Bronchiolitis

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Author Disclosure
Dr Wagner has disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

Objectives

After completing this article, readers should be able to:

1. Recognize the clinical presentation of bronchiolitis.
2. Be aware of the recommendations made in the current American Academy of Pediatrics clinical practice guideline for diagnosis and management of bronchiolitis.
3. Describe the role of laboratory testing in the diagnosis of bronchiolitis.
4. Delineate the efficacy of current therapeutic interventions in the treatment of bronchiolitis.
5. Discuss the evaluation for serious bacterial infections in patients who have bronchiolitis.
6. Outline the prognosis and risk of recurrent wheezing in patients diagnosed with bronchiolitis.

Introduction

Bronchiolitis, defined as inflammation of the bronchioles, usually is caused by an acute viral infection. Viral bronchiolitis is the most common lower respiratory tract infection in infants and children who are 2 years of age and younger. The most commonly identified infectious agent is the respiratory syncytial virus (RSV). Other identified pathogens include adenovirus, human metapneumovirus, influenza virus, and parainfluenza virus.

The pathophysiology of bronchiolitis begins with an acute infection of the epithelial cells lining the small airways within the lungs. Such infection results in edema, increased mucus production, and eventual necrosis and regeneration of these cells. The clinical presentation of bronchiolitis includes rhinitis, cough, tachypnea, use of accessory respiratory muscles, hypoxia, and variable wheezing and crackles on auscultation.

The evaluation and management of bronchiolitis varies substantially. Although bronchiolitis is a well-recognized clinical syndrome, additional tests such as viral isolation, blood serology, and chest radiographs often are ordered, although they have little impact on diagnosis. Most clinical interventions have no significant impact on length of hospital stay, severity of clinical course, or subsequent outcomes such as episodes of recurrent wheezing or ultimate diagnosis of asthma. In 2006, the American Academy of Pediatrics (AAP) released a clinical practice guideline for the diagnosis, testing, and management of bronchiolitis (Table 1). (1) These recommendations are based on current available evidence and expert opinion where necessary (Table 2). Adherence to the AAP clinical practice guideline can decrease unnecessary diagnostic testing, focus practitioners on effective therapeutic interventions, and provide appropriate anticipatory guidance for families who are caring for a child who has bronchiolitis.

Epidemiology

Infection with RSV, the most common cause of bronchiolitis, leads to more than 90,000 hospitalizations annually. (2) The cost of such hospitalizations for children younger than 1 year of age has been estimated to be more than $700 million. Hospitalization for bronchiolitis in the United States has been increasing over the past decade. For most previously well patients, bronchiolitis is a self-limited disease that responds well to supportive care within the home. However, young patients and patients who have pre-existing medical conditions form a vulnerable population that may require inpatient admission.

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Table 1. **Summary of American Academy of Pediatrics Clinical Practice Guidelines for Diagnosis and Management of Bronchiolitis**

Recommendation	Summary	Statement	Evidence Level
Recommendation 1 a	Clinicians should diagnose bronchiolitis based on history and physical findings without routine laboratory and radiologic studies	Recommendation	Level B
Recommendation 1 b	Clinicians should assess risk factors for severe disease including age <12 wk, prematurity, cardiopulmonary disease, and immunodeficiency	Recommendation	Level B
Recommendation 2 a	Bronchodilators should not be used routinely in the management of bronchiolitis	Recommendation	Level B
Recommendation 2 b	A monitored trial of alpha-adrenergic or beta-adrenergic is an option, with continuation only if a response is documented	Option	Level B
Recommendation 3	Corticosteroid medications should not be used routinely in the management of bronchiolitis	Recommendation	Level B
Recommendation 4	Ribavirin should not be used routinely in children who have bronchiolitis	Recommendation	Level B
Recommendation 5	Antibacterial medications are indicated only for treatment of coexisting bacterial infection	Recommendation	Level B
Recommendation 6 a	Clinicians should assess hydration status and ability to take fluids orally	Strong Recommendation	Level X
Recommendation 6 b	Chest physiotherapy should not be used in the management of bronchiolitis	Recommendation	Level B
Recommendation 7 a	Supplemental oxygen is indicated if oxyhemoglobin saturation persistently falls below 90%	Option	Level D
Recommendation 7 b	As the child's clinical course improves, continuous monitoring of Spo_2 is not needed routinely	Option	Level D
Recommendation 7 c	Infants who have a known history of prematurity, lung disease, or hemodynamically significant heart disease require close monitoring during oxygen weaning	Strong Recommendation	Level B
Recommendation 8 a	Clinicians may administer palivizumab to infants who have a history of prematurity, chronic lung disease, or congenital heart disease	Recommendation	Level A
Recommendation 8 b	Palivizumab should be given in five monthly doses beginning in November or December at a dose of 15 mg/kg per dose intramuscularly	Recommendation	Level C
Recommendation 9 a	Hand decontamination is the most important step in preventing nosocomial spread of respiratory syncytial virus	Strong Recommendation	Level B
Recommendation 9 b	Alcohol rubs are preferred for hand decontamination	Recommendation	Level B
Recommendation 10 a	Infants should not be exposed to passive smoking	Strong Recommendation	Level B
Recommendation 10 b	Breastfeeding is recommended to decrease a child's risk of having lower respiratory tract infection	Recommendation	Level C
Recommendation 11	Clinicians should inquire about use of complementary alternative medicine	Option	Level D

