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# CHAPTER 10 – RESPIRATORY SYSTEM

*First Nations and Inuit Health Branch (FNIHB) Pediatric Clinical Practice Guidelines for Nurses in Primary Care.*  
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## GENERAL INFORMATION

Respiratory illnesses in children are one of the most common causes of nursing station visits and hospital admissions among Aboriginal children. Such illnesses are more common in children who live in crowded

housing and those who are exposed to cigarette or wood smoke. Because of the contagious nature of many of the viral illnesses, outbreaks are common. Careful assessment is necessary to prevent morbidity.

## ASSESSMENT OF THE RESPIRATORY SYSTEM<sup>1,2,3,4,5,6,7,8</sup>

### HISTORY OF PRESENT ILLNESS AND REVIEW OF SYSTEMS

#### GENERAL

The history varies according to the child's age.

- Onset of illness (sudden, gradual)
- Symptoms (acute, chronic, pattern over time)
- Fever
- Runny nose
- Sore throat
- Chest pain or tightness (older children may complain of this symptom)
- Dyspnea (appearance of increased work of breathing; complaints of shortness of breath in older children)
- Cough (timing [for example, night cough, exercise-induced], frequency, productive/nonproductive, characteristics [for example, barking, whooping]) (*see Table 2, "Types of Cough and Most Likely Illness"*)
- Stridor
- Wheeze
- Cyanosis
- Fatigue
- Pallor
- Previous similar episodes
- History of respiratory illness/conditions (for example, asthma, premature birth, previous intubation)
- Other medical history (for example, cardiac, conditions causing immunocompromise)
- Family medical history (for example, asthma)
- Allergies
- Medications

### PHYSICAL EXAMINATION OF THE RESPIRATORY SYSTEM

Use the **IPPA** approach:

- I for inspection
- P for palpation
- P for percussion
- A for auscultation

Some of these techniques (specifically palpation and percussion) are difficult to perform on infants and toddlers, and may not yield useful information.

#### VITAL SIGNS

- Respiratory rate (*see normal range in Table 1, "Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age"*)
  - Fever can increase the respiratory rate in children as much as 10 breaths per minute per degree of temperature
  - A sustained respiratory rate in the upper end of normal in a resting child may suggest respiratory illness or an increased metabolic rate (for example, fever)
  - A very rapid respiratory rate suggests lower airway disease
  - Newborn rate may go up to 80 breaths per minute if infant is crying or stimulated
- Respiratory rhythm and depth
- Heart rate (elevated with increased work of breathing, fever) (*see normal range in Table 1, "Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age"*)
  - Pulse rates for a sleeping child may be 10% lower
  - Heart rate may be elevated with increased work of breathing

- Temperature; see “Temperature Measurement in Children” in chapter 1 for measurement methods and normal temperature ranges according to age

**Table 1 – Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age** (Adapted from<sup>9,10,11</sup>)

Age	Heart Rate Range (beats/minute [mean])	Lower Limit of Systolic Blood Pressure (mm Hg)	Respiratory Rate Range (breaths/minute)
Birth to < 6 months	80–180 [140]	60	30–60
6 months to < 12 months	70–150 [130]	70	30–50
1 year to < 3 years	90–150 [120]	72–76	24–40
3 years to < 5 years	65–135 [110]	76–80	22–34
5 years to < 12 years	60–120 [85–100]	80–90	16–30
12 years to adult	60–100 [80]	90	12–20

## INSPECTION

### Signs of Mild Respiratory Illness

- Nasal discharge, sniffing
- Discharge at inner canthus of eyes
- Skin chafing around nose, upper lip
- Voice changes
- Coughing

**Table 2 – Types of Cough and Most Likely Illness**

Nature of Cough	Likely Type of Illness
Paroxysmal, whooping	Pertussis
Loose, productive	URTI, bronchitis
Sharp, barky	Croup, foreign body
Tight, productive	Pneumonia, bronchiolitis
Chronic	Asthma, bronchiectasis, tuberculosis

### Signs of Moderate to Severe Respiratory Distress

- Child appears acutely ill (may indicate lower respiratory infection, bacterial infection)
- Decreased activity, interaction
- Irritability to decreased mental alertness (suggests hypoxemia)
- Pallor
- Cyanosis of nails and mucous membranes (late sign)
- Drooling: sign of upper airway disease (for example, epiglottitis)
- Difficulty swallowing: acute upper airway inflammation (for example, epiglottitis)

- Voice changes (muffled with epiglottitis, hoarseness with laryngeal inflammation [for example, croup])
- Prolonged expiration (may indicate asthma or bronchiolitis)
- Asymmetry of chest movements (asymmetry may indicate pneumonia)
- Nasal flaring (especially in infants)
- Grunting (especially in infants)
- Accessory muscle use for breathing (indrawings):
  - Supraclavicular – retractions at the sternal notch, use of sternocleidomastoid muscles
  - Substernal – intercostal retractions, abdominal muscle use (lower airway symptoms)
- Positioning (for example, sitting forward with head tilted back slightly to extend neck [sniffing position] with airway obstruction [epiglottitis]); sits upright, leaning forward resting on extended arms with asthma
- Silent chest
- Tachycardia (see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”)
- Tachypnea (see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”)

### Signs of Chronic Disease

- Clubbing (may indicate bronchiectasis, cystic fibrosis)
- Eczema (often associated with asthma)
- Hyperinflation

**PALPATION**

Not useful in children < 3 years old, although it may be useful in older, cooperative children. Allows further assessment of respiratory excursion.

**PERCUSSION**

Useful only in older children (> 2 years).

- Resonance is normal
- Dullness to percussion over areas of fluid or solid tissue is present in lobar pneumonia, pleural effusion and collapsed lung
- Increased resonance over areas of hyperinflation (sounding like percussion of a puffed-out cheek) is present in bronchiolitis, asthma, foreign body with obstruction to the lung that is obstructed and pneumothorax

**AUSCULTATION**

- Quality of breath sounds (tracheobronchial, bronchovesicular, vesicular)
- Volume of air entry (good air entry or decreased air entry, identify area)
- Ratio of inspiration to expiration
- Adventitious sounds: crackles, wheezes, pleural rub, stridor, bronchial breathing

In infants and small children, the sounds may be transmitted easily and may therefore be difficult to localize. Breath sounds often seem louder in children because of the thinness of the chest wall.

**Decreased Breath Sounds**

- Infection (pneumonia, bronchiolitis)
- Bronchospasm (asthma)
- Upper airway obstruction (epiglottitis)
- Pleural effusion
- Pneumothorax
- Pulmonary edema

**Prolonged Expiratory Phase**

- Asthma
- Bronchiolitis

**Localized Crackles**

- Pneumonia
- Bronchiectasis

**Diffuse Crackles**

- Severe pneumonia
- Bronchiolitis
- Pulmonary edema (congestive heart failure, fluid overload)

Crackles that disappear after coughing usually have no significance. You may not hear crackles if the child is breathing shallowly. Try to have the child take deep breaths. Some children with pneumonia may not have crackles or any respiratory signs other than tachypnea.

**Wheezes**

- May be inspiratory or expiratory
- Suggests asthma or bronchiolitis

**Stridor**

- Inspiratory
- Suggests croup, epiglottitis

**Pleural Rub**

- Sounds like two pieces of leather being rubbed together
- Suggests pneumonia or effusion

**X-RAYS IN CHILDREN**

- X-rays should be performed on site (when possible), according to regional or zone policy, in children who have signs consistent with acute involvement of the lower respiratory tract, including tachypnea, persistent crackles or high fever, if such imaging will help to clarify a diagnosis and/or affect management. Otherwise, manage the illness on clinical grounds
- X-rays are not useful in the diagnosis or treatment of asthma or bronchiolitis or for children who do not appear acutely ill (“happy wheezers”)

## COMMON PROBLEMS OF THE RESPIRATORY SYSTEM

### ASTHMA<sup>4,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28</sup>

#### ASTHMA, ACUTE (EXACERBATION)

Exacerbations should be treated promptly to reverse the signs and symptoms and prevent them from becoming severe.

The findings depend on the acuteness and severity of the attack, which can range from mild to very severe.

Clinical Index for the Diagnosis of Asthma in Children <6 Years<sup>29</sup>

≥ 3 episodes of wheezing in the first 3 years of life with:

- A. either one of the major risk factors
- parental history of asthma
  - parental history of eczema

or

- B. 2 of 3 minor risk factors
- eosinophilia
  - wheezing without colds
  - allergic rhinitis

or

- C. 1 major or 2 minor risk factors may be considered

#### DIAGNOSIS OF ASTHMA IN CHILDREN 6 YEARS AND OVER<sup>70</sup>

Suspect the diagnosis if there is recurrent symptoms (for example, breathlessness, chest tightness, wheezing, cough) that are often worse at night and in the early morning and signs (for example, wheezing, tachypnea, accessory muscle use) of airway obstruction. Signs and symptoms are often present with viral respiratory tract infections, exercise (playing or laughing) or aeroallergen exposure. They improve with bronchodilators or corticosteroids.

Confirm asthma with:

1. Pre and post bronchodilator spirometry showing reversible airway obstruction (preferred) OR
2. Pre and post bronchodilator peak expiratory flow monitoring showing variability OR
3. Postive challenge test (metacholine or exercise)

### PATHOPHYSIOLOGY

Three major events lead to obstruction:

- Mucosal edema with inflammation
- Increased production of mucus
- Smooth-muscle hyperreactivity (bronchospasm)

### CAUSES

#### *Precipitating Factors*

- Severe or recurrent RSV bronchiolitis
- Recurrent pneumonia
- Familial tendency

#### *Triggers*

- Allergens (for example, pollens)
- Exercise
- Cold air
- Cigarette smoke
- Wood smoke
- Respiratory infection
- Emotions (for example, fear, anger, crying, laughing)

#### *Risk Factors for Severe Asthma Exacerbation*

History of the following features:

- Poorly controlled asthma
- Frequent asthma attacks (more than two per week)
- Recent severe attack
- Recent visit to emergency room or admission to hospital or ICU for asthma
- Severe present attack
- Duration of current symptoms longer than 24 hours
- More than 10 puffs of salbutamol (Ventolin) in past 24 hours
- Recent use of high-dose steroids
- Long delay in seeking medical care
- Non-adherence to pharmacologic treatment (inhaler usage)

**HISTORY****Acute Episodes**

- Preceding or current URTI
- Allergy history
  - Recent exposure to known allergens (for example, pollen)
  - Eczema (current or history of)
  - Frequent nose rubbing (crease across nose)
  - Watery eyes and nose
- Review of chronic management medications and regimen
- Symptoms over previous 2–4 weeks
- Frequency of bronchodilators use (more than usual)
- Peak flow results (children > 6 who are monitoring)
- Time of onset of current exacerbation
- Frequency of attacks
- Activity level changes (for example, missed school, sedentary activity)
- Admissions for acute exacerbations
- Environmental exposures

**PHYSICAL FINDINGS****Signs of Respiratory Distress (Severe Airway Obstruction)****General Appearance**

- Irritability, anxiety
- Decreased mental alertness
- Inspiratory stridor (suggests foreign body)
- Pallor or central cyanosis

**Vital Signs**

- Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Decreased pulse oximetry reading (< 91% on room air)
- Pulsus paradoxus greater than 20 mm Hg

**Respiratory Assessment**

- Increased work of breathing
- Nasal flaring
- Retractions (substernal, intercostal, sternal notch, supraclavicular)
- Grunting; tripod or sniffing position
- Accessory muscle use (especially sternocleidomastoid muscles)
- Breath sounds faint or absent (because of lack of air entry)
- Marked expiratory wheezes, prolonged expiratory phase
- PEFr less than 40% of personal best or standard level

Beware of the silent chest. A very quiet chest is common in severe asthma, because there is little movement of air.

