



# Croup Clinical Care Guideline Age 6 Mos – 3 Yrs\*

\*Always check intranet for latest version:

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Use until: 7/14/10

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## Target Population

### Intended for patients with:

1. First or repeat episode
2. Age 6 mos – 3 yrs
3. Principal Diagnosis: **Croup** (Laryngotracheitis)

### Exclude patients with:

1. Suspicion **Tracheitis** (laryngotracheal-bronchitis or –pneumonitis)
2. Uncommon or life threatening presentation
3. Chronic Lung Disease (BPD, CF, PAH) or known airway narrowing
4. Recent airway instrumentation
5. History of aspiration
6. Neurological impairment
7. Toxic Appearance
8. Suspicion SBI
9. Immunocompromise
10. Active Varicella or TB
11. Congenital or acquired heart disease

## Key Treatment Principles

### Indicated:

1. Care Guideline use beginning in office, ED or UC
2. Differentiate **Croup** (laryngotracheitis) from **Tracheitis** (laryngotracheal-bronchitis or –pneumonitis), a more extensive process
3. Single Dose Corticosteroids
4. Nebulized epinephrine
5. Careful Clinical Monitoring
6. Passive Smoke Avoidance

### Not routinely Indicated:

1. Antibiotics
2. Viral Testing
3. Radiographs(CXR and/or Lateral Neck)
4. Laboratory studies
5. Anti-tussive or decongestant

## Clinical Management

### 1. Prevention

- Droplet precautions for all care settings
- Good hand washing
- Protect high risk patients from exposure
- Eliminate exposure to smoke

### 2. Telephone Triage

- Activate EMS (911): Severe difficulty breathing (struggling for breath, grunting noises with each breath, unable to speak or cry), blue lips or reduced level of consciousness
- ED Visit (immediate): Underlying heart or lung disease, breathing heard across room, poor fluid intake, T > 105, excessive drooling, inability to lie flat without distress
  - Age < 12 mos, RR > 60, unable to suck or sleep
  - Age > 12 mos, RR > 40, difficulty breathing, not interactive
- Office Visit same day: Worsening cough, some difficulty breathing, poor fluid intake, chronic or underlying illness
- Phone contact with PCP: barking cough, acting normally, good fluid intake

### 3. Initial Triage

Obtain brief history of presenting conditions and past medical history \ birth (hospitalization, intubation \ mechanical ventilation), sick contacts

Check Immunization Status: HIB, Pneumococcal, Tetanus. Important when considering Epiglottitis or Diphtherial Croup

Obtain all pertinent patient history, including onset and duration of symptoms including croup prodrome (rhinorrhea, sore throat, low grade fever, cough) and timing of evidence of upper airway obstruction (hoarse voice, barking cough, audible stridor) and subglottic involvement (aphonia)

Inquire regarding history of congenital or acquired heart disease, congenital or acquired subglottic stenosis, tracheomalacia, tracheal webs, choanal narrowing or atresia, micrognathia, macroglossia

Check current medications and time \ dose of last antipyretic

### 4. Clinical Assessment

Evaluation of presence of Noninvasive croup versus a more extensive or progressive process  
Evaluate hydration status. Evaluate patient using **Croup Score** every 30 – 90 min based on severity (reference figure 1)

## 5. Knowledge Base

Croup is an acute inflammatory process expressed as laryngotracheitis. Infection begins in the nasopharynx and spreads to the respiratory epithelium of larynx & trachea. Inflammation, erythema and edema of the vocal folds cause hoarseness.

Age: 6 mos - 3 yrs (Mean = 18 mos)  
 Duration: 3-7 days, symptoms maximal day 2-3  
 Morbidity: Highest first year of life  
 Epidemiology: Year round; most common fall and winter

While all medical care providers need to be aware of the potential for extension of the disease process to tracheitis (laryngotracheal-bronchitis or –pneumonitis), it is beyond the scope of this guideline.