Level A=Well-designed randomized clinical trials or diagnostic studies on relevant populations
Level B=Randomized clinical trials or diagnostic studies with minor limitations; overwhelmingly consistent evidence from observational studies
Level C=Observational studies (case control and cohort design)
Level D=Expert opinion, case reports reasoning from first principles
Level X=Exceptional situations in which validating studies cannot be performed and there is a clear preponderance of benefit or harm
Spo_2=oxygen saturation by pulse oximetry
From Subcommittee on Diagnosis and Management of Bronchiolitis. Diagnosis and management of bronchiolitis. *Pediatrics.* 2006;118:1774–1793.

Table 2. **Guideline Definitions and Evidence Quality**

Statement	Definition	Implication
Strong Recommendation	Anticipated benefits of recommended intervention exceed harms; quality of supporting evidence is excellent	Clinicians should follow unless compelling rationale for alternative approach is present
Recommendation	Anticipated benefits exceed potential harm; quality of supporting evidence is not as strong	Clinicians would be prudent to follow recommendation; should remain alert to new information and patient preference
Option	Evidence has not shown clear advantage of one approach over another	Clinicians should consider the option; patient preference may have substantial role
No Recommendation	Lack of evidence required to make recommendation	Clinicians should be alert to new published evidence

From Subcommittee on Diagnosis and Management of Bronchiolitis. Diagnosis and management of bronchiolitis. *Pediatrics*. 2006;118:1774–1793.

The most common risk factor for hospitalization is age. Most inpatient admissions are patients younger than 1 year of age. Infants younger than 3 months of age are at increased risk for apnea and severe respiratory distress. Prematurity is another important risk factor for severe bronchiolitis, especially if associated with a previous diagnosis of neonatal respiratory distress syndrome. Children who have unrepaired congenital heart disease, particularly if associated with pulmonary overcirculation, and children afflicted with chronic lung disease have diminished pulmonary reserve, thereby increasing the chance for hospitalization during an episode of acute bronchiolitis. Children born with airway abnormalities such as laryngomalacia, tracheomalacia, and cleft lip or palate may need supportive care to manage a bronchiolitis-associated increase in upper airway secretions. Patients who have neurologic abnormalities with associated dystonia also may need additional support for secretion management.

Improved recognition and advances in critical care support have decreased mortality over the past 20 years. RSV-associated deaths are rare, accounting for fewer than 500 deaths per year in the United States. Although children who have the pre-existing medical conditions listed previously are at increased risk for severe bronchiolitis, most RSV-associated deaths occur in children who have no pre-existing medical conditions.

Diagnosis

Bronchiolitis should be diagnosed on the basis of history and physical examination. Routine laboratory or radiologic studies are not recommended to support the diagnosis. Patients commonly present with a history of recent upper respiratory tract symptoms. Lower respiratory tract findings, which include cough, tachypnea, and increased work of breathing, follow the upper respiratory prodrome. Physical findings on visual inspection include nasal congestion, rhinorrhea, cough, tachypnea, and increased respiratory effort. Nasal flaring; grunting; and intercostal, supracostal, and subcostal retractions demonstrate increased respiratory effort.

