Medical Education Systems, Inc.

713 RSV Guidelines

Medical Education Systems, Inc.

TOLL FREE: 877-295-4719
LOCAL: 619-295-0284
FAX: 619-295-0252
EMAIL: Info@mededsys.com
WEBSITE: www.mededsys.com
P.O Box 81831 San Diego, CA. 92138-3939

Diagnosis and Management of Bronchiolitis (RSV)

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Learning Objectives

Upon successful completion of this CEU, you will be able to:

- Define and discuss bronchiolitis (RSV), including its diagnosis and current treatments
- Describe the goal of the new guidelines and explain how these new guidelines will impact that treatment
- Discuss the potential future for diagnosing and treating RSV

Abstract

Bronchiolitis is a disorder most commonly caused in infants by viral lower respiratory tract infection. It is the most common lower respiratory infection in this age group. It is characterized by acute inflammation, edema, and necrosis of epithelial cells lining small airways, increased mucus production, and bronchospasm.

The American Academy of Pediatrics convened a committee composed of primary care physicians and specialists in the fields of pulmonology, infectious disease, emergency medicine, epidemiology, and medical informatics. The committee partnered with the Agency for Healthcare Research and Quality and the RTI International-University of North Carolina Evidence-Based Practice Center to develop a comprehensive review of the evidence-based literature related to the diagnosis, management, and prevention of bronchiolitis. The resulting evidence report and other sources of data were used to formulate clinical practice guideline recommendations.

This guideline addresses the diagnosis of bronchiolitis as well as various therapeutic interventions including bronchodilators, corticosteroids, antiviral and antibacterial agents, hydration, chest physiotherapy, and oxygen. Recommendations are made for prevention of respiratory syncytial virus infection with palivizumab and the control of nosocomial spread of infection. Decisions were made on the basis of a systematic grading of the quality of evidence and strength of recommendation. The clinical practice guideline underwent comprehensive peer review before it was approved by the American Academy of Pediatrics.

This clinical practice guideline is not intended as a sole source of guidance in the management of children with bronchiolitis. Rather, it is intended to assist clinicians in decision-making. It is not intended to replace clinical judgment or establish a protocol for the care of all children with this condition. These recommendations may not provide the only appropriate approach to the management of children with bronchiolitis.

Abbreviations: CAM—complementary and alternative medicine • LRTI—lower respiratory tract infection • AHRQ—Agency for Healthcare Research and Quality • RSV—respiratory syncytial virus • AAP—American Academy of Pediatrics • AAFP—American Academy of Family Physicians • RCT—randomized, controlled trial • CLD—chronic neonatal lung disease • SBI—serious bacterial infection • UTI—urinary tract infection • AOM—acute otitis media • Spo_2—oxyhemoglobin saturation • LRTD—lower respiratory tract disease

Introduction

This guideline examines the published evidence on diagnosis and acute management of the child with bronchiolitis in both outpatient and hospital settings, including the roles of supportive therapy, oxygen, bronchodilators, antiinflammatory agents, antibacterial agents, and antiviral agents and make recommendations to influence clinician behavior on the basis of the evidence. Methods of prevention are reviewed, as is the potential role of complementary and alternative medicine (CAM).

The goal of this guideline is to provide an evidence-based approach to the diagnosis, management, and prevention of bronchiolitis in children from 1 month to 2 years of age. The guideline is intended for pediatricians, family physicians, emergency medicine specialists, hospitalists, nurse practitioners, and physician assistants who care for these children. The guideline does not apply to children with immunodeficiencies including HIV, organ or bone marrow transplants, or congenital immunodeficiencies. Children with underlying respiratory illnesses such as chronic neonatal lung disease (CLD; also known as bronchopulmonary dysplasia) and those with significant congenital heart disease are excluded from the sections on management unless otherwise noted but are included in the discussion of prevention. This guideline will not address long-term sequelae of bronchiolitis, such as recurrent wheezing, which is a field with distinct literature of its own.

Bronchiolitis is a disorder most commonly caused in infants by viral lower respiratory tract infection (LRTI). It is the most common lower respiratory infection in this age group. It is characterized by acute inflammation, edema and necrosis of epithelial cells lining small airways, increased mucus production, and bronchospasm. Signs and symptoms are typically rhinitis, tachypnea, wheezing, cough, crackles, use of accessory muscles, and/or nasal flaring.[1] Many viruses cause the same constellation of symptoms and signs. The most common etiology is the respiratory syncytial virus (RSV), with the highest incidence of RSV infection occurring between December and March.[2] Ninety percent of children are infected with RSV in the first 2 years of life,[3] and up to 40% of them will have lower respiratory infection.[4,5] Infection with RSV does not grant permanent or long-term immunity. Reinfections are common and may be experienced throughout life.[6] Other viruses identified as causing bronchiolitis are human metapneumovirus, influenza, adenovirus, and parainfluenza. RSV infection leads to more than 90000 hospitalizations annually. Mortality resulting from RSV has decreased from 4500 deaths annually in 1985 in the United States[2,6] to an estimated 510 RSV-associated deaths in 1997[6] and 390 in 1999.[7] The cost of hospitalization for bronchiolitis in children less than 1 year old is estimated to be more than $700 million per year.[8]

Several studies have shown a wide variation in how bronchiolitis is diagnosed and treated. Studies in the United States,[9] Canada,[10] and the Netherlands[11] showed variations that correlated more with hospital or individual preferences than with patient severity. In addition, length of hospitalization in some countries averages twice that of others.[12] This variable pattern suggests a lack of consensus among clinicians as to best practices.

In addition to morbidity and mortality during the acute illness, infants hospitalized with bronchiolitis are more likely to have respiratory problems as older children, especially recurrent wheezing, compared with those who did not have severe disease.[13–15] Severe disease is characterized by persistently increased respiratory effort, apnea, or the need for intravenous hydration, supplemental oxygen, or mechanical ventilation. It is unclear whether severe viral illness early in life predisposes children to develop recurrent wheezing or if infants who experience severe bronchiolitis have an underlying predisposition to recurrent wheezing.

Methods

To develop the clinical practice guideline on the diagnosis and management of bronchiolitis, the American Academy of Pediatrics (AAP) convened the Subcommittee on Diagnosis and Management of Bronchiolitis with the support of the American Academy of Family Physicians (AAFP), the American Thoracic Society, the American College of Chest Physicians, and the European Respiratory Society. The subcommittee was chaired by a primary care pediatrician with expertise in clinical pulmonology and included experts in the fields of general pediatrics, pulmonology, infectious disease, emergency medicine, epidemiology, and medical informatics. All panel members reviewed the AAP Policy on Conflict of Interest and Voluntary Disclosure and were given an opportunity to declare any potential conflicts.

The AAP and AAFP partnered with the AHRQ and the RTI International-University of North Carolina Evidence-Based Practice Center (EPC) to develop an evidence report, which served as a major source of information for these practice guideline recommendations.[1] Specific clinical questions addressed in the AHRQ evidence report were the (1) effectiveness of diagnostic tools for diagnosing bronchiolitis in infants and children, (2) efficacy of pharmaceutical therapies for treatment of bronchiolitis, (3) role of prophylaxis in prevention of bronchiolitis, and (4) cost-effectiveness of prophylaxis for management of bronchiolitis. EPC project staff searched Medline, the Cochrane Collaboration, and the Health Economics Database. Additional articles were identified by review of reference lists of relevant articles and ongoing studies recommended by a technical expert advisory group. To answer the question on diagnosis, both prospective studies and randomized, controlled trials (RCTs) were used. For questions related to treatment and prophylaxis in the AHRQ report, only RCTs were considered. For the cost-effectiveness of prophylaxis, studies that used economic analysis were reviewed. For all studies, key inclusion criteria included outcomes that were both clinically relevant and able to be abstracted. Initially, 744 abstracts were identified for possible inclusion, of which 83 were retained for systematic review. Results of the literature review were presented in evidence tables and published in the final evidence report.[1]

An additional literature search of Medline and the Cochrane Database of Systematic Reviews was performed in July 2004 by using search terms submitted by the members of the Subcommittee on the Diagnosis and Management of Bronchiolitis. The methodologic quality of the research was appraised by an epidemiologist before consideration by the subcommittee.

The evidence-based approach to guideline development requires that the evidence in support of a policy be identified, appraised, and summarized and that an explicit link between evidence and recommendations be defined. Evidence-based recommendations reflect the quality of evidence and the balance of benefit and harm that is anticipated when the recommendation is followed. The AAP policy statement "Classifying Recommendations for Clinical Practice Guidelines"[16] was followed in designating levels of recommendation (Fig 1; Table 1).

