Croup: assessment and evidence-based management

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ABSTRACT

- Croup affects about 2% of preschool-aged children every year.
- Most children have mild croup and are managed at home, often after review by a general practitioner, who may decide that a single dose of oral corticosteroid is indicated (eg, if a risk factor for hospital admission exists).
- A minority of children develop moderate or severe croup. They should be reviewed in an emergency department and may need hospital admission.
- More liberal use of systemic corticosteroids for croup (in both primary care and emergency department settings) has been associated with reduced rates of hospital admission, reduced admissions to the intensive care unit and a reduced need for endotracheal intubation.
- We discuss the assessment and evidence-based management of a child with mild croup presenting to a GP and a child with moderately severe croup presenting to an emergency department.
- We present a flow chart summarising an approach to assessing and treating croup in the emergency department.

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THE TERM "CROUP" refers to the clinical syndrome of a hoarse voice, harsh barking cough and inspiratory stridor.[1-6] The commonest cause of this symptom complex is viral laryngotracheobronchitis (LTB). In line with common usage, our use of the term "croup" in this article implies viral LTB.

Other causes of upper-airway obstruction must be considered in the differential diagnosis (Box 1). The presence of biphasic stridor (unlike the variable inspiratory stridor seen in croup) should alert the clinician to the likelihood of fixed airway narrowing (eg, due to vocal cord palsy, subglottic haemangioma, subglottic stenosis).

Spasmodic croup, occurring in older, often atopic, children, is treated similarly to viral croup, as it is the severity of upper-airway obstruction at the time of presentation that determines the treatment.

Croup is a common cause of upper-airway obstruction in young children, occurring in about 2% of preschool-aged children annually.[1] It mainly affects children aged 6–36 months, with a peak incidence at 12–24 months. There is a male predominance of 3:2.[1] The condition is usually mild and self-limiting, although it may occasionally cause severe respiratory obstruction. Viral infection of the upper airway results in inflammation of the pharynx, larynx, trachea and bronchi. However, it is specifically subglottic inflammation (and resultant swelling) that compromises the airway in croup. Typically, viral croup develops over several days along with a concurrent coryzal illness. The symptoms of airway obstruction disappear over 3–5 days.[3-5] A number of viruses may cause croup, the most common being parainfluenzavirus 1 and 2 and respiratory syncytial viruses.[1-4]

The use of corticosteroids to treat croup has dramatically reduced both the number of patients requiring hospital admission and the rates of endotracheal intubation.[4-6] Here we evaluate the current evidence for treatment of croup.

Assessment of severity

Determining the degree of airway obstruction (based primarily on the history) is the most important consideration when assessing children with croup. As airway obstruction can worsen rapidly, repeated careful clinical assessment is essential. Various other factors, some unrelated to the immediate clinical features, may affect the likelihood of a child with croup being admitted to hospital (Box 2).

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Important points when assessing croup severity

- *General appearance*. A child who is agitated, is tiring from the effort of breathing, or whose level of consciousness is decreasing, must immediately be given supplemental oxygen via a facemask, nebulised adrenaline and systemic corticosteroids. The child should be closely observed, and nebulised adrenaline treatment should be repeated if there is no reduction in upper-airway obstruction within minutes. Such a child may rapidly deteriorate and require intubation.
- *Degree of respiratory distress.* Stridor at rest, tracheal tug, chest-wall retractions, changing respiratory rate and pulse rate or palpable pulsus paradoxus indicate moderate to severe croup.
- *Cyanosis or extreme pallor* indicates the need for immediate supplemental oxygen (repeated), nebulised adrenaline and intubation.
- *Oxygen desaturation*, indicated by oximetry, is usually a late and unreliable sign of severity.[12] Occasionally, it may be present in less severe croup.