**Other Assessment**

- General appearance
- Allergy-related symptoms
  - “Allergic shiners” (dark circles under eyes)
  - Transverse nasal crease
  - Watery eyes and nose

**Lungs**

- Extended expiration
- Wheezing (expiratory predominant)
- Decreased air entry

**Determining Severity of Acute Asthma Exacerbation**

Use Table 3, “*Pediatric Respiratory Assessment Measure*” to determine the severity of a child’s asthma exacerbation. Assign the child a point (between 0 and 3) for each of the five signs listed and total the points for all the items. Determine the severity, as described in the table, based on the total points.

Other indicators of severity are found below.

**Table 3 – Pediatric Respiratory Assessment Measure (PRAM)<sup>12</sup>**

Signs	0	1	2	3
Suprasternal indrawing	Absent		Present	Indrawing
Scalene retractions*	Absent		Present	Retractions
Wheezing	Absent	Expiratory	Inspiratory and Expiratory	Audible without stethoscope
Air entry	Normal	Decreased/absent at bases	Decreased widespread	Absent
Oxygen	> 95%	92–95%	< 92%	

**Interpreting Total Scores:**

Mild 0–4 points	Moderate 5–8 points	Severe 9–12 points
*Scalene retractions suprasternal retractions		

### Mild Exacerbation

- Cough, wheeze, some dyspnea
- Inspiratory and expiratory wheezes
- Oxygen saturation > 95% on room air
- PEFR 75% of personal best

### Moderate Exacerbation

- Cough, wheeze, dyspnea
- Intercostal indrawing, tracheal tug
- Inspiratory and expiratory wheezes
- Oxygen saturation 92% to 95% on room air
- PEFR 40% to 75% of personal best
- May have increased respiratory rate (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)

### Severe Exacerbation

- Anxiety, confusion, fatigue, decreased level of consciousness
- Dyspnea, with inability to speak or eat
- Respiratory rate outside the normal range (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)

### DIFFERENTIAL DIAGNOSIS

- Pneumonia
- Croup
- Bronchiolitis
- Foreign-body aspiration
- Cystic fibrosis
- Pulmonary edema
- GERD with recurrent aspiration

### COMPLICATIONS

- Frequent absences from school
- Frequent admission to hospital
- Restrictions in physical activity
- Psychologic impact of chronic illness
- Localized bronchiectasis
- Status asthmaticus
- Death

### DIAGNOSTIC TESTS

- Pulse oximetry
- Peak expiratory flow (can be attempted in an older child, if he or she is not too distressed)
- Chest x-ray (if available) to rule out pneumothorax, chronic atelectasis or bronchiectasis

### MANAGEMENT OF ACUTE ASTHMA EXACERBATION

#### Goals of Treatment

- Relieve symptoms (reverse airflow obstruction, correct hypoxemia)
- Prevent complications (early bronchodilators and systemic corticosteroids)
- Prevent recurrence (adjust baseline therapy)

**Appropriate Consultation**

Consult a physician for:

- Any child with previously undiagnosed (suspected) asthma
- Any child with known asthma who is experiencing acute symptoms
- Any child receiving long-term prophylaxis whose symptoms are not well controlled with the current medication regimen
- Consider nonurgent consult with physician regarding Pulmonary Function Testing (PFT)

**Adjuvant Therapy**

- Give oxygen (6–10 L/min or more by mask) if needed, to keep oxygen saturation at  $\geq 92\%$
- Start IV therapy with normal saline to keep vein open in children with moderate to severe respiratory distress, consult physician

**Nonpharmacologic Interventions**

- Nurse infant in an upright position
- Push oral fluids to prevent dehydration and to help liquefy secretions

**Pharmacologic Interventions**

In a case of acute asthma, try to consult a physician before giving any medication to the child.

Inhaled  $\beta_2$ -agonists:

salbutamol (Ventolin) 100  $\mu\text{g}/\text{puff}$  MDI with spacer (AeroChamber), 6–10 puffs/dose q20 mins x 3 doses;

or

nebulized salbutamol (Ventolin) q20mins x 3 doses

Children <10 kg: 1.25 to 2.5 mg/dose

Children 11–20 kg: 2.5 mg/dose

Children >20 kg: 5 mg/dose<sup>71</sup>

Consult physician or a nurse practitioner for further doses.

**If a full response is achieved, consult a physician or nurse practitioner about continuing management at home:**

salbutamol (Ventolin) by MDI, 1 to 2 puffs q2–4h prn for relief, depending on severity

and

prednisone 1 to 2 mg/kg per day (to a maximum of 60 mg) PO daily for 5 days

and

if not on a regimen of inhaled corticosteroids (ICS) for example, fluticasone (Flovent) MDI:

Children 12 months–4 years of age: fluticasone 100  $\mu\text{g}$  bid with pediatric spacer and face mask

Children 4–16 years of age: fluticasone 50 to 125  $\mu\text{g}$  bid; may increase to 200 - 250  $\mu\text{g}$  bid

Children > 16 years of age: fluticasone 100 to 500  $\mu\text{g}$  bid

**If only a partial response is achieved, consult a physician or nurse practitioner. In consultation, it may be decided to:**

Continue  $\beta_2$ -agonist q20min as above and add the following:

ipratropium bromide (Atrovent) MDI, 5 puffs/dose q1h (same dose for all weights)

or

ipratropium bromide (Atrovent), 250  $\mu\text{g}$  q1h,

and

prednisone 1 to 2 mg/kg per day (maximum of 60 mg) PO daily for 5 days

or

methylprednisolone (Solumedrol), 2 mg/kg bolus IV (to a maximum of 125 mg) then 0.5 mg/kg q6h

**Monitoring and Follow-Up**

Monitor ABCs, pulse oximetry, hydration and level of consciousness while awaiting transport or discharge.

**If being discharged home after treatment of acute episode:**

- Provide instructions (preferably written) to the parents or caregiver on symptoms and signs of respiratory distress
- Advise parents or caregiver to bring the child back to the clinic if there is no response to  $\beta_2$ -agonists or the response lasts less than 2 hours
- Counsel about appropriate use of drugs, including dosages, administration techniques (for example, use of MDI with spacer), effects and side effects
- Explain strategies to prevent further attacks
- Prophylactic medication regimen as required
- If any change in pharmacologic therapy is initiated, reassess the client in 1 to 4 weeks.<sup>72</sup>

**Referral**

Medevac if severe exacerbation or if upon consultation a physician agrees. The following criteria can guide the decision.

Criteria for hospital admission:

- Child is critically ill (moderate to severe airway obstruction with respiratory distress)
- Poor response to emergency therapy: needs more than three or four salbutamol (Ventolin) treatments, post-treatment oxygen saturation < 95% on room air
- Social considerations: parents or caregiver unable to provide care, home is far from health facility

**ASTHMA, CHRONIC**

Reversible obstructive disease of the lungs characterized by hyperreactivity of the airways, which leads to recurrent episodes of cough and wheezing. It occurs in 5% to 10% of children, and the prevalence is increasing, for unknown reasons.

See the diagnostic criteria for asthma in the section “*Asthma, Acute (Exacerbation)*”.

*Mild chronic asthma* consists of mild activity limitation and infrequent episodic illness.

*Mild persistent asthma* consists of an occasional night cough relieved by  $\beta_2$ -agonists and/or an exercise-induced bronchospasm regularly relieved by  $\beta_2$ -agonists.

*Moderate asthma* is the regular use of  $\beta_2$ -agonists at night for cough, activity limitations despite use of  $\beta_2$ -agonists, recent emergency treatment for acute symptoms and/or use of prednisone for control of symptoms.

*Exercise-induced asthma* is shortness of breath induced by physical activity.

**CAUSES****Precipitating Factors**

- Severe or recurrent RSV bronchiolitis
- Recurrent pneumonia
- Familial tendency

**Triggers**

- Allergens (for example, pollens)
- Exercise
- Cold air
- Cigarette smoke
- Wood smoke
- Respiratory infection
- Emotions (for example, fear, anger, crying, laughing)

**HISTORY**

- Cough
- Wheeze
- Dyspnea
  - Frequency and severity of exacerbations
  - Current management regimen
  - Adherence to regimen
  - Degree of bronchodilator use (in recent days; number of puffers used in a month)
  - Review how puffers are used (spacer, number of puffs, frequency)

**Assess the Impact of Asthma on Child's Life**

- Number of school days missed
- Limitation of activity because of frequency of attacks
- Number of visits to clinic or emergency department for treatment
- Number of admissions to hospital or ICU
- Number of courses of systemic steroids needed to manage acute episodes

**Assess Environmental History**

- Type of home
- Heating source
- Carpeting
- Pets
- Exposure to secondhand smoke
- Stuffed animals

**PHYSICAL EXAM****General Appearance**

Full respiratory physical as described under “*Physical Examination of the Respiratory System.*”

**Signs of Atopic Disease**

- Eczema
- “Allergic shiners” (dark circles under eyes)
- Transverse nasal crease
- Frequent nose rubbing (crease across nose)
- Watery eyes and nose

**COMPLICATIONS**

- Frequent absences from school
- Frequent admission to hospital
- Restrictions in physical activity
- Psychologic impact of chronic illness
- Localized bronchiectasis
- Status asthmaticus
- Death

**DIAGNOSTIC TESTS**

- Pulse oximetry
- Peak expiratory flow (can be attempted in an older child, if he or she is not too distressed)
- Chest x-ray (if available) to rule out pneumothorax (if medevac)

**MANAGEMENT****Goals of Treatment**

- Prevent symptoms (for example, cough, shortness of breath, wheeze that interferes with daytime activities, exercise, school attendance or sleep)
- Prevent need for regular use of rescue medications (for example, salbutamol [Ventolin])
- Prevent visits to emergency department or admission to hospital
- Normalize PEF and FEV<sub>1</sub> on pulmonary function testing

**Appropriate Consultation**

Consult a physician for:

- Any child with previously undiagnosed asthma
- Any child with known asthma who is experiencing acute symptoms
- Any child receiving long-term prophylaxis whose symptoms are not well controlled with the current medication regimen

**Nonpharmacologic Interventions<sup>70</sup>**

Chronic asthma management begins with environmental control, education, a written action plan and regular follow-up (to assess control, peak expiratory flow, inhaler technique, adherence to medications, triggers, comorbidities, growth [for example, height and weight]).