Upper airway obstruction can contribute significantly to increased work of breathing. Nasal suctioning and repositioning may help decrease respiratory effort and allow a more accurate assessment of lower respiratory tract involvement. Auscultation reveals a variety of findings, including crackles, wheezes, and referred upper airway noise. In very young infants, especially those who have a history of prematurity, apnea alone may be the presenting sign as well as a complication of bronchiolitis.

The clinical presentation of bronchiolitis can range from mild tachypnea to impending respiratory failure. Physical findings reflect the dynamic nature of the disease. Significant variability between serial examinations is common. An elevated respiratory rate is the earliest and most sensitive vital sign change. In addition, patients may have tachycardia due to dehydration and variable degrees of hypoxemia. Currently, no robustly supported guidelines for vital sign parameters or physical findings that correlate with clinical outcomes exist, likely due to the high variability of physical findings in affected patients. Respiratory rate, work of breathing, and hypoxia are the most clinically significant parameters in determining illness severity and should be assessed routinely in all patients who have bronchiolitis.

The course of bronchiolitis follows a characteristic pattern. Patients can be expected to have worsening clinical symptoms, with peak symptomatology around day 3 to 4 of illness. "Day of illness" is an important variable in providing anticipatory guidance for outpatient management and in making decisions regarding admission and discharge of patients.

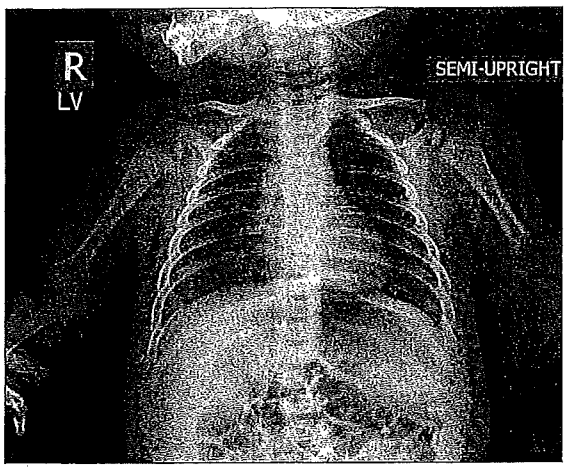

Figure. Chest radiograph of infant who has respiratory syncytial virus bronchiolitis, demonstrating hyperinflation and small areas of patchy, bilateral atelectasis.

Chest radiographs are not recommended routinely for diagnosis. Patients who have bronchiolitis often have abnormal-appearing radiographs. Common findings include hyperinflation, areas of atelectasis, and infiltrates (Figure). These findings do not correlate with disease severity and do not guide management. In addition, abnormal chest radiologic findings may prompt the use of unnecessary antibiotics for a perceived primary or concurrent bacterial pneumonia, which is rare in viral bronchiolitis.

Viral studies are not recommended for the diagnosis of bronchiolitis, and antiviral agents are not recommended in its treatment. Hence, the identification of the particular infectious agent does not affect clinical management. Because many infectious agents can cause the same clinical presentation, viral studies are useful if the information is needed for cohorting patients infected by the same viral pathogen. Isolation procedures should be based on clinical signs, regardless of viral testing.

Patients older than 60 days of age who have bronchiolitis and fever have a low risk of serious bacterial infection (SBI). This fact should reassure the practitioner that additional laboratory evaluation and use of antibiotics are not needed in routine cases.

Infants younger than 60 days of age who have clinical bronchiolitis and fever often are admitted to the hospital and receive a full sepsis evaluation for potential SBIs such as urinary tract infections, bacteremia, and meningitis. Evaluation and treatment for sepsis has been associated with parental dissatisfaction, increasing antibiotic resistance, and iatrogenic complications. There are no current guidelines for the management of young febrile infants who have obvious viral infections, including bronchiolitis. Recent literature has demonstrated that infants who present with fever and are diagnosed as having bronchiolitis are at decreased risk for SBIs compared with infants who present with fever alone. (3)(4)(5)(6)(7) Most of these studies are retrospective and based on small numbers of febrile infants younger than 60 days of age.

Management of clinical bronchiolitis in young febrile infants remains controversial. The largest prospective study examining the occurrence of SBIs in febrile infants younger than 60 days of age who had bronchiolitis concluded that such infants have a low but potential risk for concurrent SBIs. (3) Urinary tract infections are the most commonly diagnosed concurrent SBI.