### Etiology of Croup

Table 1 Etiology of Croup (Laryngotracheitis)

Parainfluenza type 1 (most common) 2, 3  
 Influenza A & B  
 Human metapneumovirus (hMPV)  
 Measles virus  
 RSV  
 Adenovirus  
 Rhinovirus  
*Mycoplasma pneumoniae*  
 Enteroviruses  
 Herpes Simplex viruses  
 ReoViruses

Table 2 Etiology of Tracheitis (laryngotracheal-bronchitis or –pneumonitis)

#### Bacterial

*Staphylococcus aureus*  
*Streptococcus pneumoniae*  
*Haemophilus influenzae*  
*Moxarella catarrhalis*  
*Streptococcus pyogenes*

#### Atypical

*Corynebacterium diphtheriae*  
*Cryptosporidium*

#### Viral

Parainfluenza type 1, 2, 3

### Clinical Symptoms Croup

Symptoms increase at night and improve during day  
 Hoarse Voice  
 Barking Cough (often described as a “barking seal”)  
 Stridor (variable, usually inspiratory)  
 Respiratory Distress (variable):

- Retractions (suprasternal, intercostal, abdominal)
- Tachypnea
- Tachycardia

### Clinical Progress Croup

Day 1-3	Rhinorrhea Sore throat Low grade fever Mild cough
Day 3-7 inflammation	Onset symptoms of upper airway Hoarseness Barking Cough Stridor (variable) Respiratory Distress (variable)

### Differential Diagnosis Croup

Table 3 Differential Diagnosis Croup

Allergic Reaction  
 Bacterial Tracheitis  
 Epiglottitis  
 Foreign Body Aspiration  
 Hemangioma (Subglottic)  
 Infectious Mononucleosis  
 Laryngeal Diphtheria  
 Laryngeal nerve compression  
 Paraquat Poisoning  
 Peritonsillar Abscess  
 Retropharyngeal Abscess  
 Spasmodic croup  
 Allergic response to viral antigen causing acute non-inflammatory recurrent intermittent swelling of laryngotracheal tissues. Acute nocturnal onset in older child than primary croup, repeat attacks same and consecutive nights  
 Subglottic Stenosis  
 Trauma  
 Tumor \ intracranial process (rare)

### Clinical Symptoms Tracheitis

Sudden worsening of symptoms airway is indicative of more severe or invasive disease and warrants immediate specialty consultation.

Aphonia  
 Cyanosis  
 Prolonged disease process  
 Acute onset high fever  
 Toxic appearance  
 Increased work of breathing with retractions  
 Severe stridor  
 Tripodding

## 6. Monitoring:

### Figure 1 CROUP SCORE (Modified Westley) [B]

Possible Score 0–17:

<4=mild croup, 4–6=moderate croup, >6=severe croup

Indicators of Disease Severity	Score
<b>Inspiratory stridor</b>	
None	0
Only with agitation or activity	1
At rest	2
<b>Intercostal Retractions</b>	
None	0
Mild	1
Moderate	2
Severe	3
<b>Air Entry</b>	
Normal	0
Mildly decreased	1
Severely decreased	2
<b>Cyanosis</b>	
None	0
With agitation \ activity	4
At rest	5
<b>Level of Consciousness</b>	
Normal	0
Altered	5

Figure 2 Severity Classification

SEVERITY CLASSIFICATION: Follow croup score classification to guide therapy and management:			
Score	Severity	Management	Treatment Considerations
<4	Mild	Outpatient	Supportive ; Consider Corticosteroids
4-6	Moderate	Inpatient / Observation	Corticosteroids Oxygen (for hypoxia) Epinephrine
≥ 6	Severe	Inpatient, Consider ICU	Corticosteroids Oxygen (for hypoxia) Epinephrine Consider Helium oxygen Consider intubation

#### Clinical Severity Reassessment Schedule

Mild: Reassess every 4 h, consider discharge  
 Moderate: Reassess every 2 h, consider admission  
 Severe: Reassess every 1 h, consider ICU admission

#### Monitoring

- SaO<sub>2</sub> usually normal in croup unless tracheitis present
- Continuous cardiac/pulse oximetry monitoring only recommended for unstable patient or receiving repeat nebulized Epinephrine

- Follow VS to assess response to therapy: T, HR, RR,
- The croup score is felt to be useful to assess the efficacy of interventions, but there is little proof of its clinical utility [B]

## 7. Laboratory and Radiology Studies

**Diagnostic tests only indicated if they will change outcome. Croup is a clinical diagnosis and usually no testing needed**

CBC	If concerns SBI or bacterial super- infection
ABG	Suspected/ impending respiratory failure
CXR	Indicated only in atypical illness Classic “Steeple sign” reflects narrowed subglottic space Patchy infiltrate seen in laryngotracheal-bronchitis or – pneumonitis
Lateral Neck Soft Tissue XR:	<u>Only</u> if atypical clinical presentation Epiglottitis: classic “thumb” sign reflects swollen epiglottis Retropharyngeal abscess: widened pre-vertebral space