**Criteria for Determining Whether Asthma is Controlled<sup>30</sup>**

Parameter	Frequency or Value
Daytime symptoms	< 4 days/week
Nighttime symptoms	< 1 night/week
Physical activity	Normal
Exacerbations	Mild, infrequent
Absent from school due to asthma	None
Need for a $\beta_2$ -agonist	< 4 doses/week*
FEV <sub>1</sub> or PEF	≥ 90% of personal best
PEF diurnal variation <sup>†</sup>	< 10–15%

FEV<sub>1</sub> = forced expiratory volume in 1 sec measured by spirometry; PEF = peak expiratory flow measured using a portable peak flow meter

\* May use 1 dose/day to prevent exercise-induced symptoms

† Diurnal variation is calculated as the highest PEF minus the lowest divided by the highest PEF multiplied by 100 for morning and night (determined over a 2-week period)

**Frequent Reasons for Poor Asthma Control<sup>30</sup>**

- Insufficient patient education, particularly in terms of what asthma is and how it can be controlled
- Misunderstanding regarding the role and side effects of medications
- Overuse of  $\beta_2$ -agonists
- Insufficient use of anti-inflammatory agents, including intermittent use, inadequate dose or lack of use
- Inadequate assessment of patient adherence
- Lack of continuity of care

**Client Education**

- Discuss diagnosis and expected course of illness
- Discuss environmental effects on asthma symptoms and ways to reduce those effects (for example, smoking, dust, pollens, viral respiratory tract infections, etc.)
- Counsel parents or caregiver about appropriate use of medications (name, action [reliever vs controller], dose, frequency, side effects)

- Advise child about proper use of aerosol delivery device, AeroChamber and spacer
- Review client demonstrating inhaler techniques at each visit to ensure optimal use (including spacer, number of puffs, frequency)
- Teach parents or caregiver how to monitor for symptoms and how to use peak flow meter (if deemed beneficial for managing symptoms)
- Provide instruction on worsening signs of asthma and when to seek help urgently
- Provide written instruction on a plan of action that the parents or caregiver should initiate when signs of worsening are first occurring (for example, increasing need for usual rescue medications). Examples of asthma action plans can be obtained from the Asthma Society (*see* <http://www.asthma.ca/adults/control/actionPlan.php>) or the Lung Association (*see* [http://www.lung.ca/diseases-maladies/asthma-asthme/treatment-traitement/index\\_e.php#plan](http://www.lung.ca/diseases-maladies/asthma-asthme/treatment-traitement/index_e.php#plan))
- Counsel parents (or caregiver) and child about how to minimize local side effects (oral candidiasis) by careful rinsing of the mouth and gargling

### Pharmacologic Interventions

#### Long-Term Prophylactic Management of Chronic Asthma

These medication are only to be prescribed by a physician or a nurse practitioner. Various medication regimens may be prescribed for prophylaxis, including the following:

##### Bronchodilators ( $\beta_2$ -agonists)

- Short-acting (for example, salbutamol [Ventolin])
- Long-acting (for example, salmeterol [Serevent] – not recommended as monotherapy in asthma, used with ICS)

##### Anti-inflammatory Agents

- Corticosteroids (for example, budesonide [Pulmicort] or fluticasone [Flovent])
- Leukotriene receptor antagonists (for example, montelukast [Singulair]) – an add-on for patients on moderate dose of ICS (200–500  $\mu\text{g}$  per day) whose asthma is inadequately controlled or as an alternative for children who cannot or will not use ICS, patients with asthma and mild allergic rhinitis

#### For Mild Chronic Asthma

inhaled salbutamol (Ventolin), 100  $\mu\text{g}$  /puff, 1 or 2 puffs q4–6h via spacer

#### For Mild Persistent Asthma

$\beta_2$ -agonist prn (for example, salbutamol [Ventolin])

and

inhaled corticosteroids, for example:

fluticasone MDI (Flovent), 100–500  $\mu\text{g}$  divided twice daily via spacer

#### For Moderate Chronic Asthma

$\beta_2$ -agonists prn (for example, salbutamol [Ventolin])

and

inhaled corticosteroids for example:

fluticasone MDI (Flovent), 100–500  $\mu\text{g}$  divided twice daily via spacer

and

prednisone 1 to 2 mg/kg/day (maximum: 60 mg) for 5 days for exacerbations

#### For Exercise-Induced Asthma

salbutamol (Ventolin), 100 $\mu\text{g}$  / puff, 1 or 2 puffs 15 minutes before exercise

Leukotriene receptor antagonist can also be considered (for example, montelukast [Singulair])

#### For Night Cough (Cough-dominant Asthma)

salbutamol (Ventolin) 100 $\mu\text{g}$  / puff (1 or 2 puffs) hs (trial for 2–4 weeks)

and

inhaled corticosteroids, for example:

fluticasone MDI (Flovent), 100–500  $\mu\text{g}$  divided twice daily via spacer

### Monitoring and Follow-Up

If any change in pharmacologic therapy is initiated, reassess the client in 4 weeks.<sup>72</sup>

Children with chronic asthma need to be seen several times a year to assess if there is adequate control of symptoms. Weight and height should be measured at each visit. Watch for growth failure in children taking more than 800  $\mu\text{g}$  of inhaled steroids per day. (falling off the growth curve) in children on inhaled steroids. If this occurs promptly discuss with a physician.<sup>70</sup>

### Referral

Refer as needed to a physician to assess control and to prescribe medications for long-term prophylaxis (control).

**BRONCHIOLITIS**<sup>31,32,33,34,35,36,37,38,39</sup>

Bronchiolitis is characterized by wheezing and airway obstruction as a complication of a respiratory infection. Invasion of the epithelial cells of the small bronchi and bronchioles cause inflammation, edema and excessive mucus that obstructs the small airways. It is a leading cause of hospitalization of infants and young children, with ~80% in the first year of life of which ~50% are 1–3 months of age. Bronchiolitis most commonly occurs in children < 2 years of age in the winter and early spring.

Bronchiolitis normally lasts 4 or 5 days, although younger infants may have a longer course. Though symptoms may resolve, radiologic findings may take 8–9 weeks to resolve. In 20% of cases, bronchiolitis may persist for weeks to months with symptoms of persistent wheezing, hyperinflation, abnormal gas exchange and in some cases lobar collapse.

**CAUSES**

Respiratory syncytial virus (RSV) is the leading cause of bronchiolitis, but other common pathogens include:

- Parainfluenza virus
- Influenza virus
- Rhinovirus
- Coronavirus
- Bacterial pathogens (rare)
- Mold exposure

**HISTORY**

Prodrome

- History of 1–4 days of upper respiratory tract infection symptoms
  - Rhinitis
  - Sneezing
  - Cough
  - Fever (38.5 to 39°C)
  - Anorexia with poor feeding
  - Irritability

Gradual onset of:

- Wheezing
- Increased, tight cough
- Low-grade fever

May progress to symptoms of respiratory distress:

- Irritability, anxiety
- Decreased mental alertness
- Increased work of breathing
- Audible wheezing/rattling with respiration
- Increased respirations

**PHYSICAL FINDINGS****General Inspection**

- Irritability, anxiety
- Decreased mental alertness
- Increased work of breathing
  - Nasal flaring
  - Retractions (substernal, intercostal, sternal notch, supraclavicular)
  - Grunting
- Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Decreased pulse oximetry reading
- Pallor or central cyanosis
- Apneic episodes (risk for premature infants, neonates and in infants with previous history of observed apnea)

**Lungs**

- Expiratory wheezing
- Hyperresonant to percussion
- May have a prolonged expiratory phase
- Widespread, fine, end-inspiratory and early-expiratory crackles
- Coarse crackles
- Decreased air entry

Severely ill children may not have wheezes or readily audible breath sounds as they are unable to move air, thus have a “silent chest.” These children are at high risk for respiratory arrest.

**Associated Findings**

- Acute otitis media (common finding in 50–60% of infants with bronchiolitis)
- Signs of dehydration (secondary to increased fluid needs from fever/tachypnea and decreased oral intake)

**DETERMINING SEVERITY**

Assessment of disease severity is important, as moderate to severe symptoms require hospitalization.

Risk factors for more severe disease:

- Prematurity
- Low birth weight
- Age < 6–12 weeks
- Pre-existing pulmonary or cardiac disease
- Congenital anomalies of the respiratory tract
- Household crowding
- Secondhand smoke

**Mild Disease**

Manageable in community with frequent follow-up:

- Feeding well, able to maintain hydration
- Absence of symptoms of respiratory distress
- Does not appear acutely ill

**Moderate to Severe Disease**

Requires hospitalization for close monitoring:

- Appears ill, lethargic
- Symptoms of respiratory distress
- Decreased pulse oximetry findings
- Significantly decreased air entry or “silent chest”

**DIFFERENTIAL DIAGNOSIS**

- Viral-triggered asthma
- Pneumonia
- Foreign body aspiration
- Asthma
- Inhaled noxious materials (for example, chemicals, fumes, toxins)
- Gastroesophageal reflux disease
- Chronic or congenital pulmonary/cardiac disease

**COMPLICATIONS**

Bronchiolitis usually resolves without complication in healthy infants; however, those with prematurity or underlying cardiopulmonary disease are at risk for more severe disease and requirement for hospitalized care. With the exception of otitis media, comorbid bacterial infection is rare.

**Acute**

- Dehydration
- Febrile seizures
- Prolonged apneic spells (risk for premature infants, neonates and in infants with previous history of observed apnea)
- Respiratory failure

**Chronic**

- Asthma (studies suggest a high correlation with RSV bronchiolitis and subsequent development of asthma)
- Bronchiolitis obliterans

**DIAGNOSTIC TESTS**

- Bronchiolitis is diagnosed based on symptom presentation. X-rays are not necessary to confirm the diagnosis
- Pulse oximetry

**MANAGEMENT****Goals of Treatment**

- Relieve symptoms
- Early identification of respiratory compromise
- Prevent complications
- Treat associated bacterial infection (otitis media)

**MILD BRONCHIOLITIS****Appropriate Consultation**

Contact a physician for any child with mild symptoms who is at increased risk:

- Prematurity
- Low birth weight
- Age < 6–12 weeks
- Pre-existing pulmonary or cardiac disease
- Congenital anomalies of the respiratory tract
- Not tolerating food
- Cannot be observed closely in the home for signs of respiratory distress

**Nonpharmacologic Interventions**

- Exercise clinical judgement when assessing the ability of parents/family to care for the child at home (for example, caregiver fatigue)
- Provide the following instructions:
  - Explain the symptoms of the illness, expected progression to improvement and signs and symptoms of respiratory distress requiring return to the health centre
  - Use a cool-mist humidifier
  - Position sleeping child in a propped-up position
  - Ensure adequate fluid intake to prevent dehydration (*see “Dehydration in Children” in the chapter, “Fluid Management” for instructions for rehydration therapy*)
  - Monitor closely for signs of respiratory distress
  - Use normal saline nose drops for nasal congestion

**Pharmacologic Interventions**

Antipyretic and analgesic for fever:

acetaminophen (Tylenol), 15 mg/kg PO or PR every 4–6 hours as needed

or

ibuprofen (Motrin), 10 mg/kg PO every 6–8 hours as needed

Bronchodilator for Wheezing

Though current evidence suggests that bronchodilators may be of limited benefit in the type of edema associated with bronchiolitis, those children who have pre-existing reactive airway or history of wheezing may respond to treatment. Children autoregulate the dose received by inhalation based on lung capacity, therefore per-kilogram dose regimens have been shifted to standard dose ranges by weight.

