

Management of croup in children

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Abstract

Laryngotracheobronchitis, commonly known as croup, is a respiratory illness, often mild, which occurs most frequently in children between six months and three years of age. It is characterised by a seal-like 'barking' cough, hoarseness of the voice and inspiratory stridor which is preceded by fever, rhinorrhoea and a non-specific cough. Respiratory distress and lethargy are uncommon exacerbations of croup which may be potentially life threatening. This article provides an overview of croup, including the epidemiology and clinical manifestations and the management thereof.

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Introduction

Croup (laryngotracheobronchitis or laryngotracheitis) is a term given to a respiratory illness which has a range of symptoms that vary from an occasional barking cough and a minimal high-pitched, wheezing sound caused by disrupted airflow when breathing in (inspiratory stridor) to dyspnoea, irritability, hypoxia and respiratory arrest.^{1,2} Viral croup (also called classic croup) is most commonly caused by the respiratory parainfluenza viruses types 1 and 3.^{1,2} Occasionally, classic croup can result from respiratory syncytial virus, adenovirus, metapneumovirus and influenza A and B. Very rarely, cases of croup from mycoplasma pneumonia infection as well as herpes simplex virus and measles in areas where measles remains prevalent have been reported.^{1,2} Croup occurs most frequently in children between six months and three years of age. However, rare cases of croup in children as young as three months and in older children and adults have been described.¹ Family history is a risk factor for croup although parental smoking, a well recognised risk factor for respiratory illness in children, does not seem to increase the risk of croup.²

The symptoms of croup usually improve during the daytime and worsen at night.³ Although croup can occur at any time during the year, it mostly occurs predominantly in late autumn to winter months. While generally a benign and self-limiting condition, the extent of the sleep disturbance and family impact of croup is sometimes distressing to the children and their caregivers.³

Several respiratory conditions present with similar clinical features to viral croup and there is no single classification based on anatomical distribution of inflammation or clinical features which is adequate to differentiate croup from other similar respiratory illnesses except based on the causative agents.^{1,2,4} For example,

spasmodic croup differs from viral croup in that the pathology appears to be primarily allergic.⁵ Similarly, epiglottitis is caused by *Haemophilus Influenzae* type B and laryngeal diphtheria is caused by infections affecting the glottis and subglottis.^{2,4,6} It is also important to distinguish croup from other conditions causing stridor, including a foreign body lodged in the upper oesophagus, retropharyngeal abscess, hereditary angioedema and inflammation affecting the upper airway structures (larynx, vocal cords and trachea) which may be secondary to mechanical injury as this has implications for the management of such patients.^{2,6}

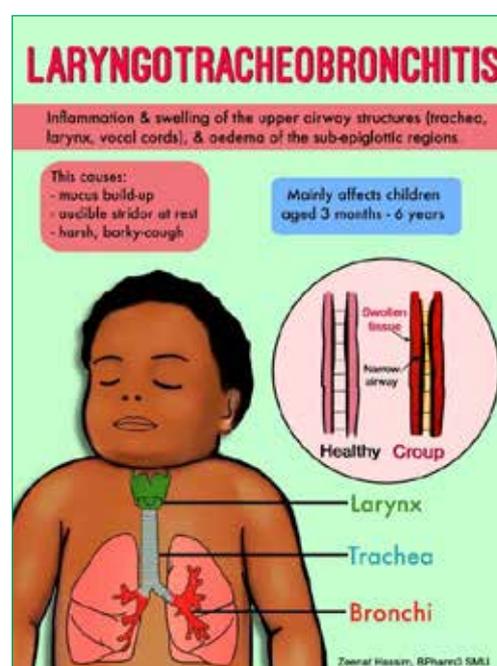


Figure 1. Inflammation of the laryngeal region in croup

Signs and symptoms

The classic signs and symptoms of croup include a barking cough, hoarse voice, inspiratory stridor due to inflammation and swelling of the laryngeal region as well as from oedema which results in narrowing of the subglottic region (see Figure 1). With croup, there is minimal if any pharyngitis.⁶

Children typically present with sudden onset of the symptoms after 24 to 72 hours of a seemingly mild upper respiratory tract illness characterised by a non-specific cough, rhinorrhoea, coryza and fever.^{6,7} Croup is usually most troublesome at night-time, leading to substantial parental anxiety. Improvement of the symptoms is seen during the day and episodes resolve within 48 hours in the majority of cases although they may last for up to one week.^{2,6,7} Progressive upper airway obstruction can result in development of biphasic (both inspiratory and expiratory) stridor and respiratory distress.⁸ After the croup symptoms subside, children usually have typical upper respiratory tract-like symptoms and occasionally a secondary bacteria-induced otitis media.^{6,8}