Mild airway obstruction

Mild airway obstruction can be assumed when the child appears happy and is prepared to drink, eat, play and take an interest in the surroundings. Most children presenting to general practitioners will fall within this category. As illustrated in Scenario 1 (Box 3), there may be mild chest-wall

1: Causes of upper-airway obstruction in young children

Supraglottic	Laryngeal/subglottic	Tracheal
Acute tonsillar enlargement (due to bacterial or viral infection)	Viral croup	Foreign body
Foreign body	Spasmodic croup	Bacterial tracheitis
Retropharyngeal abscess	Foreign body	Tumour (eg, anterior mediastinal lymphoma)
Epiglottitis (rare)	Bacterial tracheitis	Trauma (eg, haematoma)
Acute angioedema	Laryngomalacia ± viral infection (in infants)	Congenital abnormality
	Diphtheria	
	Thermal/chemical injury	
	Intubation trauma	
	Laryngospasm (associated with neural disorder, hypocalcaemia, or reflux)	

retractions and mild tachycardia, but stridor at rest will not be present. The GP should reassure the parents, explain what to expect over the coming days, and give them an information sheet. A single dose of oral corticosteroid may be warranted, especially if the child has an additional factor that increases the likelihood of hospital admission (Box 2).

Moderate airway obstruction

Moderate airway obstruction is indicated by persisting stridor at rest, chest-wall retractions, use of the accessory respiratory muscles, and increased heart rate. The child can be placated and remains interactive with people and the surroundings. The child should be treated with oral corticosteroids.

Progression from moderate to severe airway obstruction

If a child with moderate airway obstruction begins to appear worried, preoccupied or tired, sometimes sleeping for short periods, the child will require treatment, close observation in hospital and frequent clinical review (Box 3, Scenario 2). Progression of signs will indicate the need for further treatment, which may include intubation.

Severe airway obstruction

As airway obstruction increases, the child appears increasingly worried, tired and exhausted. Marked tachycardia persists, in contrast to the transient tachycardia induced by nebulised adrenaline. Restlessness, agitation, irrational behaviour, decreased level of consciousness, hypotonia, cyanosis and marked pallor are late signs of life-threatening airway obstruction. The child should not be unnecessarily disturbed, but must be given high-flow oxygen via a face-mask, with further nebulised adrenaline, while preparations are made for tracheal intubation. Intubation should be carried out, wherever possible, by someone skilled in paediatric intubation. Systemic corticosteroids, if not previously given, should be administered once the airway is secured.

Oximetry

Oximetry is never a substitute for good clinical assessment. Oxygen saturation may be close to the normal level in a child with severe croup, or, conversely, substantially lowered in a child with mild to moderate croup.[12] This variability presumably relates to ventilation–perfusion mismatching caused by lower-airway disease.

Clinical scoring systems

Croup severity scores have been used in hospital-based clinical research studies to assess the suitability of patients for treatment in a standardised manner.[7,8,14,15] They give a cumulative score, grading for the degree of stridor, chest-wall retractions, air entry, cyanosis, dyspnoea and level of consciousness. However, they are of limited value in clinical practice.

Lateral x-ray of the airway

Performing a lateral x-ray of the airway is generally not advisable in acute upper-airway obstruction, except perhaps within the intensive care unit, where bronchoscopy is more likely to be considered for a complicated airway problem. Information affecting the management of croup can rarely be gleaned from a radiograph. Although subglottic narrowing, radio-opaque foreign bodies and supraglottic swelling may be apparent on a technically good radiograph of the airway, the risk of the procedure generally outweighs any benefits. Neck extension required for the procedure may precipitate sudden severe obstruction. The need for acute resuscitation for life-threatening upper-airway obstruction in a radiology department is fraught with potential complications.

Evidence-based treatment options

Major changes in croup management over the past 25 years include the introduction of nebulised adrenaline and

2: Factors increasing the likelihood of hospital admission after initial treatment for croup[3,4,6-11]

- History of severe obstruction before presentation
- History of previous severe croup or known structural airway anomaly (eg, subglottic stenosis)
- Age less than 6 months
- Significant degree of respiratory distress (stridor at rest)
- Inadequate fluid intake
- Parental anxiety
- Proximity of home to the hospital/transport issues
- Re-presentation to the emergency department within 24 hours
- Poor response to initial treatment
- Uncertain diagnosis

