area for future research. It would appear reasonable and safe to consider using dexamethasone 0.6 mg/kg IM, or an equivalent dose of oral prednisone, to treat children with moderately severe croup in whom close follow-up can be assured and who do not, at the time of evaluation, require admission to the hospital.

An algorithm for the treatment of croup, based on studies of hospitalized patients and applied with clinical judgment to a broad range of patients with croup is presented in the Figure. It is important to understand that the use of racemic epinephrine and steroids in ambulatory patients has not been extensively studied, but is being utilized. Ambulatory care treatment of croup remains an area needing further study.

Conclusions

Croup is a common viral illness that causes upper airway obstruction in children 6 months to 6 years of age. Croup must be distinguished from other causes of upper airway obstruction in this age group including epiglottitis, retropharyngeal abscess, and foreign body aspiration. Treatment of croup consists of humidified air with or without supplemental oxygen, nebulized epinephrine, and an adequate dose of intramuscular dexamethasone.

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References

1. Denny FW, Murphy TF, Clyde WA, Collier AM, Henderson FW. Croup: an 11-year study in a pediatric practice. Pediatrics 1983; 71:871–6.
2. Freeland AP, Evans JN. Acute laryngeal infections in childhood. In: Kerr AG, ed. Scott-Brown's otolaryngology. 5th ed. Stoneham, Mass: Butterworths, 1987.
3. Baugh R, Gilmore BB. Infectious croup: a critical review. Otolaryngol Head Neck Surg 1986; 95:40–6.
4. Stern RC. Infectious croup. In: Behrman RE, Vaughan VC, eds. Nelson's textbook of pediatrics. Philadelphia: WB Saunders, 1987.
5. Goldhagen JL. Croup: pathogenisis and management. J Emerg Med 1983; 1:3–11.
6. James JA. Dexamethasone in croup. Am J Dis Child 1969; 117: 511–6.
7. Skolnik NS. Treatment of croup—a critical review. Am J Dis Child 1989; 143:1045–9.
8. Postma DS, Jones RO, Pillsbury HC. Severe hospitalized croup: treatment trends and prognosis. Laryngoscope 1984; 94:1170.
9. Stankiewicz JA, Bowes AK. Croup and epiglottitis: a radiologic study. Laryngoscope 1985; 95:1159–60.
10. Mauro RD, Poole SR, Lockhart CH. Differentiation of epiglottitis from laryngotracheitis in the child with stridor. Am J Dis Child 1988; 142:679–82.
11. Stoney PJ, Chakrabarti MK. Experience of pulse oximetry in children with croup. J Laryngol Otol 1991; 105:295–8.
12. Lenney W, Milner AD. Treatment of acute viral croup. Arch Dis Child 1978; 53:704–6.
13. Bourchier D, Fergusson DM. Humidification in viral croup: a controlled trial. Aust Paediatr J 1984; 20:289–91.
14. Kuusela AL, Vesidari T. A randomized double-blind, placebo controlled trial of dexamethasone and racemic epinephrine in the treatment of croup. Acta Paediatr Scand 1988; 77:99–104.
15. Fogel JM, Berg IJ, Gerber MA. Racemic epinephrine in the treatment of croup: nebulization alone versus nebulization with intermittent positive pressure breathing. J Pediatr 1982; 25: 1028–31.
16. Taussig L, Castro O, Peaudry PH, et al. Treatment of laryngotracheobronchitis (croup). Am J Dis Child 1975; 129:790–3.
17. Westley CR, Cotton EK, Brooks JG. Nebulized racemic epinephrine by IPPB for the treatment of croup. Am J Dis Child 1978; 132:484–7.
18. Gardner HG, Powell KR, Roden VJ, Cherry JD. The evaluation of racemic epinephrine in the treatment of infectious croup. Pediatrics 1973; 52:52–5.
19. Kelley PB, Simon JE. Racemic epinephrine use in croup and disposition. Am J Emerg Med 1992; 10:181–3.
20. Corneli HM, Bolte RG. Outpatient use of racemic epinephrine in croup. Am Fam Physician 1992; 46:683–4.
21. Waisman Y, Klein BL, Boenning DA, Young GM, Chamberlain JM, O'Connell R, Ochsenschlager DW. Prospective randomized double-blind study comparing L-epinephrine and racemic epineph-

rine aerosols in the treatment of laryngotracheitis (croup). Pediatrics 1992; 89:302–6.
22. Tunnessen WW, Feinstein AR. The steroid-croup controversy: an analytic review of methodologic problems. J Pediatr 1980; 96: 751–6.
23. Cherry JD. The treatment of croup: continued controversy due to failure of recognition of historic, ecologic, etiologic and clinical perspectives. J Pediatr 1979; 94:352–4.
24. Kairys SW, Olmstead BA, O'Connor GT. Steroid treatment of laryngotracheitis: a meta-analysis of the evidence from randomized trials. Pediatrics 1989; 83:683–93.
25. Haynes RC, Murad F. Adrenocorticotropic hormone. In: Goodman and Gilman's The pharmacological basis of therapeutics. New York, NY: Macmillan Publishing Company, 1985.
26. Goldfien A. Adrenocorticosteroids and adrenocortical antagonists. In: Katzung BG, ed. Basic and clinical pharmacology. 3rd ed. Norwalk, Conn: Appleton & Lange, 1987.
27. Koren G, Frand M, Burzilay Z, MacLeod SM. Corticosteroid treatment of laryngotracheitis vs spasmodic croup in children. Am J Dis Child 1983; 137:941–4.
28. Eden AN, Kaufman A, Yu R. Corticosteroids and croup. JAMA 1967; 200:133–4.
29. Eden AN, Larkin V. Corticosteroid treatment of croup. Pediatrics 1964; 33:768–9.
30. Martensson B, Nilsson G, Torbjar JE. The effect of corticosteroids in the treatment of pseudo-croup. Acta Otolaryngol 1960; 158(suppl):62–9.
31. Sussman S. Dexamethasone in obstructive respiratory tract infections in children. Pediatrics 1964; 34:851–5.
32. Novik A. Corticosteroid treatment of non-diphtheritic croup. Acta Otolaryngol 1960; 158(suppl):20–3.
33. Ross JA. Special problems in acute laryngotracheo-bronchitis. Laryngoscope 1969; 79:1218–26.
34. Leipzig B, Oski FA, Cummings CW, et al. A prospective randomized study to determine the efficacy of steroids in treatment of croup. J Pediatr 1979; 94:194–6.
35. Skowron PN, Turner JAP, McNaughton GA. The use of corticosteroid (dexamethasone) in the treatment of acute laryngotracheitis. Can Med Assoc J 1966; 94:528–31.
36. Muhlendahl KE, Kahn D, Spohr HL, Dressler F. Steroid treatment of pseudo-croup. Helv Paediatr Acta 1982; 37:431–6.
37. Super DM, Cartelli NA, Brooks LJ, Lembo RM, Kumar ML. A prospective randomized double-blind study to evaluate the effect of dexamethasone in acute laryngotracheitis. J Pediatr 1989; 115: 323–9.