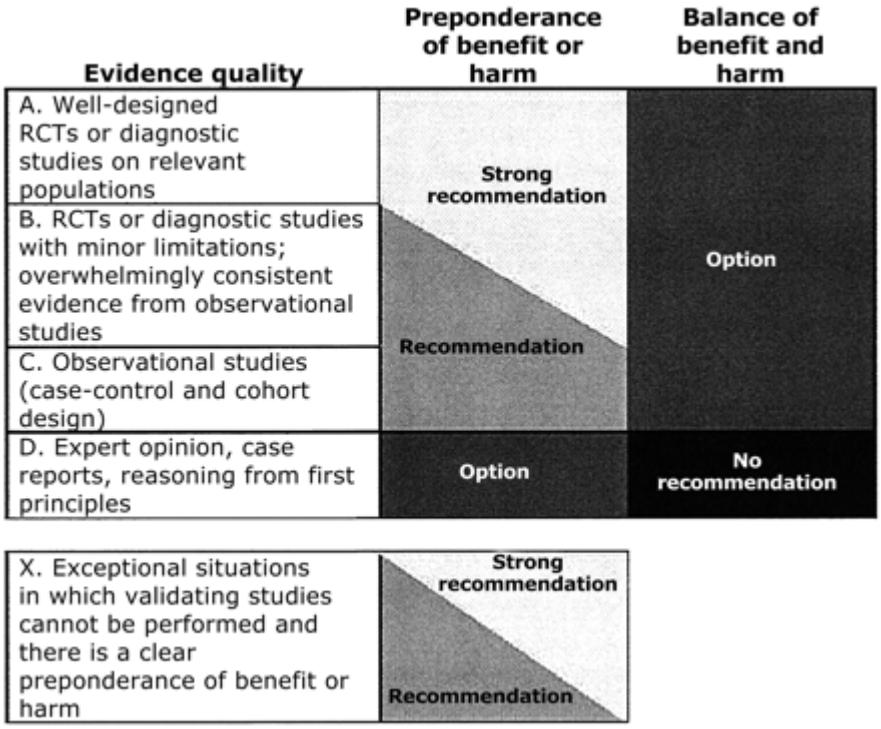

FIGURE 1 Integrating evidence quality appraisal with an assessment of the anticipated balance between benefits and harms if a policy is carried out leads to designation of a policy as a strong recommendation, recommendation, option, or no recommendation.

TABLE 1 Guideline Definitions for Evidence-Based Statements

Statement	Definition	Implication
Strong recommendation	**A strong recommendation in favor of a particular action is made when the anticipated benefits of the recommended intervention clearly exceed the harms (as a strong recommendation against an action is made when the anticipated harms clearly exceed the benefits) and the quality of the supporting evidence is excellent. In some clearly identified circumstances, strong recommendations may be made when high-quality evidence is impossible to obtain and the anticipated benefits strongly outweigh the harms.**	**Clinicians should follow a strong recommendation unless a clear and compelling rationale for an alternative approach is present.**
Recommendation	**A recommendation in favor of a particular action is made when the anticipated benefits exceed the harms but the quality of evidence is not as strong. Again, in some clearly identified circumstances, recommendations may be made when high-quality evidence is impossible to obtain but the anticipated benefits outweigh the harms.**	**Clinicians would be prudent to follow a recommendation but should remain alert to new information and sensitive to patient preferences.**
Option	**Options define courses that may be taken when either the quality of evidence is suspect or carefully performed studies have shown little clear advantage to one approach over another.**	**Clinicians should consider the option in their decision-making, and patient preference may have a substantial role.**
No recommendation	**No recommendation indicates that there is a lack of pertinent published evidence and that the anticipated balance of benefits and harms is presently unclear.**	**Clinicians should be alert to new published evidence that clarifies the balance of benefit versus harm.**

A draft version of this clinical practice guideline underwent extensive peer review by committees and sections within the AAP, American Thoracic Society, European Respiratory Society, American College of Chest Physicians, and AAFP, outside organizations, and other individuals identified by the subcommittee as experts in the field. Members of the subcommittee were invited to distribute the draft to other representatives and committees within their specialty organizations. The resulting comments were reviewed by the subcommittee and, when appropriate, incorporated into the guideline.

This clinical practice guideline is not intended as a sole source of guidance in the management of children with bronchiolitis. Rather, it is intended to assist clinicians in decision-making. It is not intended to replace clinical judgment or establish a protocol for the care of all children with this

condition. These recommendations may not provide the only appropriate approach to the management of children with bronchiolitis.

All AAP guidelines are reviewed every 5 years.

Definitions used in the guideline are:

- Bronchiolitis: a disorder most commonly caused in infants by viral LRTI; it is the most common lower respiratory infection in this age group and is characterized by acute inflammation, edema and necrosis of epithelial cells lining small airways, increased mucus production, and bronchospasm.
- CLD, also known as bronchopulmonary dysplasia: an infant less than 32 weeks' gestation evaluated at 36 weeks' postmenstrual age or one of more than 32 weeks' gestation evaluated at more than 28 days but less than 56 days of age who has been receiving supplemental oxygen for more than 28 days.[17]
- Routine: a set of customary and often-performed procedures such as might be found in a routine admission order set for children with bronchiolitis.
- Severe disease: signs and symptoms associated with poor feeding and respiratory distress characterized by tachypnea, nasal flaring, and hypoxemia.
- Hemodynamically significant congenital heart disease: children with congenital heart disease who are receiving medication to control congestive heart failure, have moderate to severe pulmonary hypertension, or have cyanotic heart disease.

RECOMMENDATION 1a

Clinicians should diagnose bronchiolitis and assess disease severity on the basis of history and physical examination. Clinicians should not routinely order laboratory and radiologic studies for diagnosis (recommendation: evidence level B; diagnostic studies with minor limitations and observational studies with consistent findings; preponderance of benefits over harms and cost).

RECOMMENDATION 1b

Clinicians should assess risk factors for severe disease such as age less than 12 weeks, a history of prematurity, underlying cardiopulmonary disease, or immunodeficiency when making decisions about evaluation and management of children with bronchiolitis (recommendation: evidence level B; observational studies with consistent findings; preponderance of benefits over harms).

The 2 goals in the history and physical examination of infants presenting with cough and/or wheeze, particularly in the winter season, are the differentiation of infants with probable bronchiolitis from those with other disorders and the estimation of the severity of illness. Most clinicians recognize bronchiolitis as a constellation of clinical symptoms and signs including a viral upper respiratory

prodrome followed by increased respiratory effort and wheezing in children less than 2 years of age. Clinical signs and symptoms of bronchiolitis consist of rhinorrhea, cough, wheezing, tachypnea, and increased respiratory effort manifested as grunting, nasal flaring, and intercostal and/or subcostal retractions.

Respiratory rate in otherwise healthy children changes considerably over the first year of life, decreasing from a mean of approximately 50 breaths per minute in term newborns to approximately 40 breaths per minute at 6 months of age and 30 breaths per minute at 12 months.[18–20] Counting respiratory rate over the course of 1 minute may be more accurate than measurements extrapolated to 1 minute but observed for shorter periods.[21] The absence of tachypnea correlates with the lack of LRTIs or pneumonia (viral or bacterial) in infants.[22,23]

The course of bronchiolitis is variable and dynamic, ranging from transient events such as apnea or mucus plugging to progressive respiratory distress from lower airway obstruction. Important issues to assess include the impact of respiratory symptoms on feeding and hydration and the response, if any, to therapy. The ability of the family to care for the child and return for further care should be assessed. History of underlying conditions such as prematurity, cardiac or pulmonary disease, immunodeficiency, or previous episodes of wheezing should be identified.

The physical examination reflects the variability in the disease state and may require serial observations over time to fully assess the child's status. Upper airway obstruction may contribute to work of breathing. Nasal suctioning and positioning of the child may affect the assessment. Physical examination findings of importance include respiratory rate, increased work of breathing as evidenced by accessory muscle use or retractions, and auscultatory findings such as wheezes or crackles.

The evidence relating the presence of specific findings in the assessment of bronchiolitis to clinical outcomes is limited. Most studies are retrospective and lack valid and unbiased measurement of baseline and outcome variables. Most studies designed to identify the risk of severe adverse outcomes such as requirement for intensive care or mechanical ventilation have focused on inpatients.[24–26] These events are relatively rare among all children with bronchiolitis and limit the power of these studies to detect clinically important risk factors associated with disease progression.

Several studies have associated premature birth (less than 37 weeks) and young age of the child (less than 6–12 weeks) with an increased risk of severe disease.[26–28] Young infants with bronchiolitis may develop apnea, which has been associated with an increased risk for prolonged hospitalization, admission to intensive care, and mechanical ventilation.[26] Other underlying conditions that have been associated with an increased risk of progression to severe disease or mortality include hemodynamically significant congenital heart disease,[26,29] chronic lung disease (bronchopulmonary dysplasia, cystic fibrosis, congenital anomaly),[26] and the presence of an immunocompromised state.[26,30]

Findings on physical examination have been less consistently associated with outcomes of bronchiolitis. Tachypnea, defined as a respiratory rate of 70 or more breaths per minute, has been associated with increased risk for severe disease in some studies[24,27,31] but not others.[32] An AHRQ report[1] found 43 of 52 treatment trials that used clinical scores, all of which included measures of respiratory rate, respiratory effort, severity of wheezing, and oxygenation. The lack of uniformity of scoring systems made comparison between studies difficult.[1] The most widely used clinical score, the Respiratory Distress Assessment Instrument,[33] is reliable with respect to scoring but has not been validated for clinical predictive value in bronchiolitis. None of the other clinical scores used in the various studies have been assessed for reliability and validity. Studies that have assessed other physical examination findings have not found clinically useful associations with outcomes.[27,32] The substantial

temporal variability in physical findings as well as potential differences in response to therapy may account for this lack of association. Repeated observation over a period of time rather than a single examination may provide a more valid overall assessment.