## 8. Therapeutics – “Prove it or don’t use it”

### Indicated therapies

#### Corticosteroids [A]

Dosing: Single Dose  
 Mechanism of action: Long lasting anti-inflammatory agent

Decrease edema in laryngeal

Adverse Effects: mucosa  
 Risk of progressive viral infection  
 Risk of secondary bacterial infection  
 Exacerbate active Varicella or TB

Mask steroid dependant upper airway lesions (hemangioma)

#### Dexamethasone [A]

Dose: 0.15 – 0.6 mg/kg PO (preferred), IV, IM

Frequency: Once

Maximum Dose: 10 mg

Peak serum levels: Oral: Within 1 – 2 h

IM: within 8 h

Duration of action: 24 – 72 h

- Note, the taste of oral dexamethasone may not be well tolerated thus the preferred method of administration may be a crushed dexamethasone tablet mixed with vehicle of choice

#### Nebulized Budesonide [C]

Equal efficacy to Dexamethasone; expensive  
 Consider in children with emesis or sever respiratory distress

#### Prednisolone [C]

Dose: 1 mg/kg

#### Prednisone [C]

Dose:

4 mg/kg/ (equivalent 0.6 mg/kg Dexamethasone)

2 mg/kg/ (equivalent 0.3 mg/kg Dexamethasone)

1 mg/kg/ (equivalent 0.15 mg/kg Dexamethasone)

## **Nebulized Epinephrine** for Croup Score >3, stridor [A]

Mechanism of Action: Stimulation  $\alpha$ -adrenergic receptors  
Constrict capillary arterioles causing fluid resorption from interstitial space and decreases interstitial edema

Duration of action:  $\leq 2$  h

Efficacy: Racemic & L-epinephrine are equally efficacious [A]

Adverse effects: Myocardial Infarction (rare)

Racemic Epinephrine (1:1 mixture of  $\delta$  &  $\theta$ -isomers epinephrine)

Dose: 0.05 mL/kg/dose of 2.25% solution in 2.5mL normal saline via nebulizer over 15 min

< 5 kg = 0.25 mL

$\geq 5$  kg = 0.5 mL

Frequency: Repeat every 20 min as indicated

Maximum Dose: 0.5 mL

L-epinephrine (use if racemic epinephrine unavailable)

Dose: 0.5 mL/kg/dose of 1:1000 L-epinephrine in 2.5 mL of NS via nebulizer over 15 min repeated every 15-20 min as indicated

Frequency: Repeat every 20 min as indicated

Maximum Dose: 5 mL

The term 'rebound phenomenon' is a misnomer. Epinephrine doesn't change the duration of croup and benefits lasts  $\leq 2$  h

It is safe to send children home from the ED after receiving racemic epinephrine if they have been observed for a minimum of 3 h post therapy

## **Antipyretics** Indicated for T > 38.3°

Acetaminophen

Dose = 15 mg/kg po q 4°

Repeat if home treatment sub therapeutic & TDD < 140 mg/kg

Ibuprofen

Dose = 10 mg/kg po q 6°

**Oxygen** Utilize supplemental oxygen to treat hypoxia

## **Other therapies**

**Mist** Humidified air with or without oxygen [C]

Controversial therapy without supporting evidence

- May moisten airway secretions
- May decrease airway inflammation
- May decrease viscosity of tracheal mucus secretions enabling patient to remove them by coughing
- May increase wheezing in laryngotracheitis-bronchitis/pneumonitis

**Anti-tussive or decongestant** [C]

**Antibiotics** [A]

No role in uncomplicated croup

Indicated only for bacterial component (tracheitis)

**Helium-Oxygen Mixture** [B]

Not shown to be more effective than nebulized epinephrine or mist

May be efficacious in patient with severe croup with impending respiratory failure.