Based on the current literature, the risk of SBI among infants 30 days of age or younger remains substantial and is unchanged by the diagnosis of bronchiolitis. Such patients should continue to receive conservative management for fever, including full evaluation for SBI and administration of empiric antibiotics. Recognition that infants older than 30 days who have clinical bronchiolitis are at a lower risk for SBIs may allow for decreased invasive testing and observation without administering antibiotics to patients who have classic presentations. Viral testing may provide additional reassurance to practitioners electing to observe without administering antibiotics. Further studies that have large cohorts of young febrile infants are needed to examine the relationship between bronchiolitis and concurrent SBIs in the youngest febrile infants.

Management

Possible therapeutic interventions for bronchiolitis are multiple: bronchodilators, corticosteroids, antiviral agents, antibacterial agents, chest physiotherapy, nasal suction, and decongestant drops have been used. Despite this extensive list, none of these therapies have demonstrated significant impact on duration of illness, severity of clinical course, or subsequent clinical outcomes, such as postbronchiolitis wheezing. (8) Newer management strategies for bronchiolitis clearly emphasize supportive care, with hydration and oxygenation as the primary therapeutic interventions.

All infants who have bronchiolitis require assessment of hydration status. Elevated respiratory rate, copious secretions, fever, and poor feeding all contribute to dehydration. Patients may require intravenous fluid rehydration and continued intravenous fluid or nasogastric feedings until feeding improves. Bronchiolitis has been

described as an independent stimulus for antidiuretic hormone release and may put patients at risk for iatrogenic hyponatremia if given hypotonic fluids. Use of isotonic fluids for such patients may be beneficial in decreasing the risk for iatrogenic hyponatremia. (9)(10) Patients who have severe bronchiolitis may benefit from nasogastric feeding for nutrition support until feeding improves.

Bronchiolitis is characterized by variable hypoxemia resulting from impaired diffusion across the blood-gas membrane as well as ventilation-perfusion mismatch caused by heterogeneous plugging of distal bronchioles. Oxygen administration is a key therapeutic intervention. The ultimate goal of maintaining normal blood oxygen saturation is to prevent hypoxia or insufficient delivery of oxygen to metabolically active tissue. Debate within the literature regarding the lower limit of tolerated saturations for patients who have a primary respiratory process is significant. Some authors have advocated a pulse oximetry saturation range of 92% or higher in a previously well patient. Others have stated that pulse oximetry saturations higher than 90% are acceptable, noting that this saturation still is associated with appropriate oxygen delivery on the oxyhemoglobin dissociation curve. The need and duration of supplemental oxygen should be based on a complete assessment of the patient.

The day of illness can guide practitioners in determining if the patient requires an increase or decrease in supportive care, including oxygen therapy. As expected on day 3 or 4, a clinically improving patient may experience intermittent decreases in pulse oximetry saturation, which should not prompt automatic continuation or reinitiation of oxygen supplementation. Reinitiation of oxygen therapy often is associated with prolonged hospitalization and may not offer significant benefit. Oxygen should be discontinued once pulse oximetry saturations rise to between 90% and 92% for most of the time and the patient is demonstrating overall clinical improvement, as evidenced by adequate feeding and improved work of breathing.

Variability in the use and interpretation of pulse oximetry in patients who have bronchiolitis is wide. The obvious advantage of pulse oximetry is rapid assessment of oxygenation without invasive testing. The disadvantages include variation in product accuracy, motion artifact, and decreased sensitivity in patients who have poor perfusion. Although pulse oximetry readings often are instrumental in determining the need for admission, use of continuous monitoring has been associated with unnecessary increased length of hospital stay for patients who have bronchiolitis. In addition, after many days of continuous monitoring, many parents feel uncomfortable taking the child home and may request a home monitor. There are no guidelines for the use of pulse oximetry in patients who have bronchiolitis but have no prior history of chronic illness.