Pulse oximetry has been rapidly adopted into clinical assessment of children with bronchiolitis on the basis of data suggesting that it can reliably detect hypoxemia that is not suspected on physical examination.[27,34] Few studies have assessed the effectiveness of pulse oximetry to predict clinical outcomes. Among inpatients, perceived need for supplemental oxygen that is based on pulse oximetry has been associated with higher risk of prolonged hospitalization, ICU admission, and mechanical ventilation.[24,26,35] Among outpatients, available evidence differs on whether mild reductions in pulse oximetry (less than 95% on room air) predict progression of disease or need for a return visit for care.[27,32]

Radiography may be useful when the hospitalized child does not improve at the expected rate, if the severity of disease requires further evaluation, or if another diagnosis is suspected. Although many infants with bronchiolitis have abnormalities that show on chest radiographs, data are insufficient to demonstrate that chest radiograph abnormalities correlate well with disease severity.[16] Two studies suggest that the presence of consolidation and atelectasis on a chest radiograph is associated with increased risk for severe disease.[26,27] One study showed no correlation between chest radiograph findings and baseline severity of disease.[36] In prospective studies including 1 randomized trial, children with suspected LRTI who received radiographs were more likely to receive antibiotics without any difference in time to recovery.[37,38] Current evidence does not support routine radiography in children with bronchiolitis.

The clinical utility of diagnostic testing in infants with suspected bronchiolitis is not well supported by evidence.[39–41] The occurrence of serious bacterial infections (SBIs; e.g., urinary tract infections [UTIs], sepsis, meningitis) is very low.[42,43] The use of complete blood counts has not been shown to be useful in either diagnosing bronchiolitis or guiding its therapy.[1]

Virologic tests for RSV, if obtained during peak RSV season, demonstrate a high predictive value. However, the knowledge gained from such testing rarely alters management decisions or outcomes for the vast majority of children with clinically diagnosed bronchiolitis.[1] Virologic testing may be useful when cohorting of patients is feasible.

Evidence Profile 1a: Diagnosis

- Aggregate evidence quality: B; diagnostic studies with minor limitations and observational studies with consistent findings
- Benefit: cost saving, limitation of radiation and blood tests
- Harm: risk of misdiagnosis
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

Evidence Profile 1b: Risk Factors

- Aggregate evidence quality: B; observational studies with consistent findings

- Benefit: improved care of patients with risk factors for severe disease
- Harm: increased costs, increased radiation and blood testing
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

RECOMMENDATION 2a

Bronchodilators should not be used routinely in the management of bronchiolitis (recommendation: evidence level B; RCTs with limitations; preponderance of harm of use over benefit).

RECOMMENDATION 2b

A carefully monitored trial of α-adrenergic or ß-adrenergic medication is an option. Inhaled bronchodilators should be continued only if there is a documented positive clinical response to the trial using an objective means of evaluation (option: evidence level B; RCTs with limitations and expert opinion; balance of benefit and harm).

The use of bronchodilator agents continues to be controversial. RCTs have failed to demonstrate a consistent benefit from α-adrenergic or ß-adrenergic agents. Several studies and reviews have evaluated the use of bronchodilator medications for viral bronchiolitis. A Cochrane systematic review[44] found 8 RCTs involving 394 children.[33,45–50] Some of the studies included infants who had a history of previous wheezing. Several used agents other than albuterol/salbutamol or epinephrine/adrenaline (e.g., ipratropium and metaproterenol). Overall, results of the meta-analysis indicated that, at most, 1 in 4 children treated with bronchodilators might have a transient improvement in clinical score of unclear clinical significance. This needs to be weighed against the potential adverse effects and cost of these agents and the fact that most children treated with bronchodilators will not benefit from their use. Studies assessing the impact of bronchodilators on long-term outcomes have found no impact on the overall course of the illness.[1,44,51]

Albuterol/Salbutamol
Some outpatient studies have demonstrated modest improvement in oxygen saturation and/or clinical scores. Schweich et al[52] and Schuh et al[53] evaluated clinical scores and oxygen saturation after 2 treatments of nebulized albuterol. Each study showed improvement in the clinical score and oxygen saturation shortly after completion of the treatment. Neither measured outcomes over time. Klassen et al[47] evaluated clinical score and oxygen saturation 30 and 60 minutes after a single salbutamol treatment. Clinical score, but not oxygen saturation, was significantly improved at 30 minutes, but no difference was demonstrated 60 minutes after a treatment. Gadomski et al[54] showed no difference between those in groups on albuterol or placebo after 2 nebulized treatments given 30 minutes apart.

Studies of inpatients have not shown a clinical change that would justify recommending albuterol for routine care. Dobson et al[55] conducted a randomized clinical trial in infants who were hospitalized with

moderately severe viral bronchiolitis and failed to demonstrate clinical improvement resulting in enhanced recovery or an attenuation of the severity of illness. Two meta-analyses[1,56] could not directly compare inpatient studies of albuterol because of widely differing methodology. Overall, the studies reviewed did not show the use of albuterol in infants with bronchiolitis to be beneficial in shortening duration of illness or length of hospital stay.

Epinephrine/Adrenaline

The AHRQ evidence report[1] notes that the reviewed studies show that nebulized epinephrine has "some potential for being efficacious." In contrast, a later multicenter controlled trial by Wainwright et al[51] concluded that epinephrine did not impact the overall course of the illness as measured by hospital length of stay. Analysis of outpatient studies favors nebulized epinephrine over placebo in terms of clinical score, oxygen saturation, and respiratory rate at 60 minutes[57] and heart rate at 90 minutes.[58] However, the differences were small, and it could not be established that they are clinically significant in altering the course of the illness. One study[59] found significant improvement in airway resistance (but no change in oxygen need), suggesting that a trial of this agent may be reasonable for such infants.

Several studies have compared epinephrine to albuterol (salbutamol) or epinephrine to placebo. Racemic epinephrine has demonstrated slightly better clinical effect than albuterol. It is possible that the improvement is related to the α effect of the medication.[60] Hartling et al[61] performed a meta-analysis of studies comparing epinephrine to albuterol and also participated in the Cochrane review of epinephrine.[62] The Cochrane report concluded: "There is insufficient evidence to support the use of epinephrine for the treatment of bronchiolitis among inpatients. There is some evidence to suggest that epinephrine may be favorable to salbutamol (albuterol) and placebo among outpatients."

Although there is no evidence from RCTs to justify routine use of bronchodilators, clinical experience suggests that, in selected infants, there is an improvement in the clinical condition after bronchodilator administration.[47,52,53,57,58] It may be reasonable to administer a nebulized bronchodilator and evaluate clinical response. Individuals and institutions should assess the patient and document pretherapy and posttherapy changes using an objective means of evaluation. Some of the documentation tools that have been used can be found in articles by Alario et al,[45] Bierman and Pierson,[63] Gadomski et al,[54] Lowell et al,[33] Wainwright et al,[51] Schuh et al,[64] and Gorelick et al.[65] In addition, a documentation tool has been developed by Cincinnati Children's Hospital (Cincinnati, OH).[66]

Extrapolation from the studies discussed above suggests that epinephrine may be the preferred bronchodilator for this trial in the emergency department and in hospitalized patients. In the event that there is documented clinical improvement, there is justification for continuing the nebulized bronchodilator treatments. In the absence of a clinical response, the treatment should not be continued.

Because of a lack of studies, short duration of action, and potential adverse effects, epinephrine is usually not used in the home setting. Therefore, it would be more appropriate that a bronchodilator trial in the office or clinic setting use albuterol/salbutamol rather than racemic epinephrine. Parameters to measure its effectiveness include improvements in wheezing, respiratory rate, respiratory effort, and oxygen saturation.

Anticholinergic agents such as ipratropium have not been shown to alter the course of viral bronchiolitis. Although a minority of individual patients may show a positive clinical response to anticholinergic agents, studies have shown that the groups as a whole showed no significant improvement. At this point there is no justification for using anticholinergic agents, either alone or in combination with ß-adrenergic agents, for viral bronchiolitis.[67–69]

Evidence Profile 2a: Routine Use of Bronchodilators

- Aggregate evidence quality: B; RCTs with limitations
- Benefit: short-term improvement in clinical symptoms
- Harm: adverse effects, cost of medications, cost to administer
- Benefits-harms assessment: preponderance of harm over benefit
- Policy level: recommendation

Evidence Profile 2b: Trial of Bronchodilators

- Aggregate evidence quality: B; RCTs with limitations
- Benefit: some patients with significant symptomatic improvement
- Harm: adverse effects, cost of medications, cost to administer
- Benefits-harms assessment: preponderance of benefit over harm in select patients
- Policy level: option

RECOMMENDATION 3

Corticosteroid medications should not be used routinely in the management of bronchiolitis (recommendation: evidence level B; based on RCTs with limitations and a preponderance of risk over benefit).