## **9. Parent Education** (see Parent Education Attachment)

- Expected clinical course < ten days
- Signs of worsening clinical status and when to notify PCP
- Smoking cessation counseling
- Provide Parent with Patient Education Materials

## **10. Discharge Criteria**

### **Begin discharge planning at time of initial presentation**

- ✓ Assess caretaker ability to provide home care
- ✓ Assess home resources adequate to support care
- ✓ Confirm transportation and telephone
- ✓ Confirm follow-up PCP/designee in specified time frame
- ✓ Complete croup teaching
- ✓ Provide verbal and written instructions to caretakers
- ✓ Assure family awareness indications return
- ✓ Provide 24-h contact number for PCP or designee
- ✓ Assure chart faxed to PCP or designee

### **Discharge Home**

- ✓ Vital signs baseline
- ✓ No hypoxia
- ✓ Able to maintain adequate hydration
- ✓ Patient at baseline level of functioning
- ✓ Presenting condition stabilized or improves
- ✓ Croup score < 4

**Patients who have received nebulized epinephrine may be discharged home after a minimum of 3 h if no stridor at rest**

### **Admit Inpatient/ Observation**

- ✓ Croup score 4 - 6
- ✓ Continued stridor at rest despite therapy
- ✓ Inadequate hydration
- ✓ Moderate retractions
- ✓ Require supplemental oxygen
- ✓ Vital signs do not return to baseline
- ✓ Condition deteriorates or does not improve

### **Admit ICU**

- ✓ Consider for croup score > 6
- ✓ Escalating stridor at rest despite therapy
- ✓ Patient benefiting from ICU monitoring, treatment, or environment
- ✓ Any patient with impending respiratory failure:
  - SaO<sub>2</sub> < 90% in 40% FiO<sub>2</sub>
  - Cyanosis with supplemental oxygen
  - Bradypnea or tachypnea outside normal limits for age
  - Severe retractions
  - Hypercarbia