Two strategies that may minimize unwanted consequences of prolonged monitoring in the hospital setting are: 1) scheduled spot checks along with measurement of vital signs and unscheduled checks when clinically indicated or 2) scheduled spot checks after a fixed period of monitoring. Continuous pulse oximetry monitoring should be reserved for those who previously required continuous oxygen supplementation, those who have risk factors for apnea, and those who have underlying cardiopulmonary conditions. Similar to pulse oximetry, there are no guidelines for cardiac monitoring of patients who have bronchiolitis. Cardiopulmonary monitoring may be considered in select patients, such as infants who have had episodes of apnea that may be associated with bradycardia or patients who have underlying cardiac conditions.

The AAP does not recommend use of bronchodilators in the routine treatment of bronchiolitis. A monitored trial of a bronchodilator may be considered but should be continued only if a clinical response is documented. Epinephrine and albuterol are the bronchodilators used most commonly. Epinephrine has been associated with slightly better temporary clinical improvement than albuterol. This effect likely is due to the alpha-adrenergic-mediated vasoconstriction that may aid in decreasing nasal congestion. Epinephrine should be reserved for hospitalized patients or those being evaluated in the emergency department. Epinephrine is not recommended in the outpatient setting due to limited data regarding safety with unmonitored administration. Albuterol is the recommended bronchodilator for continued therapy in the outpatient setting. (11)

If an improvement in clinical status is documented, continued treatment with bronchodilator therapy might be considered. A good clinical response to bronchodilator therapy may manifest as diminished work of breathing, decrease in respiratory rate, and improvement in hypoxemia. Many institutions have bronchiolitis-specific assessment tools to assess these and other clinical variables in response to medical interventions. An important area of research is development of a robust bronchiolitis scoring tool predictive of clinical course and outcome.

Corticosteroid medications, inhaled or administered systemically, should not be used in the treatment of bronchiolitis. Ambiguity regarding their use has resulted from a heterogeneous and at times difficult-to-interpret

body of medical literature. Previously, studies of corticosteroid use in bronchiolitis have suffered from interstudy design variability and wide variation in study sample size. However, an inclusive Cochrane database review on the use of corticosteroids for acute bronchiolitis concluded that there is no significant difference in length of stay or severity of disease for patients receiving such therapy. (12) The review included randomized clinical trials and involved nearly 1,200 patients who had bronchiolitis. Further, steroids have a well-established undesirable adverse effect profile. Based on current available evidence, corticosteroids should not be used to treat bronchiolitis.

Ribavirin should not be used routinely in the treatment of bronchiolitis; trials have demonstrated variable outcomes. Although some of the studies have shown benefit, this finding has not been consistent. Also, many of the studies have suffered from small sample size and variable design quality. Ultimately, high cost, difficult administration, and lack of robust evidence of benefit have limited the role of this therapy. Additional research into more cost-effective agents that are administered more easily may result in a more significant role for antiviral agents in the treatment of RSV bronchiolitis. Ribavirin may be considered in select situations of severe bronchiolitis. Examples include patients whose medical conditions are pre-existing, such as organ transplantation, malignancy, or congenital immunodeficiencies, or patients who remain critically ill despite maximized support.

Because RSV causes most cases of bronchiolitis, influenza-associated bronchiolitis represents a unique, small subset of affected patients.

Because RSV causes most cases of bronchiolitis, influenza-associated bronchiolitis represents a unique, small subset of affected patients. Treatment of influenza infection with antiviral medications may decrease the severity of symptoms and associated complications, especially if initiated within the first 48 hours of presentation. The two classes of anti-influenza medications include the adamantanes (amantadine and rimantadine) and the neuraminidase inhibitors (oseltamivir and zanamivir). The adamantanes no longer are recommended as treatment for influenza due to their lack of activity against influenza B strains and increased resistance by influenza A strains.

The Centers for Disease Control and Prevention (CDC) now recommends oseltamivir, approved for use in children older than 1 year of age, and zanamivir, approved for children older than 5 years of age, for the treatment of influenza infection. Challenges in maintaining safe and effective anti-influenza medications underscore the importance of annual influenza vaccinations. Viral testing and initiation of influenza-directed therapy should be considered only when the clinical presentation, in addition to surveillance reports in the community, suggests a high positive predictive value for influenza infection.

Antibacterial agents have no impact on viral bronchiolitis and should be used only in patients diagnosed with a concurrent bacterial infection. Acute otitis media (AOM) is the concurrent bacterial infection diagnosed most commonly. Although otitis media with middle ear effusion (OME) may be caused by the viral infection itself, no reliable physical characteristics allow the clinician to distinguish between a viral and bacterial OME. Hence, treatment should follow current AAP guidelines, which emphasize the use of key physical findings, including tympanic membrane position and mobility, distortion of light reflex, and disappearance of translucency to differentiate between AOM and nonbacterial OME.