3: Presentation with croup: two typical case scenarios

Scenario 1: A child with mild croup presents to a general practitioner at 10 am

"James", a 20-month-old boy, is brought to a GP with a barking cough, slight fever and hoarse voice. He has had a restless night. There is a family history of croup but this is James's first episode of croup and his mother is anxious. There is no significant past medical history. On examination, James is playful, smiling and interactive. He has a typical "seal bark" cough but no audible stridor. His chest is clear on auscultation, there is no tracheal tug or chest-wall recession, and his respiratory rate is normal. He has mild croup and needs no immediate treatment. His mother asks whether James will get worse tonight. The GP replies that it is possible, and discusses with James's mother the arguments for and against giving a single dose of oral corticosteroid.

For corticosteroid:

- It will reduce even mild symptoms.
- It will reduce the risk of hospital admission or reattendance.
- It is relatively safe as a single dose.
- It is easy to administer.

Against corticosteroid:

- Mild symptoms do not require any treatment.
- Before the popularisation of corticosteroids for treating croup, the risk of hospitalisation was low (about 1 in 80).[1]
- The reduction in risk of reattendance within a week after a single dose of corticosteroid given in an emergency department is small. (In one study, 12 children needed to be treated with dexamethasone to avoid 1 reattendance within a week.[13])
- Parents may inappropriately use any remaining prednisolone to treat other illnesses.

Scenario 2: A child with moderate to severe croup presents to a hospital emergency department at 10 pm

"Simon", a 23-month-old thriving boy, presents to the emergency department of the local hospital with viral croup. He has been hospitalised for croup on three previous occasions, twice having been admitted to the intensive care unit of a paediatric teaching hospital. Between bouts of croup, he is well. He has become agitated since waking 30 minutes earlier. He has loud inspiratory stridor at rest, is using his sternomastoid and abdominal muscles to aid breathing, and has obvious tracheal tug with palpable pulsus paradoxus. His parents gave him a dose of oral prednisolone earlier in the evening.

Simon needs immediate treatment with oxygen, nebulised adrenaline and further systemic corticosteroids.

4: Rating the evidence for recommendations

Our recommendations are based on the following levels of evidence, simplified from the National Health and Medical Research Council's "Quality of evidence ratings".[27]

E1 (Level I): Evidence from systematic review or meta-analysis of all relevant randomised controlled trials (RCTs).

E2 (Level II): Evidence from at least one well designed RCT.

E3 (Level III): Evidence from well designed cohort or case–control studies.

E4 (Level IV): Consensus opinion of respected authorities.

the more liberal use of systemic and nebulised corticosteroids.[9,10,16-26] Over the past decade, work has focused on corticosteroid treatment, and its utility can be seen in the levels of evidence available to ascertain its effectiveness (Box 4).

The commonly used medications for croup are summarised in Box 5. A flow chart summarising an approach to assessing and treating croup in the emergency department setting is presented in Box 6.

Mild croup

As illustrated in Scenario 1 (Box 3), mild croup is often less symptomatic during the daytime, only to become worse at night. However, the GP is often called upon to decide whether a young child warrants specific treatment for the potential deterioration that may occur subsequently. The treatment choice is simple: a dose of oral corticosteroid or not. The decision about whether to treat is less clearcut. In fact, there is no evidence available from studies in the general practice setting to guide the clinician, only recommendations based upon patient populations presenting to emergency departments. Such patients may not be representative of those presenting to GPs.[13] Fortunately, the levels of evidence favouring the use of systemic corticosteroids in the emergency department setting are generally sound.

Systemic corticosteroids

The mechanisms by which corticosteroids exert their effects are not known. It is presumed that corticosteroids possess rapidly acting anti-inflammatory or vasoconstrictive properties in the upper airway.[8,14,19] Studies using oral dexamethasone,[21,23,25] nebulised budesonide (2 mg/dose)[15,18] and nebulised dexamethasone[26] have demonstrated the efficacy of corticosteroids compared with placebo in relieving croup symptoms in the hospital setting. Commonly used alternatives to dexamethasone are prednisone or prednisolone.[6,16]