Reports indicate that up to 60% of infants admitted to the hospital for bronchiolitis receive corticosteroid therapy.[9,12,70] Systematic review and meta-analyses of RCTs involving close to 1200 children with viral bronchiolitis have not shown sufficient evidence to support the use of steroids in this illness.[1,71,72]

A Cochrane database review on the use of glucocorticoids for acute bronchiolitis[71] included 13 studies.[37,50,64,73–82] The 1198 patients showed a pooled decrease in length of stay of 0.38 days. However, this decrease was not statistically significant. The review concluded: "No benefits were found in either LOS [length of stay] or clinical score in infants and young children treated with systemic glucocorticoids as compared with placebo. There were no differences in these outcomes between treatment groups; either in the pooled analysis or in any of the sub analyses. Among the three studies evaluating hospital admission rates following the initial hospital visit there was no difference between treatment groups. There were no differences found in respiratory rate, hemoglobin oxygen saturation, or hospital revisit or readmission rates. Subgroup analyses were significantly limited by the low number of studies in each comparison. Specific data on the harm of corticosteroid therapy in this patient population are lacking. Available evidence suggests that corticosteroid therapy is not of benefit in this patient group."[71]

The 2 available studies that evaluated inhaled corticosteroids in bronchiolitis[83,84] showed no benefit in the course of the acute disease. Because the safety of high-dose inhaled corticosteroids in infants is still not clear, their use should be avoided unless there is a clear likelihood of benefit.

There are insufficient data to make a recommendation regarding the use of leukotriene modifiers in bronchiolitis. Until additional randomized clinical trials are completed, no conclusions can be drawn.

Evidence Profile 3: Corticosteroids

- Aggregate evidence quality: B; randomized clinical trials with limitations
- Benefit: possibility that corticosteroid may be of some benefit
- Harm: exposure to unnecessary medication
- Benefits-harms assessment: preponderance of harm over benefit
- Policy level: recommendation

RECOMMENDATION 4

Ribavirin should not be used routinely in children with bronchiolitis (recommendation: evidence level B; RCTs with limitations and observational studies; preponderance of harm over benefit).

The indications for specific antiviral therapy for bronchiolitis are controversial. A recent review of 11 randomized clinical trials of ribavirin therapy for RSV LRTIs, including bronchiolitis, summarized the reported outcomes.[85] Nine of the studies measured the effect of ribavirin in the acute phase of illness.[86–94] Two evaluated the effect on long-term wheezing and/or pulmonary function.[95,96] Three additional studies were identified with similar results. Two of these evaluated effectiveness in the acute phase[97,98] and one on subsequent respiratory status.[99]

Each of the 11 studies that addressed the acute treatment effects of ribavirin included a small sample size ranging from 26 to 53 patients and cumulatively totaling 375 subjects. Study designs and outcomes measured were varied and inconsistent. Seven of the trials demonstrated some improvement in outcome attributed to ribavirin therapy, and 4 did not. Of those showing benefit, 4 documented improved objective outcomes (e.g., better oxygenation, shorter length of stay), and 3 reported improvement in subjective findings such as respiratory scores or subjective clinical assessment. The quality of the studies was highly variable.

Of the studies that focused on long-term pulmonary function, one was an RCT assessing the number of subsequent wheezing episodes and LRTIs over a 1-year period.[96] Two others were follow-up studies of previous randomized trials and measured subsequent pulmonary function as well as wheezing episodes.[95,99] The first study[96] found fewer episodes of wheezing and infections in the ribavirin-treated patients, and the latter 2 studies[95,99] found no significant differences between groups. No randomized studies of other antiviral therapies of bronchiolitis were identified.

Specific antiviral therapy for RSV bronchiolitis remains controversial because of the marginal benefit, if any, for most patients. In addition, cumbersome delivery requirements,[100] potential health risks for caregivers,[101] and high cost[102] serve as disincentives for use in the majority of patients. Nevertheless, ribavirin may be considered for use in highly selected situations involving documented RSV

bronchiolitis with severe disease or in those who are at risk for severe disease (e.g., immunocompromised and/or hemodynamically significant cardiopulmonary disease).

Evidence Profile 4: Ribavirin

- Aggregate evidence quality: B; RCTs with limitations and observational studies
- Benefit: some improvement in outcome
- Harm: cost, delivery method, potential health risks to caregivers
- Benefits-harms assessment: preponderance of harm over benefit
- Policy level: recommendation

RECOMMENDATION 5

Antibacterial medications should be used only in children with bronchiolitis who have specific indications of the coexistence of a bacterial infection. When present, bacterial infection should be treated in the same manner as in the absence of bronchiolitis (recommendation: evidence level B; RCTs and observational studies; preponderance of benefit over harm).

Children with bronchiolitis frequently receive antibacterial therapy because of fever,[103] young age,[104] or the concern over secondary bacterial infection.[105] Early RCTs[106,107] showed no benefit from antibacterial treatment of bronchiolitis. However, concern remains regarding the possibility of bacterial infections in young infants with bronchiolitis; thus, antibacterial agents continue to be used.

Several retrospective studies[41,108–113] identified low rates of SBI (0%–3.7%) in patients with bronchiolitis and/or infections with RSV. When SBI was present, it was more likely to be a UTI than bacteremia or meningitis. In a study of 2396 infants with RSV bronchiolitis, 69% of the 39 patients with SBI had a UTI.[110]

Three prospective studies of SBI in patients with bronchiolitis and/or RSV infections also demonstrated low rates of SBI (1%–12%).[42,43,114] One large study of febrile infants less than 60 days of age[43] with bronchiolitis and/or RSV infections demonstrated that the overall risk of SBI in infants less than 28 days of age, although significant, was not different between RSV-positive and RSV-negative groups (10.1% and 14.2%, respectively). All SBIs in children between 29 and 60 days of age with RSV-positive bronchiolitis were UTIs. The rate of UTIs in RSV-positive patients between 28 and 60 days old was significantly lower than those who were RSV-negative (5.5% vs. 11.7%).

Approximately 25% of hospitalized infants with bronchiolitis will have radiographic evidence of atelectasis or infiltrates, often misinterpreted as possible bacterial infection.[115] Bacterial pneumonia in infants with bronchiolitis without consolidation is unusual.[116]

Although acute otitis media (AOM) in bronchiolitic infants may be caused by RSV alone, there are no clinical features that permit viral AOM to be differentiated from bacterial. Two studies address the frequency of AOM in patients with bronchiolitis. Andrade et al[117] prospectively identified AOM in 62% of 42 patients who presented with bronchiolitis. AOM was present in 50% on entry to the study and developed in an additional 12% within 10 days. Bacterial pathogens were isolated from 94% of

middle-ear aspirates, with *Streptococcus pneumoniae*, *Haemophilus influenzae*, and *Moraxella catarrhalis* being the most frequent isolates. A subsequent report[118] followed 150 children hospitalized for bronchiolitis for the development of AOM. Seventy-nine (53%) developed AOM, two thirds within the first 2 days of hospitalization. Tympanocentesis was performed on 64 children with AOM, and 33 middle-ear aspirates yielded pathogens. *H influenzae*, *S pneumoniae*, and *M catarrhalis* were the ones most commonly found. AOM did not influence the clinical course or laboratory findings of bronchiolitis. When found, AOM should be managed according to the AAP/AAFP guidelines for diagnosis and management of AOM.[119]

Evidence Profile 5: Antibacterial Therapy

- Aggregate evidence quality: B; RCTs and observational studies with consistent results
- Benefit: appropriate treatment of bacterial infections, decreased exposure to unnecessary medications and their adverse effects when a bacterial infection is not present, decreased risk of development of resistant bacteria
- Harm: potential to not treat patient with bacterial infection
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

RECOMMENDATION 6a

Clinicians should assess hydration and ability to take fluids orally (strong recommendation: evidence level X; validating studies cannot be performed; clear preponderance of benefit over harm).

RECOMMENDATION 6b

Chest physiotherapy should not be used routinely in the management of bronchiolitis (recommendation: evidence level B; RCTs with limitations; preponderance of harm over benefit).

The level of respiratory distress caused by bronchiolitis guides the indications for use of other treatments.

Intravenous Fluids

Infants with mild respiratory distress may require only observation, particularly if feeding remains unaffected. When the respiratory rate exceeds 60 to 70 breaths per minute, feeding may be compromised, particularly if nasal secretions are copious. Infants with respiratory difficulty may develop nasal flaring, increased intercostal or sternal retractions, and prolonged expiratory wheezing and be at increased risk of aspiration of food into the lungs.[120] Children who have difficulty feeding safely because of respiratory distress should be given intravenous fluids. The possibility of fluid retention related to production of antidiuretic hormone has been reported in patients with bronchiolitis.[121,122] Clinicians should adjust fluid management accordingly.