Initiation of antibiotic therapy for suspected AOM should be based on patient age, severity of illness, and diagnostic certainty. Patients younger than 6 months of age should receive amoxicillin 80 mg/kg per day divided into two doses for 7 to 10 days. Patients older than 6 months of age and younger than 2 years of age should receive treatment if diagnostic certainty is strong but may be considered for observation if the infection is not severe. Many physicians elect to provide such patients with a "safety scrip" for antibiotics, should symptoms worsen. Patients older than 2 years of age should receive antibiotic treatment only if the diagnostic certainty is strong and the infection severe.

Chest physiotherapy should not be used to treat bronchiolitis. As described previously, the pathophysiology of bronchiolitis involves infection of the epithelial cells lining the small airways. This process is diffuse, causing heterogeneous regions of perfusion-ventilation mismatch that are unaffected by regional chest physiotherapy.

Nasal suction often is used to relieve upper airway obstruction. Suctioning may increase comfort and improve feeding. However, excessive suction can be associ-

Table 3. **Palivizumab Prophylaxis Guidelines**

Prematurity	
<28 weeks gestational age	Prophylaxis recommended throughout first postnatal year
29 to 32 weeks gestational age	Prophylaxis recommended throughout first 6 postnatal months
32 to 35 weeks gestational age	Consider if infant is younger than 6 months of age and has two of the following risk factors: child care attendance, school-age siblings, exposure to environmental air pollutants, congenital abnormalities of the airway, or severe neuromuscular disease
Chronic lung disease	Prophylaxis recommended for patients <2 years who have chronic lung disease and have required medical therapy, including supplemental oxygen, diuretics, or bronchodilator or corticosteroid therapy, within 6 months of bronchiolitis season
Hemodynamically significant congenital heart disease	Prophylaxis recommended for patients <2 years of age who have cyanotic congenital heart disease or pulmonary hypertension or patients receiving medication to control congestive heart failure

From American Academy of Pediatrics. Respiratory syncytial virus. In: Pickering LK, Baker CJ, Kimberlin DW, Long SS, eds. *Red Book. 2009 Report of the Committee on Infectious Diseases.* 28th ed. Elk Grove Village, Ill: American Academy of Pediatrics; 2009:560–569.

ated with nasal edema and lead to additional obstruction. Judicious nasal suction is most beneficial before feeding and in response to copious secretions. No evidence exists to support "deep" suctioning of the lower pharynx.

Nasal decongestant drops have been used to manage upper airway obstruction, but no evidence supports the use of such medications. Various components of the medications have been shown to be harmful in adult patients, and there is no significant information regarding their use in pediatric patients. Lack of efficacy and potentially harmful adverse effects prompted the United States Food and Drug Administration to issue a public health advisory in January 2008 strongly stating that over-the-counter cough and cold products, including nasal decongestants, should not be used for infants and children younger than 2 years of age. Many manufacturers have withdrawn pediatric cough and cold preparations voluntarily from the market. Nasal decongestants should not be used to treat bronchiolitis.

Prevention

Administration of palivizumab, a monoclonal antibody (immunoglobulin G) directed against RSV, to select groups of infants might prevent hospitalization for bronchiolitis. These groups include infants who have a history of prematurity, infants who have chronic lung disease, and infants born with hemodynamically significant congenital heart disease (Table 3).

Because the risk of severe bronchiolitis increases with degree of prematurity, recommended guidelines are stratified into categories of prematurity. Infants born at 28 weeks' gestation or less benefit from protection throughout their first bronchiolitis season and should receive prophylaxis whenever bronchiolitis occurs in the community throughout their first postnatal year. Infants born at 29 through 32 weeks' gestation receive the most benefit during the first 6 postnatal months. Should a patient qualify for initiation of prophylaxis at the start of the bronchiolitis season, he or she should continue to receive prophylaxis throughout the remainder of the season. Patients born at 32 through 35 weeks' gestation should be considered for prophylaxis if they are younger than 6 months of age at the beginning of the bronchiolitis season and have at least two of the following risk factors: child care attendance, school-age siblings, exposure to environmental air pollutants, congenital abnormalities of the airway, or severe neuromuscular disease.