Oral corticosteroids are preferred in most paediatric emergency departments because they are inexpensive, easy to administer, readily available, and produce measurable improvements within hours (E2).[17] Doses of dexamethasone ranging from 0.15 to 0.6 mg/kg have been shown to be similarly efficacious for treating croup (E2).[25] For simplicity, and to avoid confusion when prescribing, commonly recommended doses of dexamethasone are 0.15–0.3 mg/kg and doses of prednisolone suspension or prednisone tablets are 1–2 mg/kg (E4).[4]

Two meta-analyses,[3,6] which included 24 randomised controlled trials (RCTs), have shown clinically significant benefit (based on clinical croup severity scores) of systemic corticosteroids given at 6 and 12 hours, but not at 24 hours (E1). Reviewing the meta-analyses together, the quality of the studies included was considered good, although it was noted that the numbers of participants were generally small (median, 40).[4] The possibility of selection bias was raised, as a funnel plot demonstrated few published studies showing no effect of systemic corticosteroids.[4]

5: Pharmacological treatment of croup in the emergency department*

Medication	Croup grade	Dose	Comments
Oxygen	Severe (Spo_2† < 90%), very severe with central cyanosis	Minimum flow rate 4 L/min, given via facemask	Give nebulised adrenaline and systemic corticosteroids as well.
Systemic corticosteroids (oral)	Moderate, severe	Dexamethasone 0.15–0.3 mg/kg OR prednisone/prednisolone 1–2 mg/kg	Onset of action is within 1 hour. Treatment can be repeated after 12–24 hours. Intramuscular route can be used for a child who will not swallow or vomits repeatedly (this is uncommon).
Nebulised corticosteroids (if child repeatedly vomits oral corticosteroids)	Moderate, severe	Budesonide 2 mg (4 mL) undiluted	Onset of action is within 30 minutes. Treatment can be repeated 12th hourly for 2 days.
Nebulised adrenaline 1:1000	Moderate, severe	0.5 mL/kg, up to maximum of 5 mL nebulised	Onset of action is within minutes. Give corticosteroids as well. Repeat doses may be needed.

* Regular review is essential to monitor response to therapy. † Pulsatile oxygen saturation.

The use of systemic corticosteroids has also been associated with a significant decrease in the number of adrenaline nebuliser treatments required and a reduced average length of stay in the emergency department (E1–E4).[3,4,6,9,13,28] Furthermore, since the earlier use of systemic corticosteroids in children attending emergency departments was advocated, the need for endotracheal intubation has been reduced and the duration of intubation has fallen (E1, E2).[13,16,28]

A number of trials comparing the method of delivery of corticosteroids have shown that oral, intravenous, intramuscular and inhaled (nebulised) forms of corticosteroid are all superior to placebo (E1, E2).[3,6,9,13,15-18,21-23,25,26] Oral and intramuscular dexamethasone 0.6 mg/kg are equally efficacious for relieving the symptoms of croup at 24 hours and 10 days (E2).[22] In addition, oral dexamethasone 0.6 mg/kg has been shown to be superior to nebulised dexamethasone 160 μg or placebo in mild croup, treated in an emergency department setting, for reducing symptoms and rates of subsequent attendance for medical review within a week.[9] Most paediatricians prefer the oral route, as it is inexpensive, easy to administer and kinder for the patient (E4).[4]

Steam inhalation and mist therapy

The use of steam inhalation for treating croup has been advocated since the 19th century,[5] but the treatment has never been scientifically validated. Three studies evaluating the use of supersaturated cold air ("cold water fog") to treat croup were unable to find evidence of benefit. One was an underpowered RCT in which 16 subjects with croup were randomly allocated to receive room air or a humidified atmosphere for 12 hours in hospital (E3).[29] The second trial involved only 7 subjects, who showed no improvement in respiratory resistance after receiving 2 mL of nebulised cold sterile water (E4).[30] The third trial, a double-blind RCT involving 71 children aged 3 months to 6 years with moderately severe croup, showed no benefit from mist (supersaturated air) therapy when given in addition to oral dexamethasone (0.6 mg/kg, given to all patients) in terms of croup score, oxygen saturation, heart rate or respiratory rate over 2 hours (E2).[31]

Moderate to severe croup

As illustrated in Scenario 2 (Box 3), a child with moderate to severe croup may present in the evening to an emergency department. In this situation, a dose of oral corticosteroid should be given immediately while the child is assessed to determine whether more rapid relief of the upper-airway obstruction is required.