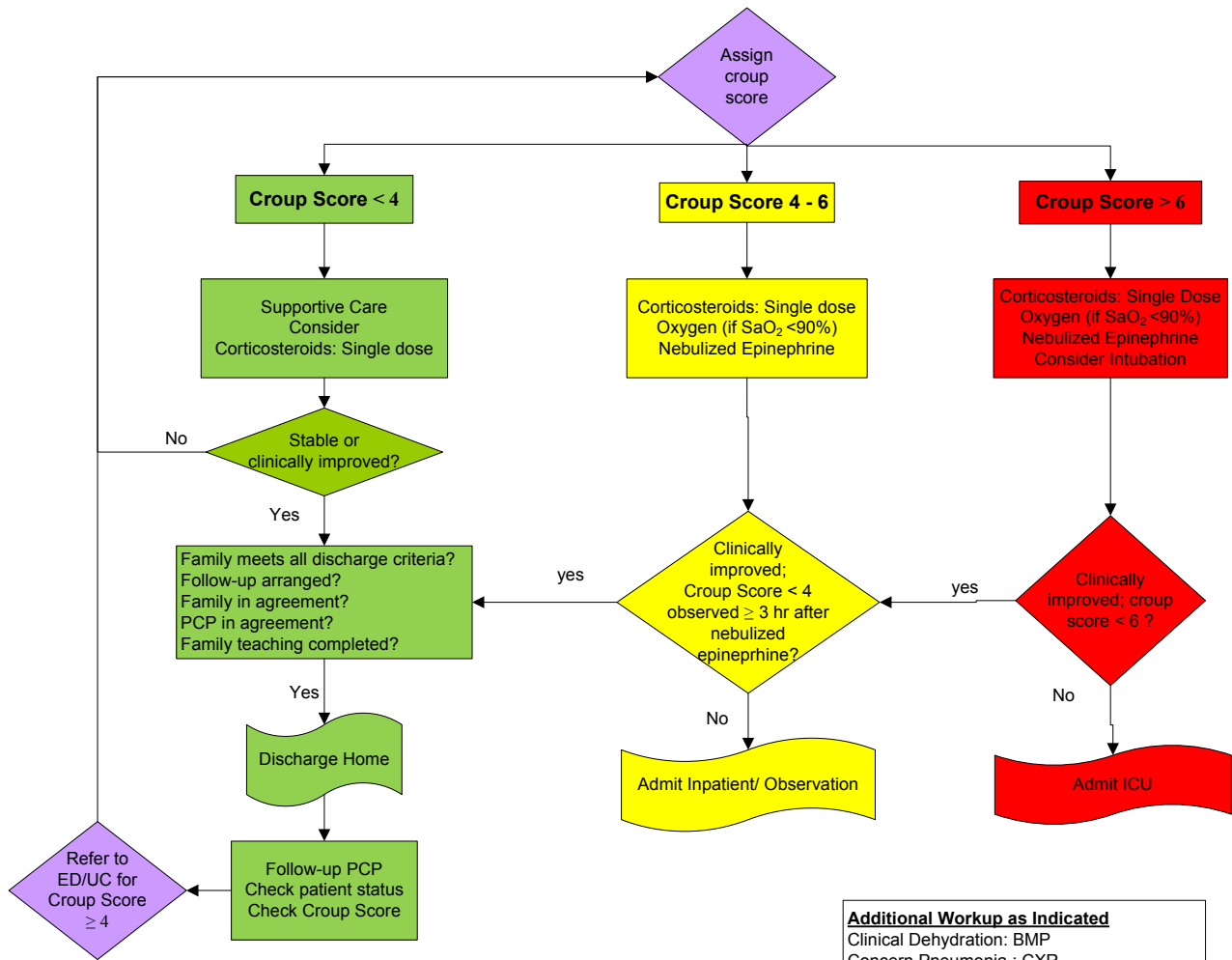
## **11. Follow-up**

- With PCP or designee as scheduled
- Evaluate severity of croup
- Evaluate vital signs and oxygen saturation
- Evaluate respiratory status
- Evaluate hydration status

## 12. Clinical Care Guideline Measures & Targets

	Measures	Target 2009
<b>Inpatient or Observation</b>		
1	Antibiotics (without coded rationale)	< 25%
2	Radiographs (CXR or Lateral Neck)	< 25%
3	Single Dose Steroid	> 75%
4	Viral Testing	< 25%
5	Laboratory studies	< 25%
6	Readmission within 7 days	< 25%
7	Average Length of Stay (< 48 h)	> 75%
<b>Outpatients</b>		
1	Antibiotics (without coded rationale)	< 25%
2	Radiographs (CXR or Lateral Neck)	< 25%
3	Single Dose Steroid	> 75%
4	Viral testing	< 25%
5	Laboratory studies	< 25%
6	Anti-tussive or decongestant	< 25%

**Figure 3 Algorithm Croup**



<b>CROUP SCORE: Modified Westley</b>	
Indicators of Disease Severity	Score
<b>Inspiratory stridor</b>	
None	0
Only with agitation or activity	1
At rest	2
<b>Retractions</b>	
None	0
Mild	1
Moderate	2
Severe	3
<b>Air Entry</b>	
Normal	0
Mildly decreased	1
Severely decrease	2
<b>Cyanosis</b>	
None	0
With agitation/activity	4
At rest	5
<b>Level of Consciousness</b>	
Normal	0
Altered	5
<b>Possible Score</b>	
< 4	0-17
4-6	Mild Croup
>6	Moderate Croup
	Severe Croup

<b>TREATMENT Croup Score ≥ 4</b>	
<b>Corticosteroids:</b> Single dose only!	
Dexamethasone	
Dose PO, IM, IV:	0.15 – 0.6 mg/kg
Max Dose:	10 mg
Onset of action:	6 hours
Duration of action:	24-72 h
<b>Nebulized Epinephrine:</b> Observe 3 h	
<b>Racemic Epinephrine</b>	
Dose: 0.05 ml/kg/dose of 2.25% in 2.5mL NS	
	0.25 ml (wt < 5 kg)
	0.5 mL (wt ≥ 5 kg)
Maximum Dose:	0.5 mL
Frequency:	every 20 min as indicated
<b>L-epinephrine</b>	
Dose: 0.5 mL/kg/dose of 1:1000 in 2.5 mL NS	
Max dose:	5 mL
Frequency:	every 20 min as indicated
<b>Oxygen</b> Supplemental oxygen for hypoxia	
<b>Antipyretic</b> for T > 38.3	
Acetaminophen	Dose = 15 mg/kg po q4
Ibuprofen	Dose = 10 mg/kg po q6°
<b>Antibiotics</b> Indicated only for bacterial tracheitis	

**Additional Workup as Indicated**  
 Clinical Dehydration: BMP  
 Concern Pneumonia : CXR  
 Concern Epiglottitis: Lateral Neck XR  
 Concern SBI? BC (> 0.5 ml)  
 CBC + automated diff  
 Respiratory Compromise: ABG

**Indications for Specialty Consultation**  
 Any Concern for Invasive Disease, including:  
 Aphonia  
 Cyanosis  
 Prolonged disease process  
 Acute onset high fever  
 Toxic appearance  
 Increased WOB with retractions  
 Symptoms > 7 days  
 Severe stridor

**Indications for Admission**  
 ≥ 3 Nebulized Epinephrine treatments in 3 h  
 Stridor at rest despite therapy  
 Continued symptoms 4 h post steroids  
 Inadequate hydration  
 Moderate – severe retractions  
 Requires supplemental oxygen  
 Condition deteriorates or does not improve  
 Cyanosis  
 Hypoxia  
 Hypercarbia  
 Aphonia – consider alternative diagnosis + start antibiotics