Palivizumab prophylaxis should be considered for patients younger than 2 years of age who have chronic lung disease and have required medical therapy, including supplemental oxygen, diuretic use, and bronchodilator or corticosteroid therapy, within 6 months before the bronchiolitis season. Select patients who have severe chronic lung disease may benefit from prophylaxis during subsequent seasons. However, the effectiveness of palivizumab beyond the second postnatal year is unknown. Consulting with a pulmonologist is suggested before initiating prophylaxis in this older age group.

All children younger than 2 years of age who have hemodynamically significant congenital heart disease of either cyanotic or acyanotic form may benefit from palivizumab prophylaxis. Among those who have congenital heart disease, children who receive the most benefit are those younger than 2 years of age who currently are receiving medication to control congestive heart failure,

those who have moderate-to-severe pulmonary hypertension, and those who have cyanotic heart disease.

Palivizumab prophylaxis should be administered in five monthly doses beginning in November or December at a dose of 15 mg/kg per dose. This recommended schedule accommodates the national variation in bronchiolitis seasons. The primary benefit of prophylaxis is a decrease in the rate of RSV-associated hospitalization. No studies have demonstrated a significant decrease in mortality among patients who received palivizumab prophylaxis. Additionally, palivizumab is not effective in the treatment of an acute RSV infection.

Despite decreased rates of hospitalization, economic analysis of palivizumab prophylaxis has not demonstrated overall cost-effectiveness, even among high-risk infants. The effect likely is due to the very high cost of the medication, the variability in cost of hospitalization, and the low mortality rates associated with RSV bronchiolitis. Future areas of research include development of less expensive prophylactic agents that have improved cost-effective benefits in the prevention of bronchiolitis.

Strict hand hygiene and isolation policies remain the cornerstone of preventing nosocomial RSV infections. The CDC has published a review of the hand hygiene literature and made recommendations regarding hand washing and the use of hand antisepsis products by patients who have bronchiolitis. Hands should be washed after direct contact with patients, after removal of gloves, and after contact with inanimate objects in the direct vicinity of the patient. If hands are not visibly soiled, an alcohol-based rub is preferred; the alternative is thorough hand washing. Additional methods for controlling nosocomial infection include changing gloves frequently, wearing gowns during direct contact with patients, and isolating or cohorting RSV-positive patients, with medical personnel specifically assigned to only their care. All physicians should model and enforce appropriate hand hygiene when caring for patients who have bronchiolitis. Physicians also should be aware of the current infection control policy at their institutions for patients who have bronchiolitis.

Additional preventive strategies include avoidance of tobacco smoke and encouragement of breastfeeding throughout the bronchiolitis season. Parents should be advised that tobacco smoke has been found to be an independent risk factor for contracting bronchiolitis. Human milk is a protective factor for decreasing the risk of RSV infection. Human milk contains immune factors that can prevent RSV infection, including immunoglobulin G, immunoglobulin A, and alpha-interferon. Human milk also has been shown to have neutralizing activity against RSV independent of the immune factors described previously.

Prognosis

Most infants who experience bronchiolitis recover without sequelae, although a portion develop recurrent wheezing episodes, especially with subsequent viral infections. Approximately 40% of infants diagnosed with bronchiolitis have subsequent wheezing episodes through 5 years of age; 10% have subsequent wheezing episodes after 5 years of age. (13) Currently, the relationship between the diagnosis of bronchiolitis in infants and subsequent wheezing is unclear. Previous theories proposed that acquiring bronchiolitis at an early age might contribute to recurrent wheezing and increased airway reactivity later in life. As the complex interaction of the developing immune system, atopic genetic predisposition, and infectious agents becomes more apparent, newer theories propose that patients who develop postbronchiolitic wheezing may have an underlying predisposition to the original RSV infection and subsequent recurrent episodes of wheezing. Anticipatory guidance regarding episodes of recurrent wheezing should be based on the known incidence of postbronchiolitis wheezing and other independent risk factors such as familial atopic disposition.