The following drugs may be ordered by a physician:

salbutamol (Ventolin) 4–10 puffs MDI via spacer with face mask

or

nebulized salbutamol (Ventolin):

Children <10 kg: 1.25 to 2.5 mg/dose

Children 11–20 kg: 2.5 mg/dose

Children >20 kg: 5 mg/dose

If there is a response to the trial, within 1 hour after treatment consult a physician about continued use at home as follows:

salbutamol (Ventolin) by MDI, 1 or 2 puffs via spacer with face mask q4h prn

Associated Illness

If finding of otitis media on examination, initiate antimicrobial therapy (*see “Otitis Media” in the chapter, “Ears, Nose Throat and Mouth”*).

**Monitoring and Follow-Up**

Follow up in 24–48 hours (sooner if symptoms worsen).

**Referral**

Refer to a physician if progressive respiratory distress.

**MODERATE TO SEVERE BRONCHIOLITIS****Appropriate Consultation**

Consult a physician if the child shows signs of respiratory distress.

**Adjuvant Therapy**

Give oxygen if there is any evidence of respiratory distress:

- 6–10 L/min or more by mask
- Keep oxygen saturation at > 97%
- Start IV NS fluid therapy to keep vein open to prevent dehydration. Consult a physician for further orders

**Pharmacologic Interventions**

Antipyretic and analgesic for fever:

acetaminophen (Tylenol), 15 mg/kg PO or PR every 4–6 hours as needed

or

ibuprofen (Motrin), 10 mg/kg PO every 6–8 hours as needed

Bronchodilator Trial

salbutamol (Ventolin) 4–10 puffs MDI via spacer with face mask

or

nebulized salbutamol (Ventolin):

Children <10 kg: 1.25 to 2.5 mg/dose

Children 11–20 kg: 2.5 mg/dose

Children >20 kg: 5 mg/dose

or

epinephrine 1:1000 (1 mg/mL): 0.5 mL/kg per dose.  
Maximum dose: 5 mL. Dilute dose with 2.5 to 3 mL of normal saline and administer by nebulization.

If there is no improvement in respiratory rate and effort between 15 to 30 minutes after a trial of inhalation therapy, then initial therapy should not be repeated nor continued. Contact a physician or nurse practitioner.

#### Antimicrobial Therapy

Antibiotics are not indicated unless there is evidence of otitis media or evidence of secondary bacterial infection, such as clinical deterioration with or without sepsis.

#### Monitoring and Follow-Up

Child awaiting transport to hospital: Monitor ABCs, pulse oximetry and hydration.

#### Referral

Medevac child for the following:

- Signs of respiratory distress
- Episodes of cyanosis with apnea
- Pre-existing respiratory or cardiac disease or congenital abnormalities
- Decreased oxygen saturation
- Inability to tolerate feeding
- Underlying illness (for example, lung disease, congenital heart disease, neuromuscular weakness or immune deficiency)
- Prematurity or low birth weight
- Less than 3 months of age
- Cannot be watched carefully at home for signs of respiratory distress

## COMMUNITY-ACQUIRED PNEUMONIA (CAP)<sup>40,41,42,43,44,45,46,47</sup>

Pneumonia is an inflammatory condition of the lungs. The condition is associated with fever, respiratory symptoms, altered findings on physical examination and infiltrates on chest x-ray. Pneumonia typically follows an upper respiratory tract infection that promotes invasion of the lower respiratory tract of viruses, bacteria, fungi or parasites. The inflammatory response within the lungs causes air spaces to fill with fluid, white blood cells and cellular debris resulting in airway obstruction and air trapping or collapse of distal airways.

#### Patterns of Pneumonia

- *Lobar pneumonia*: localized to one or more lobes of the lung
- *Bronchopneumonia*: inflammation around medium-sized airways, which causes patchy consolidation of parts of the lobes
- *Interstitial pneumonia*: inflammation of lung tissue between air sacs, usually generalized, often viral

#### CAUSES

In older infants and young children, viruses are the most common cause of CAP. *Streptococcus pneumoniae* is the most common pathogen in children over 5 years of age. Table 4 describes the most common causes of pneumonia.

**Table 4 – Common Causes of Pneumonia According to Age**

Age	Bacterial	Viral
0–<4 weeks	Group B Streptococcus, gram-negative rods, Mycoplasma, Enterobacteriaceae, Listeria monocytogenes	CMV, herpes virus
4–16 weeks	Chlamydia trachomatis, Hemophilus influenzae, Staphylococcus aureus, Streptococcus pneumoniae, Treponema pallidum, Mycoplasma hominis, Ureaplasma urealyticum, Enterobacteriaceae, Listeria monocytogenes	CMV, RSV
< 5 years	Hemophilus influenzae, Mycoplasma pneumoniae, Staphylococcus aureus, Streptococcus pneumoniae, Chlamydia pneumoniae, Streptococcus pyogenes	RSV, adenovirus, rhinovirus, Influenza A & B Parainfluenza 1, 2, 3
≥ 5 years	Mycoplasma, Streptococcus pneumoniae, Chlamydia pneumoniae	Influenza virus

**HISTORY**

- Viral
  - Gradual onset
  - Initial symptoms of upper respiratory tract infection
- Bacterial
  - Acute onset
  - High Fever

**General Symptoms**

- Fever (none or low grade with viral, high in bacterial)
- Chills
- Malaise
- Headache
- Lethargy
- Anorexia or poor feeding in infants

**Respiratory Symptoms**

- Upper respiratory tract infection symptoms
- Cough
- Shortness of breath
- Pleuritic chest pain (older children may complain of this symptom)
- Abdominal pain in younger children

In children, there is often no history of sputum production.

If there is conjunctivitis with eye discharge, consider Chlamydia or adenovirus as causative organisms.

**Associated Symptoms**

- Nausea, vomiting
- Diarrhea
- Abdominal pain (referred chest pain)
- Rash (viral etiology)

**Risk Factors for Increase Disease Severity**

- Asthma
- Congenital heart disease
- Bronchopulmonary dysplasia
- Neuromuscular disorders (swallowing disorder)
- Gastroesophageal reflux (recurrent pneumonia may present)
- Tracheoesophageal fistula (recurrent pneumonia may present)
- Immunodeficiency disorders
- Congenital anomalies of the respiratory tract

- Secondhand smoke (especially in children < 1 year of age)
- Infants  $\leq$  4 months of age

**Additional Inquiry**

- Ill contacts
- Maternal history of chlamydia during pregnancy (young infants)
- Immunization status (*Hemophilus influenzae* type b [Hib], *Streptococcus pneumoniae*, *Bordetella pertussis*)

**PHYSICAL FINDINGS****General Inspection**

- General appearance
- Fever (more common with bacterial infection in older children)
- Cough
- Rhinitis, red throat
- Symptoms of respiratory distress:
  - Irritability, anxiety
  - Decreased mental alertness
  - Inspiratory stridor
  - Pallor or central cyanosis
  - Increased work of breathing:
    - Nasal flaring
    - Retractions/indrawings (substernal, intercostal, sternal notch, supraclavicular)
    - Grunting
  - Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
  - Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
  - Decreased pulse oximetry finding
  - Tripod or sniffing position

**Lungs**

- Tactile fremitus (vibrations with spoken word “99”)
- Decreased breath sounds/air entry (over area of atelectasis or consolidation)
- Crackles (rales, rhonchi, crepitation) over affected lobes, or scattered with bronchopneumonia and interstitial pneumonia

- Bronchial breath sounds (louder than normal, short inspiration with long, higher pitched expirations over consolidation)
- Wheezing
- Bronchophony (clearly heard syllables when listening to chest with stethoscope with spoken word “99”)
- Dullness to percussion in lobar pneumonia
- Decreased unilateral chest excursion over area of lobar pneumonia
- Findings suggestive of pleural effusion:
  - Dullness to percussion
  - Pleural friction rub
  - Distant breath sounds

### **Associated Findings**

- Upper quadrant pain secondary to effusion/pneumonitis
- Signs of dehydration (secondary to increased fluid needs from fever/tachypnea and decreased oral intake)

### **Determining Severity**

Assessment of disease severity is important, as moderate to severe symptoms require hospitalization. The following are indicators of concern:

- Symptoms of respiratory distress
- Poor feeding and/or need for rehydration
- Toxic appearance
- Age younger than 3 months
- Temperature > 38.5°C
- Caregiver fatigue

### **DIFFERENTIAL DIAGNOSIS**

- Bronchiolitis
- Bronchitis
- Asthma
- Pulmonary trauma
- Croup
- Foreign body aspiration (especially in young children)
- Toxin inhalation (for example, insecticides)
- Chronic or congenital pulmonary/cardiac disease
- Intra-abdominal pathology causing splinting or reactive effusion

### **COMPLICATIONS**

- Pleural effusion
- Empyema
- Pneumatoceles (form with empyema and usually resolve over time)
- Necrotizing pneumonia
- Pneumothorax
- Lung abscesses (aspiration common underlying factor)
- Hyponatremia (with severe pneumonia)
- Respiratory failure and cardiovascular collapse
- Bacteremia/sepsis
- Pericarditis

### **DIAGNOSTIC TESTS**

Community-acquired pneumonia may be determined by clinical findings alone, however, a chest x-ray is appropriate for:

- Severe disease symptoms
- Further assessment when clinical findings are not conclusive
- Exclusion of pneumonia in young children with fever > 39°C or older children with cough and fever > 38.5°C
- Exclusion of other causes of respiratory distress, especially in the presence of cardiac or pulmonary conditions

Note: chest x-ray findings may lag behind the clinical course of the disease.

### **MANAGEMENT**

Management depends upon the cause, severity of the disease and the age of the child.

#### **Goals of Treatment**

- Relieve symptoms
- Early identification of respiratory compromise
- Prevent complications
- Antimicrobial therapy as appropriate

#### **Appropriate Consultation**

Consult a physician if any of the following apply:

- Moderate to severe respiratory distress
- Age less than 6 months
- Underlying cardiac or lung disease
- Immunosuppression

- Failure to respond to oral antibiotics within 24–48 hours
- Inability to tolerate oral antibiotics
- Symptoms involving other systems (for example, diarrhea)

### Adjuvant Therapy

- Give oxygen (humidified), by mask at 6–10 L/min or more, to any child who is in respiratory distress
- Start IV therapy with normal saline during transport to hospital, and run at a rate adequate to keep vein open. Consult a physician for further orders

### Nonpharmacologic Interventions

#### Client Education

- Explain the nature, course and expected outcomes of the illness
- Warn parents or caregivers that symptoms may worsen and of the need for close monitoring for signs of respiratory distress
- Advise parents or caregivers of the signs of respiratory distress
- Recommend that child be given adequate fluids to prevent dehydration
- Ensure child gets rest
- Care for child in propped-up position if child is short of breath

### Pharmacologic Interventions<sup>73</sup>

Antipyretic and analgesic for fever:

acetaminophen (Tylenol), 15 mg/kg PO or PR every 4–6 hours as needed

or

ibuprofen (Motrin), 10 mg/kg PO every 6–8 hours as needed

Antimicrobial therapy:

Choice of and route for antibiotic therapy are based on age and the most likely infective organism.