Airway Clearance
Bronchiolitis is associated with airway edema and sloughing of the respiratory epithelium into airways, which results in generalized hyperinflation of the lungs. Lobar atelectasis is not characteristic of this disease, although it can be seen on occasion. A Cochrane review[123] found 3 RCTs that evaluated chest physiotherapy in hospitalized patients with bronchiolitis.[124–126] No clinical benefit was found using vibration and percussion techniques. Suctioning of the nares may provide temporary relief of nasal congestion. There is no evidence to support routine "deep" suctioning of the lower pharynx or larynx.

Evidence Profile 6a: Fluids

- Aggregate evidence quality: evidence level X; validating studies cannot be performed
- Benefit: prevention of dehydration
- Harm: overhydration, especially if syndrome of inappropriate secretion of antidiuretic hormone (SIADH) is present
- Benefits-harms assessment: clear preponderance of benefit over harm
- Policy level: strong recommendation

Evidence Profile 6b: Chest Physiotherapy

- Aggregate evidence quality: B; RCTs with limitations
- Benefit: clearance of secretions, prevention of atelectasis
- Harm: stress to infant during procedure, cost of administering chest physiotherapy
- Benefits-harms assessment: preponderance of harm over benefit
- Policy level: recommendation

RECOMMENDATION 7a

Supplemental oxygen is indicated if oxyhemoglobin saturation (Spo_2) falls persistently below 90% in previously healthy infants. If the Spo_2 does persistently fall below 90%, adequate supplemental oxygen should be used to maintain Spo_2 at or above 90%. Oxygen may be discontinued if Spo_2 is at or above 90% and the infant is feeding well and has minimal respiratory distress (option: evidence level D; expert opinion and reasoning from first principles; some benefit over harm).

RECOMMENDATION 7b

As the child's clinical course improves, continuous measurement of Spo_2 is not routinely needed (option: evidence level D; expert opinion; balance of benefit and harm).

RECOMMENDATION 7c

Infants with a known history of hemodynamically significant heart or lung disease and premature infants require close monitoring as the oxygen is being weaned (strong recommendation: evidence level B; observational studies with consistent findings; preponderance of benefit over harm).

Healthy infants have an Spo_2 greater than 95% on room air, although transient decreases to an Spo_2 of less than 89% occur.[127,128] In bronchiolitis, airway edema and sloughing of respiratory epithelial cells cause mismatching of ventilation and perfusion and subsequent reductions in oxygenation (Pao_2 and Spo_2).

In the clinical setting, pulse oximeters are convenient, safe tools to measure oxygenation status. Clinicians ordering pulse oximetry should understand that the shape of the oxyhemoglobin dissociation curve dictates that when Spo_2 is above 90%, large increases in Pao_2 are associated with small increases in Spo_2. In contrast, when Spo_2 is below 90%, a small decrease in Pao_2 is associated with large decreases in Spo_2 (Fig 2). This raises the question of whether there is a single value for Spo_2 that can serve as a decision point to hospitalize or initiate supplemental oxygen in infants with bronchiolitis.

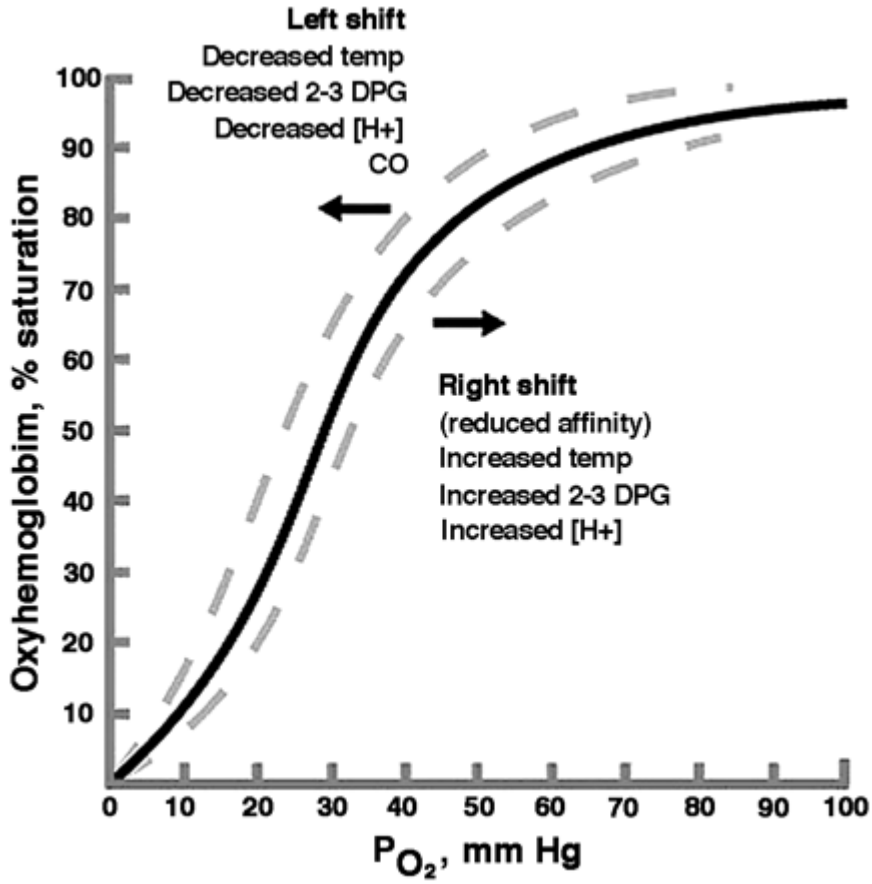

FIGURE 2 Oxyhemoglobin dissociation curve showing percent saturation of hemoglobin at various partial pressures of oxygen. Note that the position of the curve and the affinity of hemoglobin for

oxygen changes with changing physiologic conditions. (Reproduced with permission from the educational website www.anaesthesiauk.com.)

In studies that examined treatment for bronchiolitis in hospitalized infants, some investigators started supplemental oxygen when SpO_2 fell below 90%, and others started oxygen before the SpO_2 reached 90%.[98,129]

Although data are lacking to codify a single value of Spo_2 to be used as a cutoff point for initiating or discontinuing supplemental oxygen, these studies and the relationship between Pao_2 and Spo_2 support the position that otherwise healthy infants with bronchiolitis who have Spo_2 at or above 90% at sea level while breathing room air likely gain little benefit from increasing Pao_2 with supplemental oxygen, particularly in the absence of respiratory distress and feeding difficulties. Because several factors including fever, acidosis, and some hemoglobinopathies shift the oxyhemoglobin dissociation curve so that large decreases in Pao_2 begin to occur at an Spo_2 of more than 90%, clinicians should consider maintaining a higher Spo_2 in children with these risk factors.[130,131]

Although widely used pulse oximeters have some shortcomings, under normal circumstances the accuracy of Spo_2 may vary slightly (most oximeters are accurate to ±2%). More importantly, poorly placed probes and motion artifact will lead to inaccurate measurements and false readings and alarms.[132] Before instituting O_2 therapy, the accuracy of the initial reading should be verified by repositioning the probe and repeating the measurement. The infant's nose and, if necessary, oral airway should be suctioned. If Spo_2 remains below 90%, O_2 should be administered. The infant's clinical work of breathing should also be assessed and may be considered as a factor in a decision to use oxygen supplementation.

Premature or low birth weight infants and infants with bronchopulmonary dysplasia or hemodynamically significant congenital heart disease merit special attention because they are at risk to develop severe illness that requires hospitalization, often in the ICU.[7,29,133–135] These infants often have abnormal baseline oxygenation coupled with an inability to cope with the pulmonary inflammation seen in bronchiolitis. This can result in more severe and prolonged hypoxia compared with normal infants, and clinicians should take this into account when developing strategies for using and weaning supplemental oxygen.

Evidence Profile 7a: Supplemental Oxygen

- Aggregate evidence quality: D; expert opinion and reasoning from first principles
- Benefit: use of supplemental oxygen only when beneficial, shorter hospitalization
- Harm: inadequate oxygenation
- Benefits-harms assessment: some benefit over harm
- Policy level: option

Evidence Profile 7b: Measurement of SpO_2

- Aggregate evidence quality: D; expert opinion

- Benefit: shorter hospitalization
- Harm: inadequate oxygenation between measurements
- Benefits-harms assessment: some benefit over harm
- Policy level: option

Evidence Profile 7c: High-Risk Infants

- Aggregate evidence quality: B; observational studies with consistent findings
- Benefit: improved care of high-risk infants
- Harm: longer hospitalization, use of oxygen when not beneficial
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: Strong recommendation

RECOMMENDATION 8a

Clinicians may administer palivizumab prophylaxis to selected infants and children with CLD or a history of prematurity (less than 35 weeks' gestation) or with congenital heart disease (recommendation: evidence level A; RCT; preponderance of benefit over harm).

RECOMMENDATION 8b

When given, prophylaxis with palivizumab should be given in 5 monthly doses, usually beginning in November or December, at a dose of 15 mg/kg per dose administered intramuscularly (recommendation: evidence level C; observational studies and expert opinion; preponderance of benefit over cost).