**Strength of Evidence:**



## GLOSSARY

Abbreviation	Definition
<	Less than
≤	Less Than or equal to
>	Greater than
≥	Greater than or equal to
=	Equals
%	Percent
&	And
ABG	Arterial blood gas
BP	Blood Pressure
BPD	Bronchopulmonary dysplasia
CBC	Complete Blood Count
CF	Cystic Fibrosis
CXR	Chest radiograph
D	Day
ED	Emergency Department Emergency Medical Services
EMS	(911)
FiO2	Fraction of Inspired Oxygen
h	Hour
HR	Heart Rate
HIB	<i>Haemophilus influenzae type b</i>
hMPV	Human metapneumo virus
I/O	Intake and Output
IV	Intra Venous
IM	Intramuscular
KG	Kilogram
Min	minute
Mg	Milligram
mL	milliliter
Mos	Month
NC	Nasal Cannula
PAH	Pulmonary Artery Hypertension
PCP	Primary Care Provider
PO	By mouth
q	every
RR	Respiratory Rate
RSV	Respiratry Syncitial Virus
SaO2	Oxygen Saturation
SBI	Serious Bacterial Illness
T	Temperature
TB	Tuberculosis
TDD	Total Daily Dose
UC	Urgent Care
VS	Vital Signs
XR	X-Ray
Yr	Year

## REFERENCES

### General

1. Argent, A.C., C.J. Newth, and M. Klein, *The mechanics of breathing in children with acute severe croup*. Intensive Care Med, 2008. **34**(2): p. 324-332.
2. Briassoulis, G., et al., *Unexpected combination of acute croup and myocarditis: case report*. BMC Clin Pathol, 2005. **5**: p. 5.
3. Brown, J.C., *The management of croup*. Br Med Bull, 2002. **61**: p. 189-202.
4. Chan, P.W., *Risk factors associated with severe viral croup in hospitalised Malaysian children*. Singapore Med J, 2002. **43**(3): p. 124-7.
5. Cherry, J.D., *State of the evidence for standard-of-care treatments for croup: are we where we need to be?* Pediatr Infect Dis J, 2005. **24**(11 Suppl): p. S198-202, discussion S201.
6. Cherry, J.D., *Clinical practice. Croup*. N Engl J Med, 2008. **358**(4): p. 384-91.
7. Ewig, J.M., *Croup*. Pediatr Ann, 2002. **31**(2): p. 125-30.
8. Fisher, J.D., *Out-of-hospital cardiopulmonary arrest in children with croup*. Pediatr Emerg Care, 2004. **20**(1): p. 35-6.
9. Garyfallou, G.T., S.K. Costalas, and C.J. Murphy, *Acute pulmonary edema in a child with spasmodic croup*. Am J Emerg Med, 1997. **15**(2): p. 211-3.
10. Greenberg, R.A., N.C. Dudley, and K.K. Rittichier, *A reduction in hospitalization, length of stay, and hospital charges for croup with the institution of a pediatric observation unit*. Am J Emerg Med, 2006. **24**(7): p. 818-21.
11. Johnson, D., *Croup*. Clin Evid, 2005(14): p. 310-27.
12. Kwong, K., M. Hoa, and J.M. Cotichia, *Recurrent croup presentation, diagnosis, and management*. Am J Otolaryngol, 2007. **28**(6): p. 401-7.
13. Leung, A.K., J.D. Kellner, and D.W. Johnson, *Viral croup: a current perspective*. J Pediatr Health Care, 2004. **18**(6): p. 297-301.
14. Li, S.F., *The Westley croup score*. Acad Emerg Med, 2003. **10**(3): p. 289; author reply 289.
15. Magomedov, M.K., *[A fatal outcome of false croup in lacunar angina complicated by peritonsillar abscess]*. Arkh Patol, 2001. **63**(1): p. 36-7.
16. Marx, A., et al., *Pediatric hospitalizations for croup (laryngotracheobronchitis): biennial increases associated with human parainfluenza virus 1 epidemics*. J Infect Dis, 1997. **176**(6): p. 1423-7.
17. Myers, C., et al., *Multiple pulmonary abscesses caused by Legionella pneumophila infection in an infant with croup*. Pediatr Infect Dis J, 2006. **25**(8): p. 753-4.
18. Peltola, V., T. Heikkinen, and O. Ruuskanen, *Clinical courses of croup caused by influenza and parainfluenza viruses*. Pediatr Infect Dis J, 2002. **21**(1): p. 76-8.
19. Savenkova, M.S., et al., *[Causes of lethal outcomes in croup syndrome in children]*. Vestn Otorinolaringol, 2001(3): p. 50-1.
20. Sturludottir, M., et al., *[Case report: prolonged croup due to herpes simplex infection]*. Laeknabladid, 2006. **92**(12): p. 855-7.
21. Szenborn, L., et al., *[Croup in children--results of prospective, multicenter observation]*. Przegl Lek, 2004. **61**(5): p. 457-62.
22. TJ, O.L. and A. Messner, *Subglottic hemangioma*. Otolaryngol Clin North Am, 2008. **41**(5): p. 903-11, viii-ix.
23. van der Hoek, L., et al., *Croup is associated with the novel coronavirus NL63*. PLoS Med, 2005. **2**(8): p. e240.
24. Westley, C.R., E.K. Cotton, and J.G. Brooks, *Nebulized racemic epinephrine by IPPB for the treatment of croup: a double-blind study*. Am J Dis Child, 1978. **132**(5): p. 484-7.