#### Neonate

Cover for group B *Streptococcus* and coliform bacteria before transfer:

ampicillin (Ampicil), 200 mg/kg/day, divided q6h, IV

and

gentamicin (Garamycin), 4 mg/kg IV q24h

#### 1–4 Months of Age

Cover for *Hemophilus influenzae*, *Staphylococcus aureus* and *Streptococcus pneumoniae* before transfer.

For a child awaiting transfer to hospital:

cefuroxime (Zinacef), 150 mg/kg/day IV, divided q 8 hours

±

erythromycin 40 mg/kg/day, PO/IV, divided q6h

For a severely ill child with the possibility of meningitis awaiting transfer to hospital:

cloxacillin 200 mg/kg/day IV divided q6h

and

cefotaxime 200mg/kg/day IV divided q6h

#### > 4 Months to 5 Years Old

Treat mildly ill child as an outpatient:

amoxicillin (Amoxil), 40–90 mg/kg/day PO, divided q8h, for 7–10 days (higher dose suggested if child has been treated with antibiotics in the previous 3 months and/or attends daycare or equivalent)

For beta-lactam allergy:

erythromycin, 40 mg/kg/day PO, divided every 6 hours, 7–10 days

or

azithromycin 10 mg/kg the first day, then 5 mg/kg/day PO for 4 days

For a moderately to severely ill child awaiting transfer to hospital:

cefuroxime (Zinacef), 150 mg/kg/day, divided q8h, IV or IM

±

erythromycin 40 mg/kg/day PO/IV divided q6h

#### > 5 Years Old

Treat mildly ill child as an outpatient:

erythromycin 30–50 mg/kg/day, divided q6–8h, PO for 7–10 days (maximum 2 g/day)

or (in an older child)

erythromycin 250 mg, PO q6h for 10 days (or erythromycin 333 mg PO q8h for 10 days)

or

azithromycin 10 mg/kg PO on day 1 (maximum 500 mg/first day dose), then 5 mg/kg once daily for 4 days PO (maximum dose 250 mg/day)

For macrolide allergy (only in children > 8 years of age):

doxycycline 4 mg/kg/day PO, divided q12h  
(maximum 200 mg/day)

For a moderately to severely ill child awaiting transfer to hospital:

cefuroxime (Zinacef), 150 mg/kg/day, divided q8h,  
IV or IM (maximum 1.5 g/dose)

and

azithromycin 10 mg/kg PO first dose on day 1,  
(maximum 500 mg), then 5 mg/kg daily for  
4 additional days

or

erythromycin 40 mg/kg/day PO /IV divided q6h

### Monitoring and Follow-Up

- Follow up in 24–48 hours (sooner if symptoms worsen)
- Child awaiting transport to hospital: Monitor ABCs, pulse oximetry and hydration

### Referral

Medevac, after consultation with a physician, in the following situations:

- Moderate to severe respiratory distress
- Age less than 3 months
- Underlying cardiac or lung disease
- Immunosuppression
- Failure to respond to oral antibiotics within 24–48 hours
- Inability to tolerate oral antibiotics
- Adequate care at home cannot be guaranteed

## CROUP (LARYNGOTRACHEITIS; LARYNGOTRACHEOBRONCHITIS)<sup>7,19,48,49,50,51,52,53,54</sup>

Croup is characterized by inspiratory stridor, barking cough and hoarseness. The symptoms result from an upper respiratory tract infection that causes inflammation of the larynx, trachea and bronchi. Involvement of the bronchi may be more severe and include lower airway signs of wheezing, rales and tachypnea. Symptoms result from narrowing of the subglottic trachea due to the inflammation.

Croup is the most common cause of stridor in children and occurs commonly in infants and children 3 months to 3 years of age. It occurs more often in boys than girls (ratio 1.4:1). Younger infants have greater risk of respiratory stress due to their small airways. Croup occurs predominantly in late fall and late spring. Symptoms mostly occur at night and may be relieved by cool air. The course is variable, with symptoms usually improving by 3–5 days.

### CAUSES

#### Viruses

The most common viral etiologies to croup include:

- Parainfluenza virus (most common cause – about 70% of cases)
- Respiratory syncytial virus (RSV)
- Adenovirus

#### Bacteria

- *Mycoplasma pneumoniae* may cause primary bacterial infection leading to croup
- Secondary bacterial infection leading to croup may be caused by *Staphylococcus aureus*, *Streptococcus pyogenes* and *Streptococcus pneumoniae*

### HISTORY

Most children are not markedly ill. Some may have symptoms of mild airway compromise:

- Preceded by 48–72 hours of symptoms of URTI (fever, runny nose, sore throat)
- Evening/nighttime onset of symptoms
- Hoarse-sounding voice/cry
- Barky, seal-like cough
- Stridor
- Progressive symptoms of respiratory distress including:
  - Retractions (substernal, intercostal, sternal notch, supraclavicular)
  - Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
  - Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)

- Symptoms to consider that suggest another airway etiology for upper airway stridor include:
  - Irritability and agitation that may progress to decreased level of consciousness
  - Decreased drinking
  - Drooling
  - Dysphagia
  - New onset fever
  - Neck trauma
  - Choking episode and/or ingestion of a foreign body
- Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Decreased pulse oximetry readings
- Tripod or sniffing position
- Decreased air entry

### Other Assessment

### PHYSICAL FINDINGS

Signs may be minimal to marked. The first priority is rapid assessment of respiratory function to determine symptoms of respiratory distress. If the child shows signs of respiratory distress, avoid invasive techniques such as taking a temperature or performing throat or ear examination.

### Signs of Respiratory Distress

- Irritability, anxiety (may indicate hypoxia)
- Decreased mental alertness (may be due to hypercarbia)
- Inspiratory stridor (at rest)
- Pallor or central cyanosis (hypoxemia)
- Increased work of breathing
  - Nasal flaring
  - Retractions (substernal, intercostal, sternal notch, supraclavicular)
  - Grunting
- Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Temperature increased (fever is usually low grade)
- Hydration status
- Breath sounds usually normal, but transmitted upper airway stridor can be heard
- Wheezing and hyperinflation (expiratory wheezing – lower airway obstruction)
- Rales, crackles suggest lower airway involvement (laryngotracheobronchitis, laryngotracheobronchopneumonitis, bacterial tracheitis)
- Purulent upper airway secretions (bacterial laryngotracheitis, particularly if febrile)
- Inflamed oropharynx, tonsillar edema, exudate (usually minimal in laryngotracheitis; consider pharyngitis, peritonsillar abscess, retropharyngeal abscess – pronounced single-sided edema)
- White membrane (diphtheria – rare)
- Tympanic membranes red (otitis media)
- Lymph node enlargement (more pronounced with abscess)

### Determining Severity

Follow Table 5, “Westley Croup Score” to determine the severity of an infant’s or child’s croup.

**Table 5 – Westley Croup Score**

<b>Cyanosis</b>	None	0	With agitation	4	At rest	5		
<b>Stridor</b>	None	0	With agitation	1	At rest	2		
<b>Air entry</b>	Normal	0	Decreased	1	Markedly decreased	2		
<b>Retractions</b>	None	0	Mild	1	Moderate	2	Severe	3
<b>Level of consciousness</b>	Normal, including sleep		0	Disoriented/Obtunded		5		

Score ≤ 2 – Mild croup

Score 3–7 – Moderate croup

Score ≥ 8 – Severe croup

**Mild Croup**

- Occasional barking, seal-like cough
- Hoarse voice/cry
- No stridor at rest, but may have stridor when upset or crying
- None to mild intercostal/substernal/suprasternal retractions /indrawing
- No agitation or distress

**Moderate Croup**

- Barking, seal-like cough (frequent)
- Hoarse voice/cry
- Stridor at rest (easily audible)
- Intercostal/substernal/suprasternal retractions/indrawings at rest
- Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Decreased air entry
- No or minimal irritability, agitation or distress

**Severe Croup**

- Barking, seal-like cough (frequent)
- Significant stridor (inspiratory and occasionally expiratory) at rest (may decrease with increasing obstruction and decreased air entry)
- Pronounced substernal/intercostal/sternal/supraclavicular retractions/indrawings

- Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- May be anxious, agitated, distress, combative or obtunded
- Pallor, central cyanosis
- Markedly decreased air entry

**DIFFERENTIAL DIAGNOSIS**

- Epiglottitis (*see Table 6, “Clinical Features of Acute Upper Airways Disorders”*)
- Bacterial tracheitis
- Retropharyngeal abscess
- Diphtheria (rare, check immunization status)
- Aspiration of a caustic substance
- Foreign-body aspiration
- Thermal injury
- Smoke inhalation (laryngospasm/bronchospasm)
- Laryngeal fracture (trauma)
- Congenital problems (for example, tracheomalacia, hemangioma of larynx)
- Neurologic disease causing hypotonia
- Allergic reaction
- Acute angioneurotic edema
- Peritonsillar abscess

**Table 6 – Clinical Features of Acute Upper Airway Disorders**

Clinical Feature	Supraglottic Disorders (Epiglottitis)	Subglottic Disorders (Croup)
Stridor	Quiet	Loud
Voice alteration	Aphonic, muffled	Hoarse
Dysphagia	+	--
Postural preference	+	±
Barky cough	--	+
Fever	+++	±
Appearance of acute illness	++	--

Note: +, present in mild form; ++, present in moderate form; +++, present in severe form; ±, may be present or absent; --, absent.

**COMPLICATIONS**

- Respiratory distress
- Respiratory failure
- Hypoxia
- Dehydration

**DIAGNOSTIC TESTS**

Pulse oximetry.

**MANAGEMENT****Goals of Treatment**

- Relieve symptoms
- Prevent complications

**MILD CROUP****Appropriate Consultation**

Consult a physician or a nurse practitioner for pharmacological therapy as it shortens the course of illness, improves the child's sleep and decreases the need for unscheduled visits.

**Nonpharmacologic Interventions****Client Education**

- Explain the nature, course and expected outcomes of the illness
- Warn parents or caregiver that croup may worsen at night
- Advise parents or caregiver to watch for signs of respiratory distress and when to return to nursing station
- Recommend that child be given adequate fluids to prevent dehydration
- Recommend increasing humidity through use of a cool-mist humidifier, exposure to a steamy bathroom or going outside in the cool air

**Pharmacologic Interventions**

Antipyretic and analgesic for fever and sore throat:

acetaminophen (Tylenol), 15 mg/kg PO or PR every 4–6 hours as needed

ibuprofen (Motrin), 10 mg/kg PO every 6–8 hours as needed

The following drug must be ordered by a physician:

corticosteroids (for example, dexamethasone [Decadron]) 0.6 mg/kg PO or IM one dose;  
Maximum dose: 10mg

**Monitoring and Follow-Up**

Follow up in 24–48 hours (sooner if symptoms worsen).

**Referral**

Refer electively to a physician any child with recurrent croup (even if it is mild) for evaluation of coexisting problems (for example, subglottic stenosis, hemangioma of larynx).

**MODERATE TO SEVERE CROUP****Appropriate Consultation**

Consult a physician if the child shows any sign of respiratory distress.