The 2006 Report of the Committee on Infectious Disease (*Red Book*) included the following recommendations for the use of palivizumab[136]:

- Palivizumab prophylaxis should be considered for infants and children younger than 24 months of age with chronic lung disease of prematurity who have required medical therapy (supplemental oxygen, bronchodilator or diuretic or corticosteroid therapy) for CLD within 6 months before the start of the RSV season. Patients with more severe CLD who continue to require medical therapy may benefit from prophylaxis during a second RSV season. Data are limited regarding the effectiveness of palivizumab during the second year of life. Individual patients may benefit from decisions made in consultation with neonatologists, pediatric intensivists, pulmonologists, or infectious disease specialists.

- Infants born at 32 weeks of gestation or earlier may benefit from RSV prophylaxis, even if they do not have CLD. For these infants, major risk factors to consider include their gestational age and chronologic age at the start of the RSV season. Infants born at 28 weeks of gestation or earlier may benefit from prophylaxis during their first RSV season, whenever that occurs during the first 12 months of life. Infants born at 29 to 32 weeks of gestation may benefit most from prophylaxis up to 6 months of age. For the purpose of this recommendation, 32 weeks' gestation refers to an infant born on or before the 32nd week of gestation (i.e., 32 weeks, 0 days). Once a child qualifies for initiation of prophylaxis at the start of the RSV season, administration should continue throughout the season and not stop at the point an infant reaches either 6 months or 12 months of age.

- Although palivizumab has been shown to decrease the likelihood of hospitalization in infants born between 32 and 35 weeks of gestation (i.e., between 32 weeks, 1 day and 35 weeks, 0 days), the cost of administering prophylaxis to this large group of infants must be considered carefully. Therefore, most experts recommend that prophylaxis should be reserved for infants in this group who are at greatest risk of severe infection and who are younger than 6 months of age at the start of the RSV season. Epidemiologic data suggest that RSV infection is more likely to lead to hospitalization for these infants when the following risk factor are present: child care attendance, school-aged siblings, exposure to environmental air pollutants, congenital abnormalities of the airways, or severe neuromuscular disease. However, no single risk factor causes a very large increase in the rate of hospitalization, and the risk is additive as the number of risk factors for an individual infant increases. Therefore, prophylaxis should be considered for infants between 32 and 35 weeks of gestation only if 2 or more of these risk factors are present. Passive household exposure to tobacco smoke has not been associated with an increased risk of RSV hospitalization on a consistent basis. Furthermore, exposure to tobacco smoke is a risk factor that can be controlled by the family of an infant at increased risk of severe RSV disease, and preventive measures will be far less costly than palivizumab prophylaxis. High-risk infants never should be exposed to tobacco smoke. In contrast to the well-documented beneficial effect of breastfeeding against many viral illnesses, existing data are conflicting regarding the specific protective effect of breastfeeding against RSV infection. High-risk infants should be kept away from crowds and from situations in which exposure to infected individuals cannot be controlled. Participation in group child care should be restricted during the RSV season for high-risk infants whenever feasible. Parents should be instructed on the importance of careful hand hygiene. In addition, all high-risk infants and their contacts should be immunized against influenza beginning at 6 months of age.

- In the Northern hemisphere and particularly within the United States, RSV circulates predominantly between November and March. The inevitability of the RSV season is predictable, but the severity of the season, the time of onset, the peak of activity, and the end of the season cannot be predicted precisely. There can be substantial variation in timing of community outbreaks of RSV disease from year to year in the same community and between communities in the same year, even in the same region. These variations, however, occur within the overall pattern of RSV outbreaks, usually beginning in November or December, peaking in January or February, and ending by the end of March or sometime in April. Communities in the southern United States tend to experience the earliest onset of RSV activity, and Midwestern states tend to experience the latest. The duration of the season for western and northeast regions typically occurs between that noted in the South and the Midwest. In recent years, the national median duration of the RSV season has been 15 weeks and even in the South, with a seasonal duration of 16 weeks, the range is 13 to 20 weeks.

Results from clinical trials indicate that palivizumab trough serum concentrations >30 days after the fifth dose will be well above the protective concentration for most infants. If the first dose is administered in November, 5 monthly doses of palivizumab will provide substantially more than 20 weeks of protective serum antibody concentrations for most of the RSV season, even with variation in season onset and end. Changes from this recommendation of 5 monthly doses require careful consideration of the benefits and costs.

- Children who are 24 months of age or younger with hemodynamically significant cyanotic and acyanotic congenital heart disease will benefit from palivizumab prophylaxis. Decisions regarding prophylaxis with palivizumab in children with congenital heart disease should be made on the basis of the degree of physiologic cardiovascular compromise. Children younger than 24 months of age with congenital heart disease who are most likely to benefit from immunoprophylaxis include: • Infants who are receiving medication to control congestive heart failure• Infants with moderate to severe pulmonary hypertension• Infants with cyanotic heart disease

Results from 2 blinded, randomized, placebo-controlled trials with palivizumab involving 2789 infants and children with prematurity, CLD, or congenital heart disease demonstrated a reduction in RSV hospitalization rates of 39% to 78% in different groups.[137,138] Results from postlicensure observational studies suggest that monthly immunoprophylaxis may reduce hospitalization rates to an even greater extent than that described in the prelicensure clinical trials.[139] Palivizumab is not effective in the treatment of RSV disease and is not approved for this indication.

Several economic analyses of RSV immunoprophylaxis have been published.[140–147] The primary benefit of immunoprophylaxis with palivizumab is a decrease in the rate of RSV-associated hospitalization. None of the 5 clinical RCTs have demonstrated a significant decrease in rate of mortality attributable to RSV infection in infants who receive prophylaxis. Most of the economic analyses fail to demonstrate overall savings in health care dollars because of the high cost if all at-risk children were to receive prophylaxis. Estimates of cost per hospitalization prevented have been inconsistent because of considerable variation in the baseline rate of hospitalization attributable to RSV in different high-risk groups. Other considerations that will influence results include the effect of prophylaxis on outpatient costs and a resolution of the question of whether prevention of RSV infection in infancy decreases wheezing and lower respiratory tract problems later in childhood.

Evidence Profile 8a: Palivizumab Prophylaxis

- Aggregate evidence quality: A; RCTs
- Benefit: prevention of morbidity and mortality in high-risk infants
- Harm: cost
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

Evidence Profile 8b: Five-Dose Regimen

- Aggregate evidence quality: C; observational studies and expert opinion
- Benefit: decreased cost resulting from using minimal number of needed doses

- Harm: risk of illness from RSV outside the usual season
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

RECOMMENDATION 9a

Hand decontamination is the most important step in preventing nosocomial spread of RSV. Hands should be decontaminated before and after direct contact with patients, after contact with inanimate objects in the direct vicinity of the patient, and after removing gloves (strong recommendation: evidence level B; observational studies with consistent results; strong preponderance of benefit over harm).

RECOMMENDATION 9b

Alcohol-based rubs are preferred for hand decontamination. An alternative is hand-washing with antimicrobial soap (recommendation: evidence level B; observational studies with consistent results; preponderance of benefit over harm).

RECOMMENDATION 9c

Clinicians should educate personnel and family members on hand sanitation (recommendation: evidence level C; observational studies; preponderance of benefit over harm).

Efforts should be made to decrease the spread of RSV and other causative agents of bronchiolitis in medical settings, especially in the hospital. RSV RNA has been identified in air samples as much as 22 feet from the patient's bedside.[148] Secretions from infected patients can be found on beds, crib railings, tabletops, and toys. Organisms on fomites may remain viable and contagious for several hours.[149]

It has been shown that RSV as well as many other viruses can be carried and spread to others on the hands of caregivers.[150] Frequent hand-washing by health care workers has been shown to reduce RSV's nosocomial spread.[150] The Centers for Disease Control and Prevention published an extensive review of the hand-hygiene literature and made recommendations as to indications for hand-washing and hand antisepsis.[151] Among the recommendations are that hands should be decontaminated before and after direct contact with patients, after contact with inanimate objects in the direct vicinity of the patient, and after removing gloves. If hands are not visibly soiled, an alcohol-based rub is preferred. An alternative is to wash hands with an antimicrobial soap. The guideline also describes the appropriate technique for using these products.

Other methods that have been shown to be effective in controlling the spread of RSV are education of personnel and family members; surveillance for the onset of RSV season; use of gloves, with frequent changes to avoid the spread of organisms on the gloves; and wearing gowns for direct contact with the patient. It has not been clearly shown that wearing masks offers additional benefit to the above-listed measures.[149] Isolation and/or cohorting of RSV-positive patients, including assignment of personnel to care only for these patients, is effective[152,153] but may not be feasible. Strict hand decontamination and education of staff and families about prevention of spread of organisms is essential regardless of whether isolation is used.