The clinical progression and response to treatment helps to distinguish viral croup from alternative diagnoses. For example, children with croup usually remain interactive and well-looking, in contrast to the toxic appearance of those with infections of bacterial origin such as epiglottitis and bacterial tracheitis.^{3,7} The continuous nature of symptoms and relative wellness of the child distinguishes viral croup from spasmodic croup, in which the symptoms are episodic.⁵ Also, an alternative diagnosis should be considered if the child is younger than six months or older than six years or if the child is drooling or has dysphagia.^{2,3} Presence of a high fever, toxic appearance and poor response to adrenaline in particular suggest bacterial tracheitis. Sudden onset of symptoms with high fever, absence of barking cough, dysphagia, drooling,

anxious appearance, and sitting forward in a 'sniffing position' suggests epiglottitis.^{5,6}

Children with viral croup can be broadly categorised as having four levels of severity: Grade 1 (Mild), Grade 2 (Moderate), Grade 3 (Severe) and Grade 4 (Impending Respiratory Failure). Mild croup can generally be managed at home while moderate croup may require three to four hours observation in a hospital. Severe croup will usually require hospitalisation while impending respiratory failure will need urgent medical attention and the involvement of an anaesthetic or paediatric ICU team.^{6,7} Table I presents a summary of the signs and symptoms of croup as well as the main recommendations for management of the different disease states.

Several clinical scores of illness severity for croup exist. Commonly, the Westley croup score and the Syracuse score are used to track changes in the disease over time and predict possible outcome mostly for academic purposes.⁵

Laboratory and radiological assessments are not required as the diagnosis of croup can be reliably made based on the clinical presentation in combination with a careful history and physical examination. Laboratory tests and imaging may be considered in a child with atypical presentation or suspected alternative diagnosis.^{2,6} In such instances, healthcare workers should monitor the patient as the progression of airway obstruction may be rapid. Measurement of arterial blood gas may be conducted if there is suspected or impending respiratory failure although sometimes, especially in more severe cases of croup, investigations can actually be dangerous by causing the child to become agitated, which can result in worsening of airway obstruction.⁸ During clinical investigations, the child should be made to sit on the lap of the parent or caregiver in order for the child to be as comfortable as possible with minimal distress. Between clinical investigations, the child should not be shifted from the posture they have naturally adopted as this will usually be one that minimises airway obstruction and be most comfortable for the child.^{3,8}

Management of croup

Croup is usually mild and self-limiting in most cases and can be managed symptomatically by encouraging a good oral fluid intake and administering antipyretics as required.^{2,8} Management is based on the severity of the condition (mild, moderate, severe and impending respiratory failure) and children with croup of any severity should be made as comfortable as possible with minimal agitation.^{9,10} Management of croup also depends on the age of the child, degree of hydration of the child, parents' ability, and other social issues such as access to emergency medical care.^{3,10} Children with mild symptoms can be successfully treated at home and fewer than 5% of children with croup will require hospitalisation.¹⁰

Since croup is usually caused by a viral infection, antibiotics are not routinely required and should be reserved for children with other signs suggestive of bacterial illness such as epiglottitis. Such children typically appear toxic and are sufficiently unwell that they require hospital admission, in contrast to those with viral croup,

Table I. Signs and symptoms of croup^{2,3,6,7,8}

Severity	Signs and symptoms
Grade 1 (Mild)	<ul style="list-style-type: none"> Occasional barking cough Hoarse voice No audible stridor at rest Mild inspiratory stridor during activity or agitation No to mild suprasternal and/or intercostal drawing (work of breathing)
Grade 2 (Moderate)	<ul style="list-style-type: none"> Frequent barking cough Tachypnoea Easily audible stridor at rest No to mild suprasternal and/or intercostal drawing Little or no distress or agitation Difficulty talking or feeding
Grade 3 (Severe)	<ul style="list-style-type: none"> Frequent barking cough Prominent inspiratory and expiratory stridor with active expiration using abdominal muscles Severe work of breathing Inability to talk or feed Significant distress or agitation
Grade 4 (Impending Respiratory Failure)	<ul style="list-style-type: none"> Barking cough (often not prominent) Cyanosis Bradypnoea, decreased breath sounds with decreasing stridor at rest (occasionally hard to hear) Decreasing sternal wall retractions (may not be marked) Lethargy or decreased level of consciousness Changes in mental status

who generally remain interactive and well-looking. Similarly, there is no evidence to support the use of cough suppressants, decongestant medications or inhaled beta-2 agonists.^{3,6,9}