**Adjuvant Therapy**

Give oxygen if there is any evidence of respiratory distress:

- 6–10 L/min or more by mask
- Keep oxygen saturation at > 97%

**Nonpharmacologic Interventions**

- Increase fluid intake to prevent dehydration
- Nurse the child in upright position

**Pharmacologic Interventions**

The following drugs must be ordered by a physician:

epinephrine 1:1000 (1 mg/mL): 0.5 mL/kg per dose by nebulization. Maximum dose: 5 mL

and

corticosteroids (for example, dexamethasone [Decadron]) (0.6 mg/kg PO or IM; Maximum dose: 10mg (one dose before transfer)

**Monitoring and Follow-Up**

Monitor ABCs, pulse oximetry, hydration, intake and output. If child appears acutely ill and has a high fever, consider diagnosis of bacterial tracheitis (*Staphylococcus* or *Hemophilus influenzae*) and consult a physician about antibiotic therapy.

**Referral**

Medevac.

**FOREIGN BODY CAUSING WHEEZING**

Wheezing may be due to a foreign body in a bronchus or a large esophageal foreign body that causes airway compression. Children under 3 years are at the greatest risk for foreign body aspiration. Wheezing when there is a witnessed choking episode is highly suspicious for foreign body aspiration, even if the child is no longer coughing. Suspect foreign body with a sudden onset of wheezing, even when there is no witnessed choking episode.

**HISTORY**

- Sudden onset
- May or may not have history of choking, having an item in mouth
- May have absence of other causes for wheezing
- Difficulty feeding or swallowing (esophageal foreign body)

**PHYSICAL FINDINGS**

- Wheezing on one side (aspiration is not more common on the right side in children)
- Unequal breath sounds
- Stridor, hoarseness (with laryngeal foreign body)
- Cough
- Gagging
- Tachypnea
- Retractions if significant obstruction
- Nasal flaring
- Decreased chest wall movement (may be one sided)
- Respiratory arrest

**DIFFERENTIAL DIAGNOSIS**

- Epiglottitis
- Asthma
- Croup
- Bronchiolitis

**COMPLICATIONS**

- Respiratory arrest
- Pneumonia

**DIAGNOSTIC TESTS**

- Chest x-ray (may confirm foreign body, however, negative findings do not rule out a foreign body)
- Suspected foreign body requires laryngoscopy/bronchoscopy to confirm/remove object(s)

**MANAGEMENT****Goals of Treatment**

- Relieve symptoms
- Early identification of respiratory compromise
- Prevent complications
- Remove foreign body

**Appropriate Consultation**

Consult a physician if the child shows signs of respiratory distress or wheezing if caused by a suspected foreign body or of unknown origin.

**Interventions****Symptoms of Complete or Partial Upper Airway Obstruction**

- Initiate Basic Life Support maneuvers to clear the airway
- Oxygen (including post-event if foreign body cleared)
- Observation
- Medevac

**Symptoms of Wheezing without Respiratory Distress**

- Oxygen as required
- Observation
- Consult physician, consider Medevac

**PERSISTENT COUGH**<sup>20,24,28,55,56,57</sup>

Cough is a forceful explosive expiration and release of air, which serves to remove secretions and foreign material from the respiratory tract. Chronic or persistent cough is a cough lasting longer than 4 weeks. Cough may result from processes occurring anywhere in the upper or lower airways. Cough is a symptom of some other specific diagnosis.

**HISTORY****Nature of Cough**

- Production of sputum suggests pneumonia, bronchiectasis or bronchitis
- Presence of whoop indicates pertussis
- Paroxysmal nature (for example, continuous, short coughs on a single expiration) suggests pertussis, parapertussis, some viruses such as adenovirus
- Dry hacking cough suggests tracheal irritation
- Barky/honking cough suggests tracheal or bronchial compression
- Staccato cough in young infants is associated with *Chlamydia trachomatis*
- Increased cough in supine position may suggest gastroesophageal reflux
- Cough induced by cold, exercise, allergens or nocturnal onset/worsening suggests asthma

**Associated Symptoms and Events**

- URTI symptoms
- Upper airway cough syndrome
- Timing/triggers (for example, infection, choking episode, cold air, exercise)
- Allergic “shiners”
- Exposure to infectious persons
- Diarrhea, poor weight gain (for example, cystic fibrosis)

**Past History**

- Age of onset (neonatal onset warrants investigation of physiologic abnormalities, neurologic disorders or pulmonary infection)
- Prenatal course, labour, delivery, prematurity, low-birth weight
- Developmental delay
- Neuromuscular abnormalities
- Eczema (may precede asthma, family history of same)
- Respiratory – bacterial and viral pneumonia (due to RSV or adenovirus) may be followed by airway damage, chronic cough and wheeze

**PHYSICAL FINDINGS**

Assess for:

**Respiratory Signs**

- Presence of respiratory distress (respiratory rate, use of accessory muscles)
- Increased work of breathing, retractions, accessory muscle use, chest wall hyperinflation or deformity, abnormal breath sounds (reduced intensity, asymmetry, wheezing, stridor, crackles)
- Dullness over areas of lung consolidation
- Sound of cough
- Breath sounds
- Adventitious sounds

**Other Signs**

- Hoarseness
- Nasal congestion
- Allergic “shiners”; nasal crease
- Swollen nasal turbinates
- Skin rash
- Muscle wasting
- Developmental delay
- General appearance of chronic illness
- Poor growth, thinness or obesity
- Enlarged tonsils, pharyngeal cobblestoning
- High arched palate; cleft palate
- Tympanic membrane scarring
- Neurologic abnormalities
- Dysmorphism; signs of disease syndromes

**DIFFERENTIAL DIAGNOSIS****Infection**

- Upper respiratory tract infection
- Upper airway cough syndrome (UACS) – previously referred to as postnasal drip syndrome but includes rhinitis of all causes and sinusitis
- Bronchitis caused by or related to virus, Mycoplasma, pertussis, tuberculosis or (rarely) other organisms or parasites
- Pneumonia, especially that caused by Mycoplasma

**Post-infection**

- After bronchiolitis or pneumonia
- Allergy: allergic rhinitis with postnasal drip
- Asthma: cough may predominate, rather than wheeze

**Suppurative Lung Disease**

- Bronchiectasis
- Cystic fibrosis

**Environmental Irritants**

- Dry air
- Fumes
- Smoke

**Aspiration**

- Cough with feeding in neonates suggests possible aspiration
- Foreign body: onset of cough is usually sudden, but symptoms may be chronic if aspirated material is small
- Gastroesophageal reflux with aspiration
- Neuromuscular disorders: aspiration especially associated with feeding

**Anatomic Defects**

- Compression of airways by lung or blood vessel anomalies or tumours

**MANAGEMENT**

Management depends on the diagnosis.

**Goals of Treatment**

Identify underlying diagnosis.

**Appropriate Consultation**

Consult with a physician about the need for investigation and, in some cases, referral to tertiary care centre.

**Pharmacologic Interventions**

Health Canada has recommended that no cough or cold medications be given to children under 6 years of age as there is no substantive evidence of benefit and there have been serious adverse events including deaths, though the overall risk of serious harm is small. For children 6 years of age and older, there is no substantive evidence of benefit and there have been serious adverse events, though the overall risk of serious harm is small. Further, there is no evidence that the currently used dosing regimen based on age ranges is appropriate.

**REACTIVE AIRWAY DISEASE**

Reactive airway disease is primarily triggered by inflammation causing edema with narrowing of the airway, increased mucus production, hyperresponsiveness of the smooth muscle and bronchoconstriction, increasing the work of breathing. Wheezing, high pitched musical sounds heard during inspiration and/or expiration, is caused by vibration of the narrowed airways.

**CAUSES**

- Infection (upper respiratory tract infection, bronchiolitis, croup)
- Allergies (environmental, ingestion)
- Aspiration
- Inhaled irritants (for example, cigarette smoke)
- Pulmonary disease (for example, tracheomalacia)
- Reversible airway hyperresponsiveness of infancy
- Asthma (*see “Asthma”* for children with a diagnosis of asthma who present with wheezing)

**HISTORY**

For non-asthmatic wheezing, ask about:

- Upper respiratory tract infection
- Exposure to inhaled irritant (for example, smoke, fumes)
- Past intubation (increased risk of wheezing)
- Recurrent wheezing (review past episodes)
- Eating/drinking changes
- Environmental allergies (review types of allergies and reaction)
- Food allergies with known/suspected ingestion of allergen, presence of wheals/hives (*see “Anaphylaxis” in the chapter, “General Emergencies and Major Trauma”*)
- Report of choking, child having an item in mouth and sudden onset of wheezing (suspect foreign body)
- Medications

**PHYSICAL FINDINGS**

- Signs of upper respiratory tract infection (for example, pharyngitis, rhinitis)
- Fever
- Cough
- Difficulty feeding (infants)

**Signs of Respiratory Distress (Severe Airway Obstruction)****General Appearance**

- Irritability, anxiety
- Decreased mental alertness
- Inspiratory stridor (suggests foreign body)
- Pallor or central cyanosis

**Vital Signs**

- Tachycardia (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Tachypnea (*see normal range in Table 1, “Normal Pediatric Heart Rate, Blood Pressure and Respiratory Rate By Age”*)
- Decreased pulse oximetry reading (< 91% on room air)

**Respiratory Assessment**

- Increased work of breathing
- Nasal flaring
- Retractions (substernal, intercostal, sternal notch, supraclavicular)
- Grunting; tripod or sniffing position
- Accessory muscle use (especially sternocleidomastoid muscles)
- Breath sounds faint or absent (because of lack of air entry)
- Marked expiratory wheezes, prolonged expiratory phase
- Wheezing
- Distant breath sounds, hyperresonance (very decreased breath sounds with no wheezing)
- Decreased peak expiratory flow rate (use for children  $\geq 6$  years)

**DIFFERENTIAL DIAGNOSIS**

- Croup (*see “Croup”*)
- Bronchiolitis (*see “Bronchiolitis”*)
- Pneumonia (*see “Community-Acquired Pneumonia”*)
- Foreign body (*see “Foreign Body causing Wheezing”*)
- Anaphylaxis (*see “Anaphylaxis” in the chapter, “General Emergencies and Major Trauma”*)

**COMPLICATIONS**

Respiratory failure.

**DIAGNOSTIC TESTS**

- Pulse oximetry
- Chest x-ray is not routinely required for assessment of reactive airways unless presenting with symptoms of suspected pneumonia

**MANAGEMENT****Goals of Treatment**

- Reverse airflow obstruction
- Reverse hypoxemia
- Early identification of respiratory compromise
- Prevent complications

**Appropriate Consultation**

Consult a physician if the child shows signs of respiratory distress.

Contact a physician for any child with mild symptoms who is at increased risk:

- Prematurity
- Low birth weight
- Age < 6–12 weeks
- Pre-existing pulmonary or cardiac disease
- Congenital anomalies of the respiratory tract
- Not tolerating food
- Cannot be observed closely in the home for signs of respiratory distress

**Adjuvant Therapy**

Give oxygen if there is any evidence of respiratory distress:

- 6–10 L/min or more by mask
- Keep oxygen saturation at > 97%

**Nonpharmacologic Interventions**

- Provide information about wheezing and possible causes
- Warn parents or caregivers that symptoms may worsen and to closely monitor for signs of respiratory distress
- Advise parents or caregivers of the signs of respiratory distress
- Reduce environmental triggers
- Recommend that child be given adequate fluids to prevent dehydration
- For children with underlying upper respiratory tract infection *see “Upper Respiratory Tract Infection” for further information*

**Pharmacologic Interventions**

Bronchodilation:

Bronchodilation

salbutamol (Ventolin) MDI with spacer,  
4–10 puffs/dose

or

nebulized salbutamol (Ventolin):

Children <10 kg: 1.25 to 2.5 mg/dose

Children 11–20 kg: 2.5 mg/dose

Children >20 kg: 5 mg/dose

Consult with physician or a nurse practitioner for further doses.