Summary

- Based on good evidence, the diagnosis of bronchiolitis should be based on clinical evaluation without supportive laboratory or radiologic studies.
- Based on good evidence, the mainstay of therapy is supportive care and involves oxygen, hydration, and nutrition support.
- Based on good evidence, many current therapeutic interventions have not demonstrated efficacious improvement in the clinical course or subsequent outcomes. A trial of bronchodilator therapy is optional but should be continued only if a clinical response is documented. Corticosteroids should not be used to treat bronchiolitis, and ribavirin therapy should be reserved for special situations.
- Based on good evidence, effective measures to prevent bronchiolitis include administration of palivizumab, encouragement of breastfeeding, avoidance of tobacco smoke, and strict handwashing as well as adherence to other institutional infection control policies.
- Future areas of research include defining the roles of pulse oximetry and oxygen therapy in bronchiolitis, developing a robust clinical scoring tool for assessing respiratory distress in patients who have bronchiolitis, delineating the relationship between early clinical bronchiolitis and recurrent wheezing episodes, and developing cost-effective immunoprophylaxis and ultimately vaccination against RSV.

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PIR Quiz

Quiz also available online at pedsinreview.aappublications.org.

5. The *most* important triad of findings for assessing severity of bronchiolitis are respiratory rate, work of breathing, and:

   A. Degree of cough.
   B. Level of oxygen saturation.
   C. Pitch of wheezing.
   D. Presence of crackles.
   E. Rapidity of heart rate.

6. Among the following, the *best* reason to obtain viral studies in those suspected of having bronchiolitis is to:

   A. Administer specific antiviral therapy.
   B. Determine the need for hospitalization.
   C. Guide the type of supportive care needed.
   D. Identify febrile infants >30 days of age who are at low risk for serious bacterial infection and may not need empiric antibiotics.
   E. Provide the most accurate diagnosis.

7. Among the following, the febrile patients *most* likely to have a serious bacterial infection associated with bronchiolitis:

   A. Are younger than 30 days of age.
   B. Are 31 to 60 days old.
   C. Are neurologically impaired.
   D. Have infiltrates on chest radiography.
   E. Have survived neonatal respiratory distress syndrome.

8. The primary treatment of bronchiolitis includes hydration and:

   A. Bronchodilators.
   B. Chest physiotherapy.
   C. Corticosteroids.
   D. Decongestants.
   E. Oxygenation.

9. The major benefit of palivizumab prophylaxis is:

   A. Decreased hospitalization rate.
   B. Improved treatment.
   C. Increased cost-effectiveness.
   D. Lower mortality rate.
   E. Shorter duration of illness.

to alkali supplementation, children may develop chronic renal failure. Initial evaluation, management, and follow-up planning routinely involve consultation with a pediatric nephrologist.

Lessons for the Clinician

- The presence of a nonanion gap metabolic acidosis in the context of growth failure should alert the clinician to the possibility of net body loss of bicarbonate, either in the GI tract or the renal tubule.
- Although RTA is rare, a clinical history of growth failure in association with analysis of serum electrolytes, urine pH, and urine anion gap can direct the clinician to the appropriate diagnosis.
- Compliance with prescribed alkali supplementation is important to prevent long-term complications, including renal failure.

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To view Suggested Reading lists for these cases, visit pedsinreview.aappublications.org and click on Index of Suspicion.

Clarification

In the article by Onady on evidence-based medicine in the August 2009 issue (*Pediatrics in Review.* 2009;30:317–324), an example is used that involves a hematologic condition. The clinical example presented and the references used in the discussion are meant to illustrate the application principles of evidence-based medicine for an individual patient at a moment of time requiring urgent and sound medical decision-making. That example, using a specific case, was not intended to be part of a clinical guideline. Readers should use the article to understand principles of evidence-based medicine. However, because information has been updated since this case was analyzed, the reader should not apply the material to direct care of individual patients. Clinicians wishing to find more in-depth information on von Willebrand disease are referred to the NCH Guidelines at: http://www.guideline.gov/summary/summary.aspx?doc_id=12275&nbr=006357&string=von+AND+Willebrand+AND+disease.

In the quiz that follows the article on bronchiolitis in the October issue (*Pediatr Rev.* 2009;30:395), answer D in question 6 reads, in the print edition, "Identify febrile infants ≥30 days of age who are at low risk for serious bacterial infection and may not need empiric antibiotics." That answer is correct, and there is a typographical error in the online edition, which reads "<30 days."