### Epinephrine

1. Argent, A.C., et al., *The effect of epinephrine by nebulization on measures of airway obstruction in patients with acute severe croup*. Intensive Care Med, 2008. **34**(1): p. 138-147.
2. Rzos, J.D., et al., *The disposition of children with croup treated with racemic epinephrine and dexamethasone in the emergency department*. J Emerg Med, 1998. **16**(4): p. 535-9.
3. Taussig, L.M., et al., *Treatment of laryngotracheobronchitis (croup). Use of intermittent positive-pressure breathing and racemic epinephrine*. American Journal of Diseases of Children, 1975. **129**(7): p. 790-3.
4. Thomas, L.P. and L.R. Friedland, *The cost-effective use of nebulized racemic epinephrine in the treatment of croup*. Am J Emerg Med, 1998. **16**(1): p. 87-9.
5. Waisman, Y., et al., *Prospective randomized double-blind study comparing L-epinephrine and racemic epinephrine aerosols in the treatment of laryngotracheitis (croup)*. Pediatrics, 1992. **89**(2): p. 302-6.

## Heliox

1. Beckmann, K.R. and W.M. Brueggemann, Jr., *Heliox treatment of severe croup*. Am J Emerg Med, 2000. **18**(6): p. 735-6.
2. Vorwerk, C. and T.J. Coats, *Use of helium-oxygen mixtures in the treatment of croup: a systematic review*. Emerg Med J, 2008. **25**(9): p. 547-50.
3. Weber, J.E., et al., *A randomized comparison of helium-oxygen mixture (Heliox) and racemic epinephrine for the treatment of moderate to severe croup*. Pediatrics, 2001. **107**(6): p. E96.

## Humidified Air

1. Bird, E., *Humidified air appears to be of no benefit in treating moderate croup*. J Pediatr, 2006. **149**(1): p. 141.
2. Colletti, J.E., *Myth: Cool mist is an effective therapy in the management of croup*. CJEM, 2004. **6**(5): p. 357-8.
3. Lavine, E. and D. Scolnik, *Lack of efficacy of humidification in the treatment of croup: Why do physicians persist in using an unproven modality?* CJEM, 2001. **3**(3): p. 209-12.
4. Moore, M. and P. Little, *Humidified air inhalation for treating croup*. Cochrane Database Syst Rev, 2006. **3**: p. CD002870.
5. Neto, G.M., et al., *A randomized controlled trial of mist in the acute treatment of moderate croup*. Acad Emerg Med, 2002. **9**(9): p. 873-9.
6. Scolnik, D., et al., *Controlled delivery of high vs low humidity vs mist therapy for croup in emergency departments: a randomized controlled trial*. JAMA, 2006. **295**(11): p. 1274-80.
7. Wyer, P.C., *Delivery of 100%, 40%, and blow-by humidity did not differ for change in croup scores in children with moderate croup*. Evid Based Med, 2006. **11**(5): p. 142.