**Monitoring and Follow-Up**

Follow up in 24–48 hours (sooner if symptoms worsen).

**Referral**

Medevac if poor response to treatment or progressive respiratory distress.

**UPPER AIRWAY DISORDERS  
COMPARISON**

Disorders of the upper airway are common clinical problems. Differentiation of the various disorders is often difficult. *See Table 7, “Features of Upper Airway Disorders”* for common features with some key information of their clinical manifestations.

**Table 7 – Features of Upper Airway Disorders**

Entity	Usual Age Range	Mode of Onset of Respiratory Distress
<b>Severe tonsillitis</b>	Late preschool or school age	Gradual
<b>Peritonsillar abscess</b>	Usually > 8 years	Sudden increase in temperature, appears acutely ill, unilateral throat pain, “hot potato” speech
<b>Retropharyngeal abscess</b>	Infancy to adolescence	Fever and appearance of acute illness after URTI, pharyngitis or penetrating injury
<b>Epiglottitis</b>	1–7 years	Acute onset of hyperpyrexia, dysphagia and drooling
<b>Croup</b>	6 months to 4 years	Gradual onset of stridor and barking cough after mild URTI
<b>Foreign-body aspiration</b>	Late infancy to 4 years	Choking episode resulting in immediate or delayed respiratory distress
<b>Bacterial tracheitis</b>	Infancy to 4 years	Moderately rapid onset of fever, appearance of acute illness, respiratory distress

**UPPER RESPIRATORY TRACT  
INFECTION (URTI)**<sup>58,59,60,61,62,63,64</sup>

Viral infection and inflammation of the upper airway structures, also known as the common cold. There is a higher incidence of colds in children, with those younger than 6 years averaging 8–12 colds per year. URTI has a seasonal pattern with higher prevalence during the fall and winter months.

**CAUSES**

A variety of viruses cause URTI, with some viruses causing characteristic presentations:

- Rhinoviruses are the most common cause of URTI and are associated with acute asthma exacerbations
- Respiratory syncytial virus (RSV) commonly causes bronchiolitis in children under 2 years of age through direct infection of small bronchiolar epithelial cells; also associated with croup
- Parainfluenza viruses are the leading cause of croup and are associated with complications of otitis media (30–50% of infections)
- Adenoviruses commonly cause URTI with fever and are also associated with conjunctivitis and tonsillitis; also cause pneumonia

**HISTORY**

- Onset over 1–2 days
- Usually runs a 14-day course in younger children; 5–7 days in older children
- Fever (in first 3 days, more common in younger children)
- Runny nose
- Cough
- Sore throat
- Irritability
- Difficulty sleeping
- Exposure to others with URTI
- Decrease in appetite
- Earache (associated with abnormal middle ear pressures and/or otitis media)

**PHYSICAL FINDINGS****General Inspection**

- Signs of respiratory distress indicates complications from URTI (for example, asthma, bronchiolitis)
- Consider influenza or complications of URTI in the presence of fever (for example, otitis media, pneumonia)
- May have macular rash (viral exanthem)

**Head, Eyes, Ears, Nose and Throat**

- Oropharynx may be inflamed with/without tonsillar edema, exudate
- Tympanic membranes may be slightly red, or have displaced light reflex
- Nares may be red and swollen with clear to purulent discharge
- Nasal turbinates may be red
- May have palpable tender/nontender cervical lymph nodes
- Sinus tenderness on palpation
- May have purulent discharge of eyes

**Lungs**

- Breath sounds usually normal, with good bilateral air entry
- Crackles that clear with coughing may be present
- May have upper airway transmitted sounds (sound on auscultation is loudest over the trachea)<sup>65</sup>

**DIFFERENTIAL DIAGNOSIS**

Bacterial URTI.

**COMPLICATIONS**

- Otitis media
- Bronchiolitis
- Croup
- Asthma exacerbation
- Pneumonia
- Sinusitis

**DIAGNOSTIC TESTS**

None unless complications suspected.

**MANAGEMENT****Goals of Treatment**

- Primarily to relieve symptoms

**Nonpharmacologic Interventions**

- Rest
- Adequate fluids
- Normal saline nose drops for infants with nasal congestion
- Normal saline spray for older children with nasal congestion

There is limited evidence that suggests normal saline irrigation results in fewer medications used and fewer physician visits.<sup>58</sup>

**Pharmacologic Interventions**

Antipyretic for fever:

acetaminophen (Tylenol) 15 mg/kg PO or PR every 4–6 hours as required

or

ibuprofen (Motrin) 10 mg/kg every 6–8 hours as required

Cough and cold medications for symptom relief:

Health Canada has recommended that no cough or cold medications be given to children under 6 years of age as there is no substantive evidence of benefit and there have been serious adverse events, including deaths, though the overall risk of serious harm is small. For children 6 years of age and older, there is no substantive evidence of benefit and there have been serious adverse events, though the overall risk of serious harm is small. Further, there is no evidence that the currently used dosing regimen based on age ranges is appropriate.

### Monitoring and Follow-Up

Follow-up is necessary only if symptoms worsen, there is onset of new symptoms or the symptoms do not resolve as expected.

Advise the parents or caregiver to watch for the following symptoms:

- Development of respiratory distress with increased respiratory rate and retractions (bronchiolitis, croup, asthma, pneumonia)
- Persistent wet-sounding cough in children under 2 years of age (bronchiolitis)
- Development of secondary complications after initial onset of symptoms (otitis media, pneumonia, secondary bacterial pharyngitis [group A streptococcus])
- Development of ear pain and fever (otitis media)
- Precipitation of wheezing (asthma)
- Onset of stridor and barking cough at night with increased work of breathing (croup)
- Onset of fever, drooling, difficulty swallowing, stridor (epiglottitis)

### Referral

Not usually required unless there are complications.

## EMERGENCY PROBLEMS OF THE RESPIRATORY SYSTEM

### EPIGLOTTITIS

An acute, life-threatening infection, consisting of cellulitis of the epiglottis and resulting in critical narrowing of the airway with significant inspiratory obstruction. It progresses rapidly with less than 12 hours from onset to respiratory distress. Epiglottitis usually occurs in children 3–7 years old, however, older children are also at risk. Children inadequately immunized against *Hemophilus influenzae* type B may be particularly susceptible.

### CAUSES

Usually a bacterial infection:

- *Hemophilus influenzae* type B (accounted for more than 90% of cases before vaccines were introduced, but is now rare)
- *Staphylococcus aureus*
- *Streptococcus pneumoniae*
- Beta-hemolytic streptococci, Groups A, B, C and F

### HISTORY

- Abrupt onset
- Limited or no prodrome
- High fever (> 39°C)
- Severe sore throat
- Drooling
- Dysphagia
- Muffled speech
- Stridor, but not may not be prominent
- No cough, runny nose or other symptoms of URTI

Check that primary immunization series (for *Hemophilus influenzae* type B) is complete.

**PHYSICAL FINDINGS**

**Do not attempt to examine oropharynx, since this may provoke sudden obstruction. Examination should be minimal to minimize distress to the child.**

- Child may look acutely ill, distressed and anxious
- High fever
- Cyanosis
- Slow, laboured breathing
- Suprasternal indrawing
- Drooling
- Child will not talk and sits erect in the classic “sniffing” position, leaning forward with hyperextension of the neck
- Stridor relatively quiet given the degree of distress
- Breath sounds normal, with transmitted stridor
- Air entry reduced

The symptoms of increased work of breathing are not as pronounced as with croup, so the severity of the illness may be underestimated, creating the risk of progressive hypoxia and hypercapnia.

**Table 8 – Comparison of Epiglottitis and Croup**

Feature	Epiglottitis	Croup
Age	2–8 years	6 months to 4 years
Onset	Acute	Gradual; child often has a cold first
Temperature	High (> 39°C)	Low (< 38°C)
Swallowing	Difficulty; salivation	No difficulty
Position	Sitting up, leaning forward	Variable

**COMPLICATIONS**

- Complete obstruction of airway causing respiratory arrest, hypoxia and death
- Sepsis
- Septic shock

**DIAGNOSTIC TESTS**

None.

**MANAGEMENT**

ABCs are the first priority.

**Goals of Treatment**

- Maintain the airway
- Rapid treatment of infection with appropriate antibiotics
- Prevent complications

**DIFFERENTIAL DIAGNOSIS**

- Laryngotracheitis or croup (*see Table 8, “Comparison of Epiglottitis and Croup”; see also Table 6, “Clinical Features of Acute Upper Airways Disorders”*)
- Bacterial tracheitis
- Peritonsillar or retropharyngeal abscess
- Uvulitis
- Angioedema
- Diphtheria
- URTI in the presence of congenital or acquired airway disease (for example, subglottic stenosis or laryngeal web)

Peritonsillar or retropharyngeal abscess may present with very painful infections, drooling and neck extension, but clients are often not as ill and are not as anxious.

**Appropriate Consultation**

Consult a physician as soon as the child’s ABCs are stabilized.

**Adjuvant Therapy**

- Give oxygen by mask at 6–10 L/min or more, unless this is distressing to the child
- Oxygen by nasal prongs at 2–4 L/min may be less distressing or ask caregiver to hold mask near child’s face
- Start IV therapy with normal saline to keep vein open, unless this is likely to distress the child and thereby increase respiratory distress

### Nonpharmacologic Interventions

- Nurse the child in the parent’s or caregiver’s arms
- Give nothing by mouth
- Allow the child to assume any position that makes him or her comfortable
- Continuous monitoring

### Pharmacologic Interventions

Administration of antibiotics effective against *H. influenzae* should be started before transport, if possible.

A child with epiglottitis should be given initial doses of antibiotic therapy, unless he or she is likely to become distressed by this treatment. Discuss with a physician.

cefuroxime (Zinacef), 150 mg/kg/day, divided q8h, IV (maximum 4.5 g/day)

Depending on clinical presentation and the risk of MRSA, patients may require more aggressive antibiotic therapy with a third-generation cephalosporin such as cefotaxime and clindamycin or vancomycin if MRSA resistant to clindamycin is known. Discuss with physician.<sup>66</sup>

Prophylaxis with rifampin 20 mg/kg daily in a single dose for 4 days (maximum 600 mg/dose) is recommended for the child and for family, household and possibly daycare contacts. Discuss prophylaxis with a physician.<sup>67</sup>

### Monitoring and Follow-Up

Monitor ABCs and pulse oximetry as frequently as possible, but be discreet and **try not to agitate the child**.

### Referral

**Medevac immediately** to a facility where controlled intubation is possible.

**A physician or paramedic skilled in intubation should accompany the child during transfer.**

## NEONATAL RESUSCITATION

Any situation where a newborn needs intervention(s) to help him/her breathe and/or help his/her heart beat.