Pharmacological management

The two main classes of drugs used in the management of croup are corticosteroids and adrenaline.¹⁰

Corticosteroids

Corticosteroids act by suppressing the inflammatory process which increases the release of inflammatory mediators by causing vasoconstriction.¹¹ They cause improvement of symptoms within six hours and limit the need for endotracheal intubation due to worsening of croup symptoms.¹² Although there is no one drug, dose, or route which has been found to be superior to another, the oral route may be preferred in most instances due to its non-invasiveness.^{11,13} Nevertheless, alternative routes such as nebulisation or parenteral route may be used in children who are not able to tolerate oral medication.¹⁴ Dexamethasone is the corticosteroid of choice and is recommended to be given

to all children diagnosed with croup in all severities.^{10,11} The recommended dose is 0.5 mg/kg, intravenously/intramuscularly as a single dose.¹³

Oral administration of the corticosteroid prednisolone (1–2 mg/kg as a single dose) is used as a first-line treatment to minimise any discomfort from injections to the child, due to it being easily available and a registered oral corticosteroid in the country.¹⁵ Nebulised budesonide was found to be equivalent but not superior to oral corticosteroids.¹² However, due to the higher cost and the tedious process of administering a nebulised drug (which usually takes between 10 to 15 minutes to administer and may cause more distress when administering to a child), the oral route is normally preferred. A combination of inhaled budesonide (2 mg) and dexamethasone (0.5 mg/kg orally) was found superior to dexamethasone alone in terms of improvement in croup score.^{13,16}

Budesonide is sometimes prescribed to nebulise the patient with the recommend dose of 2 mg/kg according to the patient's weight using high-flow oxygen.⁹ In children with moderate to severe

Table II . Management guidelines for croup^{8,9,10,15,18}

Severity	Emergency	Inpatients	Outpatients
Grade 1 (Mild)	<ul style="list-style-type: none"> Oral prednisolone 1–2 mg/kg immediately as a single dose OR If the child is vomiting or is reluctant to drink: Dexamethasone 0.5 mg/kg IM/IV single dose 	<ul style="list-style-type: none"> Oral prednisolone 1–2 mg/kg immediately as a single dose OR If the child is vomiting or is reluctant to drink: Dexamethasone 0.5 mg/kg IM/IV single dose 	<ul style="list-style-type: none"> Prednisolone 1–2 mg/kg orally for three days Symptomatic management and encouraging a good oral fluid intake and administering antipyretics (Paracetamol 10–15 mg/kg/dose six hourly when required)
Grade 2 (Moderate)	<ul style="list-style-type: none"> Oral prednisolone 1–2 mg/kg immediately as a single dose OR If the child is vomiting or is reluctant to drink: Dexamethasone 0.5 mg/kg IM/IV single dose PLUS Adrenaline 1:1000 diluted in 1 ml NaCl 0,9% every 15–30 min to nebulise Discharge if the child improves and the symptoms settle. Observe for minimum of three hours following adrenaline administration If the child does not improve, admit to hospital or arrange transfer to a facility with paediatric beds 	<ul style="list-style-type: none"> Oral prednisolone 1–2 mg/kg immediately as a single dose Additional dexamethasone can be given or budesonide 2 mg/kg to nebulise with high flow oxygen single dose Discharge if the child improves and the symptoms settle. Observe for minimum of three hours following adrenaline administration If the child does not improve, expert assistance (e.g. senior anaesthetist or ICU staff) should be alerted 	<ul style="list-style-type: none"> Oral prednisolone 1–2 mg/kg immediately as a single dose Additional nebulisation with budesonide and epinephrine as a single dose
Grade 3 (Severe)	<ul style="list-style-type: none"> Dexamethasone 0.5 mg/kg IM/IV single dose PLUS Adrenaline 1:1000 diluted in 1 ml NaCl 0,9% every 15–30 min PLUS High flow oxygen by mask If the condition does not improve or gets worse consider a second dose of epinephrine Repeated observations (½–1 hourly) of heart rate, respiratory rate, stridor, alertness and pulse oximetry are required until improvement occurs. Then manage as per instructions for moderate croup If the child does not improve, admit to hospital or arrange transfer to a facility with paediatric beds 	<ul style="list-style-type: none"> If there is no improvement on the condition or it worsens, recommend diagnostic tests and intubate Expert assistance (e.g. senior anaesthetist or ICU staff) should be alerted 	<ul style="list-style-type: none"> Oral prednisolone 1–2 mg/kg immediately as a single dose Additional nebulisation with budesonide and epinephrine as a single dose
Grade 4 (Impending Respiratory Failure)	<ul style="list-style-type: none"> Intubate (If not possible, treat as severe) 	<ul style="list-style-type: none"> Intubate (If not possible, give same as severe treatment) 	

croup, budesonide is more effective at reducing its severity over six to 24 hours.¹³