## Steroids

1. Amir, L., et al., *Oral betamethasone versus intramuscular dexamethasone for the treatment of mild to moderate viral croup: a prospective, randomized trial*. Pediatr Emerg Care, 2006. **22**(8): p. 541-4.
2. Ausejo, M., et al., *Glucocorticoids for croup*. Cochrane Database Syst Rev, 2000(2): p. CD001955.
3. Bjornson, C.L., et al., *A randomized trial of a single dose of oral dexamethasone for mild croup*. N Engl J Med, 2004. **351**(13): p. 1306-13.
4. Cetinkaya, F., B.S. Tufekci, and G. Kutluk, *A comparison of nebulized budesonide, and intramuscular, and oral dexamethasone for treatment of croup*. Int J Pediatr Otorhinolaryngol, 2004. **68**(4): p. 453-6.
5. Chub-Uppakarn, S. and P. Sangsupawanich, *A randomized comparison of dexamethasone 0.15 mg/kg versus 0.6 mg/kg for the treatment of moderate to severe croup*. Int J Pediatr Otorhinolaryngol, 2007. **71**(3): p. 473-7.
6. Donaldson, D., et al., *Intramuscular versus oral dexamethasone for the treatment of moderate-to-severe croup: a randomized, double-blind trial*. Acad Emerg Med, 2003. **10**(1): p. 16-21.
7. Fifoot, A.A. and J.Y. Ting, *Comparison between single-dose oral prednisolone and oral dexamethasone in the treatment of croup: a randomized, double-blinded clinical trial*. Emerg Med Australas, 2007. **19**(1): p. 51-8.
8. Geelhoed, G.C., *Budesonide offers no advantage when added to oral dexamethasone in the treatment of croup*. Pediatr Emerg Care, 2005. **21**(6): p. 359-62.
9. Godden, C.W., et al., *Double blind placebo controlled trial of nebulised budesonide for croup*. Arch Dis Child, 1997. **76**(2): p. 155-8.
10. Griffin, S., et al., *Nebulised steroid in the treatment of croup: a systematic review of randomised controlled trials*. Br J Gen Pract, 2000. **50**(451): p. 135-41.
11. Johnson, D.W., et al., *A comparison of nebulized budesonide, intramuscular dexamethasone, and placebo for moderately severe croup*. N Engl J Med, 1998. **339**(8): p. 498-503.
12. Klassen, T.P., et al., *Nebulized budesonide and oral dexamethasone for treatment of croup: a randomized controlled trial*. JAMA, 1998. **279**(20): p. 1629-32.
13. Luria, J.W., et al., *Effectiveness of oral or nebulized dexamethasone for children with mild croup*. Arch Pediatr Adolesc Med, 2001. **155**(12): p. 1340-5.
14. O'Mara, L., *Dexamethasone reduced the incidence of children with mild croup who returned for medical care*. Evid Based Nurs, 2005. **8**(2): p. 41.
15. Parker, R., C.V. Powell, and A.M. Kelly, *How long does stridor at rest persist in croup after the administration of oral prednisolone?* Emerg Med Australas, 2004. **16**(2): p. 135-8.
16. Paton, J.Y., *Oral dexamethasone led to fewer treatment failures than did nebulized dexamethasone or placebo in children with mild croup*. ACP J Club, 2002. **137**(1): p. 31.
17. Rittichier, K.K. and C.A. Ledwith, *Outpatient treatment of moderate croup with dexamethasone: intramuscular versus oral dosing*. Pediatrics, 2000. **106**(6): p. 1344-8.

18. Roberts, G.W., et al., *Repeated dose inhaled budesonide versus placebo in the treatment of croup*. J Paediatr Child Health, 1999. **35**(2): p. 170-4.
19. Rowe, B.H., *Corticosteroid treatment for acute croup*. Ann Emerg Med, 2002. **40**(3): p. 353-5.
20. Russell, K., et al., *Glucocorticoids for croup*. Cochrane Database Syst Rev, 2004(1): p. CD001955.
21. Sparrow, A. and G. Geelhoed, *Prednisolone versus dexamethasone in croup: a randomised equivalence trial*. Arch Dis Child, 2006. **91**(7): p. 580-3.
22. Sumboonnanonda, A., S. Suwanjutha, and S. Sirinavin, *Randomized controlled trial of dexamethasone in infectious croup*. J Med Assoc Thai, 1997. **80**(4): p. 262-5.
23. Worster, A., P.H. Tang, and G. Hall, *Dexamethasone for mild croup*. CJEM, 2006. **8**(4): p. 282-3.

**Work Group Members**

Alison Brent, MD

Margaret Ferguson, MD

David Fox, MD

Simon Hambidge, MD