### CAUSES

Try to anticipate situations in which a child may need resuscitation. The following situations represent some of the predisposing risk factors.

### Risk Factors

History of Maternal Perinatal Complications

- Preterm labour
- Placental abnormalities: placenta previa, abruptio placentae or cord compression
- Amniotic fluid abnormalities: polyhydramnios or oligohydramnios
- Infectious process: maternal fever
- Infectious agents (maternal source): group B Streptococcus, gram-negative bacteria, viruses, (for example, HSV, toxoplasmosis, CMV, HIV)
- Maternal abnormalities: diabetes mellitus, size of pelvic outlet
- Neonatal abnormalities: genetic, anatomic or cardiac
- Maternal drugs: prescription or illicit

### PHYSICAL EXAMINATION

The physical examination may have to be done while resuscitation is performed.

- *Airway*: Is it patent? Is foreign material (for example, meconium) present?
- *Breathing effort*: Present or absent?
- *Circulation*: Is pulse present? What is heart rate? What is infant’s colour?
- *Disability*: neurologic status, floppy tone, absence of reflex and grimace
- *Environment*: heat loss
- *Apgar score*: should be assessed at 1 and 5 minutes after birth (see Table 9, “Determination of Apgar Score”)

**Table 9 – Determination of Apgar Score\***

Feature Evaluated	0 Points	1 Point	2 Points
Heart rate	0	< 100 beats/min	> 100 beats/min
Respiratory effort	Apnea	Irregular, shallow or gasping breaths	Vigorous, crying
Colour	Pale or blue all over	Pale or blue extremities	Pink
Muscle tone	Absent	Weak, passive tone	Active movement
Reflex irritability	Absent	Grimace	Active avoidance

\*Sum the scores for each feature. Maximum score = 10, minimum score = 0.

## MANAGEMENT

### **Procedure for Resuscitation**

1. Position the airway.
2. Suction the mouth and nasopharynx.
3. Dry the neonate and keep warm with thermal blanket or dry towel. Cover scalp.
4. Stimulate by drying the baby and rubbing his or her back.
5. Clamp and cut the cord.
6. Evaluate respirations.
7. Use blow-by method or simple face mask to deliver 100% oxygen for neonate in mild distress. For an infant with apnea or severe respiratory depression, begin assisted breathing with bag-valve mask (BVM) and 100% oxygen; ventilate at 30 breaths/minute.
8. Check heart rate (apical beat). Further action depends on heart rate:

#### **If heart rate < 60 beats/minute:**

9. Continue assisted ventilation (30 breaths/minute).
10. Begin chest compressions at 90/minute.
11. If no improvement after 30 seconds, continue ventilation and compressions.

12. If no improvement after a further 30 seconds, establish vascular access and give epinephrine solution (1:10 000) at 0.01–0.03 mg/kg IV or IO. Subsequent doses must be ordered by a physician.

13. Reassess heart rate and respirations.

#### **If heart rate 60–80 beats/minute:**

9. Continue assisted ventilation.
10. If no improvement after 30 seconds of ventilation with 100% oxygen, begin chest compressions. Ratio of compressions to ventilations should be 3:1 (90 compressions to 30 ventilations).
11. Reassess heart rate and respirations each minute.

#### **If heart rate 81–100 beats/minute and rising:**

9. Give 100% oxygen by mask or blow-by method.
10. Provide tactile stimulation.
11. Reassess heart rate and respirations after 15–30 seconds. If heart rate < 100 beats/minute, begin assisted BVM ventilation with 100% oxygen.
12. Reassess heart rate after 15–30 seconds.

#### **If heart rate > 100 beats/minute:**

9. Check skin colour. If peripheral cyanosis is present, give oxygen by mask or blow-by method.
10. Reassess heart rate after 1 minute.

(See Table 10, “Summary of Steps in Neonatal Resuscitation.”)

**Table 10 – Summary of Steps in Neonatal Resuscitation: ABCDEF****A for Airway**

- Clear or suction airway
- Consider giving oxygen prn (see Table 11, “Oxygen Delivery Techniques”)

**B for Breathing**

- Support breathing with oral airway and bag-valve mask prn (see “Respiratory Failure and Mechanical Ventilation”)
- 100% oxygen

**C for Circulation**

- No support needed if apical heart rate > 100 beats/minute
- If heart rate ≤ 100 beats/minute, ventilate and observe
- If there is a response (heart rate increases to > 100 beats/minute), no further support is needed  
If response is poor (heart rate 60–80 beats/minute), recheck airway; if airway and breathing are adequate, initiate chest compressions  
If “ABC” (above) fail to produce a response, consider “D” (as follows)

**D for Drugs**

- IV fluid (for volume expansion): 0.9% NS (see “Fluid Administration Guidelines for Newborns”)
- epinephrine solution (1:10 000 which is 0.1 mg/mL), 0.01–0.03 mg/kg IV or IO; Discuss further doses with a physician
- Consider naloxone (Narcan), if there is a possibility of maternal narcotics use

**E for Exposure**

- Keep infant under radiant warmer or surrounded by warmed blankets (see “Thermoregulation”)

**F for Final Steps**

Consult physician regarding medevac to neonatal ICU at nearest tertiary care facility if child needs more than simple oxygen and transient (for < 5 minutes) assisted ventilation with bag-valve mask.

**MANAGEMENT OF SPECIAL CONDITIONS****Aspiration of Meconium**

If infant shows signs of respiratory distress, suction thick meconium from the airway as soon as possible after delivery.

**Pneumothorax**

Depending on respiratory compromise, needle aspiration of pneumothorax (if tension) may be necessary. Keep infant in oxygen-rich environment.

**Seizures**

Administer anticonvulsants to control seizure activity:  
lorazepam (Ativan), 0.05 mg/kg per dose IV<sup>68</sup>

**Shock**

If shock is suspected, volume expansion is indicated (for example, 20 mL/kg bolus of normal saline or Ringer’s lactate).

**Exposed Abdominal or Neural Contents**

Treat infant with sterile technique. Wrap defect in warm, sterile saline dressing and cover with plastic wrap to prevent drying. Position so that no pressure is applied to the defect.

**Gastrointestinal Obstruction**

Examples include duodenal atresia, ileal atresia and anal atresia. Give nothing by mouth. Insert an orogastric tube to remove gastric contents and prevent abdominal distension. Establish IV infusion with normal saline.

**POST-RESUSCITATION CARE****Signs of Continuing Perinatal Asphyxia**

- Altered gaze, slack face
- Increasing irritability
- Seizures
- Decreased muscle tone
- Decreased suck, swallow or gag reflex
- Breathing irregularities
- Stupor or coma
- Signs of increased intracranial pressure (for example, bulging fontanel, frequent emesis, blunted reflexes, “sunset” eyes)

## STABILIZATION

### Monitoring and Assessment

- Observe infant continuously
- Do not leave unattended
- Handle gently

### Vital Signs

Record vital signs every 15 minutes or more frequently, depending on situation.

- *Heart rate*: normally 120–160 beats/minute (use pulse oximetry)
- *Respiratory rate*: normally 40–60 breaths/minute (airway can be kept open by slightly extending the position of the head and suctioning as necessary)
- *Axillary temperature*: normally 36.5°C to 37°C
- *Blood pressure*: difficult to assess in newborns without special equipment; signs of adequate perfusion include good capillary refill, good colour, adequate urinary output and normal alertness; determine capillary refill time (to assess skin perfusion) by blanching area with digital pressure (normal refill time is 2–4 seconds)

### Thermoregulation

Provide warmth to maintain normal body temperature. Ambient temperature at which an infant uses the least energy to maintain body temperature depends on the infant's weight, gestational age at birth and postnatal age. Prolonged cold stress results in increased oxygen consumption and abnormal glucose utilization, which can lead to hypoglycemia, hypoxemia and acidosis.

### Measures to Maintain Warmth

- Dry the baby and keep the environment warm and humid
- Maintain a warm room temperature, keep the infant away from cold windows and use double-walled incubators or radiant heaters (if available)
- Warm linen in contact with the baby and change wet linen

### Maintenance of Oxygenation and Ventilation

#### Signs of Respiratory Distress

- Periodic breathing
- Tachypnea (respiratory rate > 60 breaths/minute)
- Grunting
- Chest wall retractions
- Nasal flaring

### Common Causes of Respiratory Distress in Newborns

- Respiratory distress syndrome
- Aspiration syndrome
- Pneumonia
- Pulmonary air leak

In these situations, consult a physician.

### Respiratory Failure and Mechanical Ventilation

- Progressively increased oxygen demands and respiratory distress
- If there is evidence of respiratory failure, take steps immediately to provide positive pressure ventilation (PPV)
- Maintain oxygen saturation in the range of 90% to 95% by pulse oximetry (if available)
- Initiate PPV with infant resuscitation bag at 30 respirations/minute and pressure of 20–30 cm H<sub>2</sub>O
- Effectiveness of ventilation judged by infant's clinical response, symmetric chest movement and auscultation of air entry to both lungs
- Major cardiopulmonary failure may be prevented by early intervention with 100% oxygen and PPV

### Maintenance of Circulation

Adequate cardiac output is essential to maintain circulation. The best way to maintain circulation is provision of adequate fluids and electrolytes. Babies with unstable conditions are usually given nothing by mouth, and an IV infusion is started.

### Conditions Necessitating IV Infusion

- Extreme prematurity
- GI anomalies (for example, gastroschisis)
- Cardiac anomalies
- Respiratory distress syndrome
- Dehydration
- Shock

### Fluid Administration Guidelines for Newborns

- Term infant: 80–100 mL/kg every 24 hours
- Preterm infant: 100–140 mL/kg every 24 hours

### Maintenance of Homeostasis

The most common problem is hypoglycemia, which occurs in a variety of situations:

- Prematurity
- Restricted intrauterine growth
- Asphyxia during birth
- Hypothermia
- Diabetic mother

Use a reagent strip or blood glucose monitor to assess blood glucose level every hour. Maintain glucose levels at greater than 2 mmol/L.

IV administration of a 10% dextrose solution (approximately 3–4 mL/kg each hour) is usually adequate to correct transient hypoglycemia. Persistent hypoglycemia should be treated with a bolus of D5W or D10W (2–3 mL/kg). Discuss with a physician.

Abnormalities such as hypocalcemia, hypomagnesemia, hyponatremia and hyperkalemia can complicate homeostasis, especially if resuscitation and stabilization processes are prolonged.

### Infection

If sepsis is suspected or if mother is Group B strep positive obtain swabs from ear canal, umbilicus and tracheal secretions. Obtain blood for culture if possible. IV administration of antibiotics should not be delayed. Discuss with a physician prior to initiating.

Usual antibiotic dosages<sup>69</sup>:

ampicillin (Ampicin), 200 mg/kg/day divided q6h by slow IV push

and

gentamicin (Garamycin), 4 mg/kg/day divided q24h by slow IV push or IM

**Table 11 – Oxygen Delivery Techniques**

Device	Flow (L/min)	Oxygen (%)
Nasal prongs	2–4	24–28
Simple face mask	6–10	35–60
Face tent	10–15	35–40
Venturi mask	4–10	25–60
Partial rebreathing mask	10–12	50–60
Oxyhood	10–15	80–90
Non-rebreather mask	10–12	90–95

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