Nebulised epinephrine (adrenaline)

Adrenaline acts by reducing mucosal swelling in the laryngeal region through reducing bronchial and tracheal epithelial vascular permeability, thereby decreasing airway oedema.¹⁷ This results in an increase in the airway radius and improved airflow.¹⁷ Nebulised adrenaline is also associated with significant reduction of symptoms of croup through vasoconstriction leading to reduced airway oedema.^{14,17} Adrenaline has an onset of action of 30 minutes.^{14,17} This effect is however short-lived, and nebulised adrenaline alone does not reduce the overall duration of hospitalisation or the incidence of tracheotomy in patients with croup.⁶

Instead, nebulisation using adrenaline in combination with the corticosteroid, especially in moderate to severe croup and given every 15–30 minutes is recommended.^{9,14,15} The child should be observed for a minimum of three hours following adrenaline administration. If the child does not improve, admit to hospital for further management.⁹

Oxygen supplementation

Supplemental oxygen in conjunction with corticosteroids and adrenaline, should be initiated for saturations < 90% in room air or when the child presents with significant respiratory distress.⁹ Oxygen therapy should never be forced on a child, and avoid upsetting the child if possible.^{8,9,10} Consider holding oxygen tubing a few centimetres from the child's nose and mouth (blow by oxygen).⁹ If possible, the parent or caregiver should reassure the child and medical devices like oxygen or nebuliser masks should be administered with the assistance of the parent as the presence of a stranger (healthcare worker) alone may usually cause the child to become agitated which could result in a worsening of the symptoms.^{8,14}

Table II shows important pharmacotherapy in the management of croup based on the severity and level of care (emergency room, inpatient or outpatient), including pointers on when the child should be managed under expert assistance such as senior anaesthetist or ICU staff.

Non-pharmacological management

Treatment of croup has changed significantly over the years. In the past, steam or humidified air was felt to be essential for the management of patients with croup but there is no supporting evidence for added benefit of this therapy over other evidence-based therapies in a hospital setting.^{9,19} However, in an outpatient setting, mist from a humidifier may be useful in ameliorating some of the symptoms associated with croup thus reducing distress and this option should be recommended to caregivers.^{9,19,20} Hot steam humidifiers should be avoided due to the risk of burns and scalding. Parents should also be advised to give children oral fluids to avoid dehydration and for them to look out for signs of

severe croup (See Table I) which include increased agitation and sleeplessness together with any stridor present in inactivity.^{8,20}

Warm clear fluids may assist to loosen mucus of the vocal cords thereby relieving the coughing and hoarseness associated with croup. Smoking in the home should be avoided as it can worsen a child's cough.²⁰ The child's head should be elevated although pillows should not be used in children younger than 12 months.²⁰

There is no single vaccine against all of the viruses that cause croup, however, yearly vaccination against influenza virus is recommended for individuals older than six months. In addition, simple hygiene measures such as frequent hand washing with soap and water and limiting close contact with other adults and children with upper respiratory tract infections can help to prevent infection with viruses that cause croup.²⁰

Conclusion

Croup is an acute respiratory illness commonly occurring in childhood and is often mild and self-limiting. Exacerbations of croup are rare and are characterised by a harsh biphasic stridor with signs of respiratory distress which warrant urgent medical attention. Referral to a paediatric ICU or emergency medicine specialist is indicated for children who experience recurrent or atypical attacks and other signs of airway obstruction.

Parental education and support is an essential component of effective management; in particular, parents should be reassured about the short and self-limiting nature of the illness, but warned that symptoms are usually worse at night and may recur after apparently having disappeared during the day. Mild croup can generally be managed at home, although hospital admission might be considered if the child experiences worsening of the symptoms of croup. Hospital admission may also be required if the child develops agitation and cyanosis as well as respiratory distress or as a precautionary measure in children with risk factors for developing severe disease. Corticosteroid therapy is the treatment of choice regardless of the severity of the illness. Additionally, oxygen and nebulised adrenaline can provide symptomatic relief in more severe cases.

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