Programs that implement the above-mentioned principles have been shown to decrease the nosocomial spread of RSV. Johns Hopkins Hospital (Baltimore, MD) instituted a program of pediatric droplet precaution for all children less than 2 years old with respiratory symptoms during RSV season until the child is shown to not have RSV. Nosocomial transmission of RSV decreased by approximately 50%. Before intervention, a patient was 2.6 times more likely to have nosocomially transmitted RSV than after the intervention.[154] A similar program at Children's Hospital of Philadelphia (Philadelphia, PA) resulted in a decrease of nosocomial RSV infections of 39%.[155]

Evidence Profile 9a: Hand Decontamination

- Aggregate evidence quality: B; observational studies with consistent findings
- Benefit: decreased spread of infection
- Harm: time
- Benefits-harms assessment: strong preponderance of benefit over harm
- Policy level: strong recommendation

Evidence Profile 9b: Alcohol-Based Rubs

- Aggregate evidence quality: B; observational studies with consistent findings
- Benefit: decreased spread of infection
- Harm: irritative effect of alcohol-based rubs
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

Evidence Profile 9c: Education

- Aggregate evidence quality: C; observational studies
- Benefit: decreased spread of infection
- Harm: time, cost of gloves and gowns if used, barriers to parental contact with patient
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

RECOMMENDATION 10a

Infants should not be exposed to passive smoking (strong recommendation: evidence level B; observational studies with consistent results; strong preponderance of benefit over harm).

RECOMMENDATION 10b

Breastfeeding is recommended to decrease a child's risk of having lower respiratory tract disease (LRTD) (recommendation: evidence level C; observational studies; preponderance of benefit over harm).

Tobacco Smoke
Passive smoking increases the risk of having an RSV infection with a reported odds ratio of 3.87.[156] There have been numerous studies on the effect of passive smoking on respiratory illness in infants and children. In a systematic review of passive smoking and lower respiratory illness in infants and children, Strachan and Cook[157] showed a pooled odds ratio of 1.57 if either parent smoked and an odds ratio of 1.72 if the mother smoked. Stocks and Dezateux[158] reviewed 20 studies of pulmonary function in infants. These studies showed a significant decrease in pulmonary function in infants of mothers who smoked during and after pregnancy. Forced expiratory flow was decreased by approximately 20%. Other measures of pulmonary function were likewise abnormal.

Paternal smoking also has an effect. The prevalence of upper respiratory tract illness increased from 81.6% to 95.2% in infants under 1 year of age in households where only the father smoked.[159]

Breastfeeding
Breast milk has been shown to have immune factors to RSV including immunoglobulin G and A antibodies[160] and interferon-.[161] Breast milk has also been shown to have neutralizing activity against RSV.[162] In one study the relative risk of hospital admission with RSV was 2.2 in children who were not being breastfed.[163] In another study, 8 (7%) of 115 children hospitalized with RSV were breastfed, and 46 (27%) of 167 controls were breastfed.[164]

A meta-analysis of the relationship of breastfeeding and hospitalization for LRTD in early infancy[165] examined 33 studies, all of which showed a protective association between breastfeeding and the risk of hospitalization for LRTD. Nine studies met all inclusion criteria for analysis. The conclusion was that infants who were not breastfed had almost a threefold greater risk of being hospitalized for LRTD than those exclusively breastfed for 4 months (risk ratio: 0.28).

Evidence Profile 10a: Secondhand Smoke

- Aggregate evidence quality: B; observational studies with consistent findings
- Benefit: decreased risk of LRTI
- Harm: none
- Benefits-harms assessment: strong preponderance of benefit over harm

- Policy level: strong recommendation

Evidence Profile 10b: Breastfeeding

- Aggregate evidence quality: C; observational studies
- Benefit: improved immunity, decreased risk of LRTI, improved nutrition
- Harm: implied inadequacy of mothers who cannot or prefer to not breastfeed
- Benefits-harms assessment: preponderance of benefit over harm
- Policy level: recommendation

RECOMMENDATION 11

Clinicians should inquire about use of CAM (option: evidence level D; expert opinion; some benefit over harm).

No recommendations for CAM for treatment of bronchiolitis are made because of limited data. Clinicians now recognize that an increasing number of parents/caregivers are using various forms of nonconventional treatment for their children. Treatments that have been used specifically for bronchiolitis include homeopathy, herbal remedies, osteopathic manipulation, and applied kinesiology. Substantially more data are available regarding the use of homeopathic and herbal remedies for the treatment of bronchitis and the common cold. Whether these therapies would prevent the development of bronchiolitis is unknown. A single recent trial indicated that an herbal preparation containing *Echinacea*, propolis, and vitamin C prevented the development of upper respiratory infections in children between the ages of 1 and 5 years.[166] Bronchiolitis was not specifically studied.

To date, there are no studies that conclusively show a beneficial effect of alternative therapies used for the treatment of bronchiolitis. Recent interest in the use of CAM has led to research efforts to investigate its efficacy. It is difficult to design and conduct studies on certain forms of CAM because of the unique nature of the treatment. Any study conducted will need to show proof of effectiveness of a specific therapy when compared with the natural history of the disease. Conclusions regarding CAM cannot be made until research evidence is available. However, because of the widespread use of CAM, clinicians should ask parents what alternative forms of treatment they are using and be ready to discuss potential benefits or risks.

Evidence Profile 11: Asking About CAM

- Aggregate evidence quality: D; expert opinion
- Benefit: improved parent-physician communication, awareness of other, possibly harmful treatments being used
- Harm: time required for discussion, lack of knowledge about CAM by many pediatricians
- Benefits-harms assessment: some benefit over harm
- Policy level: option

FUTURE RESEARCH

The AHRQ evidence report[1] points out that outcomes measured in future studies of bronchiolitis should be clinically relevant and of interest to parents, clinicians, and health systems. Among the recommended outcomes are rates of hospitalization, need for more intensive services in the hospital, costs of care, and parental satisfaction with treatment.[1] One of the difficulties with the bronchiolitis literature is the absence of validated clinical scoring scales that are objective, replicable, and can be easily be performed in the hospital, emergency department, and outpatient settings. Studies should also be of sufficient size to be able to draw meaningful conclusions for the above-mentioned outcomes. Because bronchiolitis is a self-limited disease, large numbers of patients would need to be enrolled to observe small changes in outcome. This would necessitate large multicenter study protocols. Currently, such multicentered studies are being conducted in the United States and Canada on the use of corticosteroids in the emergency department.

Future research should include:

- development of rapid, cost-effective tests for viruses other than RSV that may also play a role in bronchiolitis;
- studies to determine if there are selected patients who may benefit from bronchodilators or corticosteroids;
- clinical studies of the target SpO_2 for the most efficient use of oxygen and oxygen monitoring;
- development of new therapies including new antiviral medications;
- continued research into the development of an RSV vaccine; and
- continued development of immunoprophylaxis that would require fewer doses and decreased cost.

SUMMARY

This clinical practice guideline provides evidence-based recommendations on the diagnosis and management of bronchiolitis in infants less than 2 years of age. It emphasizes using only diagnostic and management modalities that have been shown to affect clinical outcomes.

Bronchiolitis is a clinical diagnosis that does not require diagnostic testing. Many of the commonly used management modalities have not been shown to be effective in improving the clinical course of the illness. This includes the routine use of bronchodilators, corticosteroids, ribavirin, antibiotics, chest radiography, chest physiotherapy, and complementary and alternative therapies. Options for the appropriate use of oxygen and oxygen monitoring have been presented. Specific prevention with palivizumab and general prevention, particularly the use of hand decontamination to prevent nosocomial spread, were also discussed.

CONCLUSIONS

1.

   a. Clinicians should diagnose bronchiolitis and assess disease severity on the basis of history and physical examination. Clinicians should not routinely order laboratory and radiologic studies for diagnosis (recommendation).

   b. Clinicians should assess risk factors for severe disease such as age less than 12 weeks, a history of prematurity, underlying cardiopulmonary disease, or immunodeficiency when making decisions about evaluation and management of children with bronchiolitis (recommendation).

2.

   a. Bronchodilators should not be used routinely in the management of bronchiolitis (recommendation).

   b. A carefully monitored trial of α-adrenergic or ß-adrenergic medication is an option. Inhaled bronchodilators should be continued only if there is a documented positive clinical response to the trial using an objective means of evaluation (option).

3. Corticosteroid medications should not be used routinely in the management of bronchiolitis (recommendation).

4. Ribavirin should not be used routinely in children with bronchiolitis (recommendation).

5. Antibacterial medications should only be used in children with bronchiolitis who have specific indications of the coexistence of a bacterial infection. When present, bacterial infection should be treated in the same manner as in the absence of bronchiolitis (recommendation).

6.

   a. Clinicians should assess hydration and ability to take fluids orally (strong recommendation).

   b. Chest physiotherapy should not be used routinely in the management of bronchiolitis (recommendation).

7.

   a. Supplemental oxygen is indicated if SpO_2 falls persistently below 90% in previously healthy infants. If the SpO_2 does persistently fall below 90%, adequate supplemental oxygen should be used to maintain an SpO_2 at or above 90%. Oxygen may be

discontinued if SpO_2 is at or above 90% and the infant is feeding well and has minimal respiratory distress (option).

b. As the child's clinical course improves, continuous measurement of SpO_2 is not routinely needed (option).

c. Infants with a known history of hemodynamically significant heart or lung disease and premature infants require close monitoring as oxygen is being weaned (strong recommendation).