Oxygen

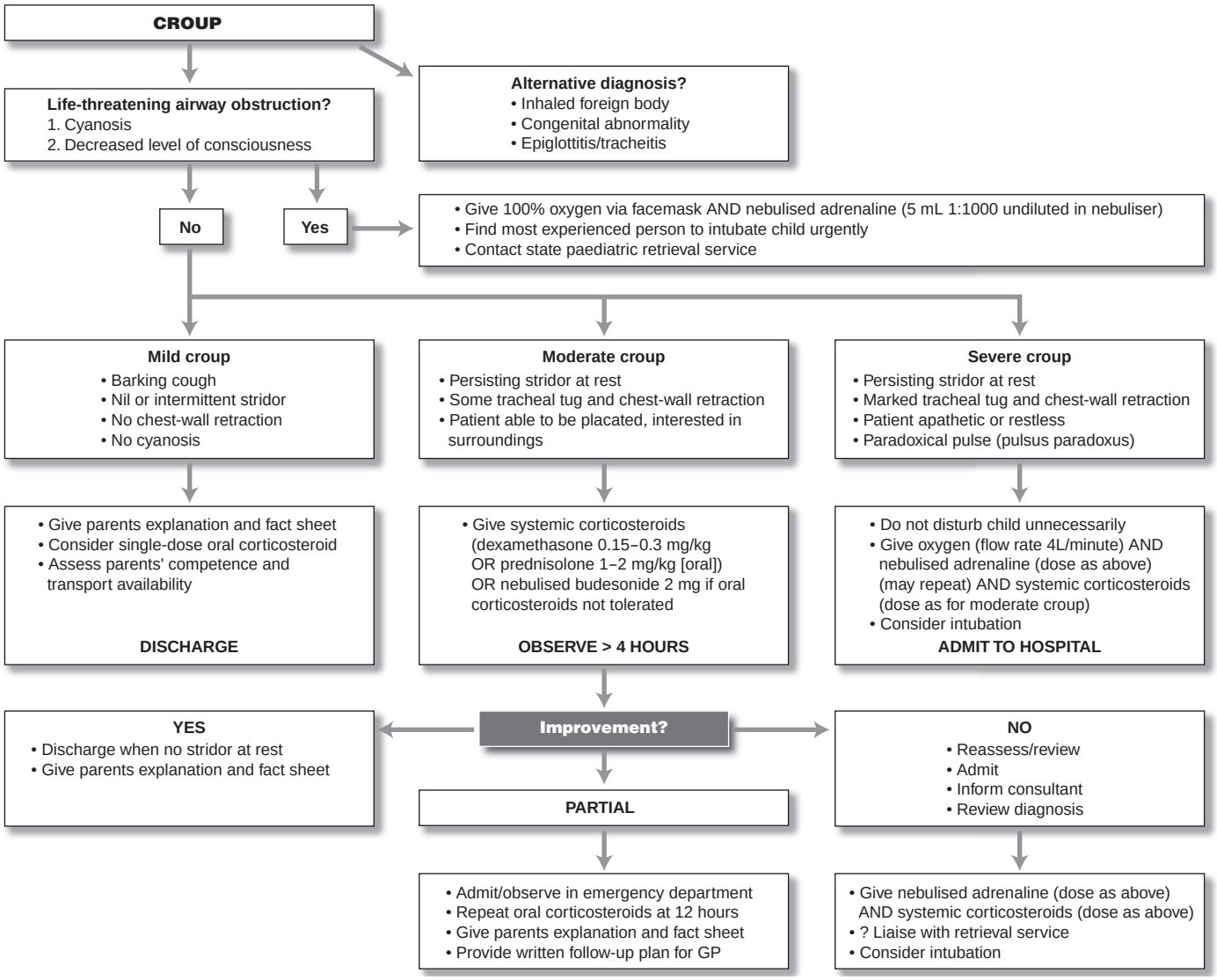
Oxygen is the most important treatment for a child with moderate or severe croup who has considerable upper-airway obstruction with significant oxygen desaturation (Spo_2 [pulsatile oxygen saturation] < 90%) (E4).[11] There have been no RCTs of oxygen therapy. Oxygen is the initial treatment before the administration of pharmacological treatment in the hospital setting. Theoretically, the relief of hypoxia should increase respiratory muscle endurance, increase lung oxygen reserves and make intubation under anaesthesia, where needed, a safer procedure (E4).

Nebulised adrenaline

A child with persisting inspiratory stridor at rest and marked chest-wall retractions has severe croup. Such a child, who may be severely obstructed without being centrally cyanosed, should receive immediate treatment with nebulised adrenaline (1:1000 dilution at a dose of 0.5 mL/kg of body weight to a maximum dose of 5 mL, delivered neat to the nebuliser bowl) (E1, E2).[8,13,19,20,24] For a child still at home or in the GP's surgery, this dose could be administered while awaiting the ambulance for transfer to hospital. In addition, a dose of oral corticosteroid should be given (E4).[11] The child should be reassessed regularly.

The mechanism of action of nebulised adrenaline is uncertain. It has been suggested that nebulised adrenaline reduces bronchial and tracheal epithelial vascular permeability, thereby decreasing airway oedema, which, in turn, increases the airway radius and improves airflow (E4).[4,8,19,20,24] The onset of action is rapid: double-blind RCTs of this treatment document a fall in croup symptom scores within 30 minutes (E2),[8,24] and the effect lasts for about 2 hours (E2).[4,8,24] The need for several doses of

6: Assessment and management of a child with croup presenting to the emergency department



nebulised adrenaline in a short period of time highlights the need to consider urgent transfer to a paediatric centre and/or intubation (E4).[4]

Nebulised corticosteroids

The use of 2–4 mg of nebulised budesonide to treat croup (a treatment that began to attract attention during the 1990s) has been shown to be effective (E2).[8,9,18] The onset of action is within 30 minutes,[8] which compares favourably with systemically administered corticosteroids that have an effect within one hour (E2).[21-23,25] (The response to systemic corticosteroids in croup at less than one hour after administration has not been assessed.)

Repeated doses of 2 mg nebulised budesonide 12th hourly for up to 48 hours in a hospital setting has been shown to reduce croup symptoms and relapse rates compared with placebo (E2).[18] A recent meta-analysis of trials of inhaled corticosteroids for croup concluded that croup symptom scores were significantly lowered within 5 hours and that hospital admission rates were also reduced (E1).[10] However, the cost of equipment and medication, the time needed for administration and the potential for the child to become upset when inhaled preparations are used mean that *oral* corticosteroids are the preferred option, unless a child repeatedly vomits the oral corticosteroid (E2, E4).[4,9,11]

Summary

Croup is common, but most children experience only mild symptoms. The question of whether all children presenting to a GP need an oral corticosteroid is controversial and untested. There are no RCTs on interventions for croup in primary care settings. If the primary purpose for giving oral corticosteroids to all children with croup in general practice were to prevent hospital admission (a readily measurable outcome), then the majority of children would be treated

unnecessarily, as the risk of admission is low. However, if any subjective improvement, such as minimising cough and mild breathing discomfort, was considered an outcome justifying corticosteroid treatment, then one could argue that the risks of harm are low and the potential benefits to the child and parent warrant the treatment.

Children who present to emergency departments are routinely given a dose of corticosteroid to decrease croup severity, avoid admission to hospital, reduce the risk of admission to intensive care and reduce the risk of progression to endotracheal intubation. A minority with moderate to severe croup will need oxygen, nebulised adrenaline and repeated doses of corticosteroids. Only a small proportion of those presenting with moderate to severe croup will need intubation.

Perhaps the most important aspect of management in croup, which is beyond the scope of evidence-based practice, is to keep the young child near their parent for reassurance when assessing and treating the condition.

Competing interests

None identified.

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