8.

a. Clinicians may administer palivizumab prophylaxis for selected infants and children with CLD or a history of prematurity (less than 35 weeks' gestation) or with congenital heart disease (recommendation).

b. When given, prophylaxis with palivizumab should be given in 5 monthly doses, usually beginning in November or December, at a dose of 15 mg/kg per dose administered intramuscularly (recommendation).

9.

a. Hand decontamination is the most important step in preventing nosocomial spread of RSV. Hands should be decontaminated before and after direct contact with patients, after contact with inanimate objects in the direct vicinity of the patient, and after removing gloves (strong recommendation).

b. Alcohol-based rubs are preferred for hand decontamination. An alternative is hand-washing with antimicrobial soap (recommendation).

c. Clinicians should educate personnel and family members on hand sanitation (recommendation).

10.

a. Infants should not be exposed to passive smoking (strong recommendation).

b. Breastfeeding is recommended to decrease a child's risk of having LRTD (recommendation).

Clinicians should inquire about use of CAM (option).

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Glossary of Respiratory Terms

Accolate
: Trade name for zafirlukast, an anti-leukotriene drug. Accolate was the first such drug introduced in the United States.

Accuhaler
: Dry powder inhaler for use with Serevent. It consists of a foil strip of blisters, each containing a single dose. Activating the inhaler's lever punctures the blister, allowing the drug to be inhaled through the mouthpiece. Available in the UK.

Adrenergic Drugs
: The term adrenergic refers to the adrenaline-like action of a class of drugs that mimic natural stimulation of the sympathetic nervous system. The most common adrenergic drug used to treat asthma is albuterol, a bronchodilator.

AeroBid and AeroBid-M
: Trade name for flunisolide, an inhaled cortocosteroid. The two are the exact same drug; Aerobid-M has mint flavoring added, as the high steroid concentration in this preparation causes a strong bitter taste.

Aerochamber/Aerochamber with Mask
: Spacing device for use with a Metered Dose Inhaler (MDI). Consists of a short tube with a mouthpiece (or mask) on one end and a flexible opening for the MDI on the opposite end. The inhalant is propelled into the tube and held until the patient inhales slowly. Beneficial for young children unable to master the timing required for effective use of an MDI expelled directly into the mouth. Additional benefit is that many particles that would otherwise deposit in the patient's mouth and throat are left in the chamber, which can help reduce incidence of thrush. It can also help lessen the bitter taste of some of the stronger inhaled steroids.

Airway Remodeling
: This serious condition occurs when asthma is left uncontrolled or untreated. The airways actually 'learn' that being in an asthma attack is their normal state, leading to possible chronic lung disease (COPD included) and a lifetime of asthma. It also makes it even more difficult for relief and controller medications to work effectively, requiring increased dosing. For more on this syndrome, see Medscape and ACAAI. It is vitally important to treat and manage asthma as early and effectively as possible to avoid this syndrome.

Albuterol
: Generic name for the most popular short-term bronchodilator prescribed for asthmatics. It works to loosen the thread-like muscles that tighten around and constrict airways during an

asthma flare. Also prevents and reverses airway narrowing. It is generally prescribed to be used as needed, since it has little preventive effect except perhaps on exercise-induced asthma.

Common trade names include Proventil and Ventolin. It can be inhaled via MDI or nebulized solution. Timed-release albuterol is prescribed for short-term use and is available as oral syrup and tablets. Side effects may include dry mouth, irritated throat, dizziness, headache, lightheadedness, heartburn, loss of appetite, altered taste sensation. restlessness, anxiety, nervousness, trembling, heart palpitations and sweating but should subside as the body adjusts to the medication.

Alupent

Trade name for metaproterenol. Available in inhaler (MDI) form only, it is a bronchodilator.

Anti-Cholinergic Drugs

These agents suppress some of the effects of acetylcholine, a short-acting neurotransmitter that stimulates the autonomic nervous system. Atrovent (ipatropium bromide) is an anticholinergic sometimes used in asthma patients to alleviate bronchospams but it's more commonly prescribed for COPD and chronic bronchitis. More on anti-cholinergics.

Amoxicillin

Penicillin-based antibiotic commonly prescribed for children, particularly when an asthmatic is experiencing mucus buildup in the lungs. Pooled mucus in the airways is a prime breeding ground for bacterial pneumonia. A non-asthmatic who is allergic to penicillin and is treated with a penicillin-based antibiotic can develop respiratory sensitization and asthma symptoms[1]. Hence, if your child is allergic to penicillin, make sure your primary care providers are aware of this.

Anti-Leukotrienes

A recently developed class of non-steroidal asthma drugs which can prevent or reduce inflammation of the airways. Anti-leukotrienes fall into one of two categories: inhibitors or antagonists (blockers.) Leukotriene inhibitors (Accolate) prevent leukotriene creation, while antagonists (Singulair) block the leukotriene receptors that mediate airway hyperreaction, mucus production and bronchoconstriction. By either preventing or getting in the way of the inflammatory reaction, anti-leukotrienes may reduce or eliminate the need for corticosteroids. They are taken orally, usually once or twice daily. More on anti-leukotrienes.

Asthma Management Program

An essential outline which includes monitoring breathing efficiency, attention to environmental factors that contribute to broncho-constriction (irritants, allergens, exercise, cold air inhalation,

and infection,) and drug therapy. Usually designed as a step-like model, so that therapy escalates as the asthma severity does.

Atrovent
: Trade name for ipratropium bromide, it is an inhaled bronchodilator, available in both nebulizer solution and MDI form. Not yet FDA-approved for use in children under age 6, Atrovent by nebulizer is nevertheless becoming commonly used for children in the ER, alternating with albuterol nebs.

Autohaler
: MDI made by 3M which is activated by one's breath and doesn't need the breath-hand coordination that an aerosol MDI does. Available in U.S., UK, and NZ.

Autonomic Nervous System
: Known as the involuntary nervous system, it reacts to transmitted signals from the brain to control the heart, smooth muscle tissue and glands. Involuntary body functions such as heart rate, blood pressure, bowel and bladder function are affected. Many asthma drugs do their thing on this system.

Azmacort
: Inhaled (MDI) corticosteroid; trade name for triamcinolone.

B

Beclomethasone
: Inhaled (MDI) anti-inflammatory corticosteroid. It works topically on the lung surface to help prevent inflammation and hypersensitivity in the airways. It does little to relieve inflammation (the way systemic oral corticosteroids can) once an asthma flare is occurring. Side effects may include dry or irritated throat, hoarseness or coughing. A bad taste in the mouth, headache, nausea, diarrhea, thirst and tiredness have also been reported. These symptoms can subside as the body adjusts to the medication. If they persist or worsen your doctor should be consulted. Also notify a doctor if your child develops a rash, sore throat, mouth sores, swelling of the face, wheezing, breathing trouble or behavioral changes. Sold in the US under trade names Beclovent and Vanceril for asthmatic use; Beconase and Vancenase for nasal inhalation.

Beclovent
: Trade name for beclomethasone, an inhaled corticosteroid.

Breath Actuated Inhaler
: It is similar to an MDI except that the beginning of inhalation is what triggers the release of the medication. Maxair, salbutamol/albuterol and beclomethasone are available in breath actuated

inhaler form in some countries. With the recent ban of CFC-based propellants in the US, breath actuated inhaler devices are becoming popular in the States.

Bronchiolitis

Frequently caused by RSV, bronchiolitis is an infection of the small airways, resulting in obstruction. It begins with mild symptoms of an upper respiratory tract infection and progresses to include cough, wheeze, increased respiratory rate and retractions of axillary respiratory muscles in the collarbone and abdominal areas. Airway obstruction in young children can very dangerous as their airways are so much smaller than adults' and pneumonia can set in quickly.

Bronchiole

Small airway passages that branch off the lungs' larger bronchial tubes. At the end of the bronchiole are the alveole, which are little sac-like structures where 'dirty' blood gets re-oxygenated before routing back through the heart. If the air we inhale cannot make it through the bronchiole to the alveole, the blood's oxygen saturation level will go down. Here's an illustration of bronchiole during an asthma flare.

Bronchodilator

These drugs act principally to reverse narrowing of the airways, and dilate them by relaxing the bronchial smooth muscles that encircle the bronchiole (small airways.) As a class, bronchodilators include: beta$_2$-adrenergic agonists (albuterol), beta-agonists (Salmeterol), anti-cholinergics (Atrovent), and methylxanthines (theophylline-based drugs such as Theo-Dur and Slo-Bid.) More trade names and information: bronchodilators / long-acting bronchodilators.

BronchoSaline

Sterile saline solution sometimes required for dilution of albuterol (and other drugs) for nebulization.

Budesonide

Rhinocort and Pulmicort are trade names for this corticosteroid.

C

Chronic Obstructive Pulmonary Disease(COPD)

Used most often to describe emphysema, COPD is actually an overall term for any long-standing condition (including asthma) which impairs airflow in and out of the lungs. When chronic asthma develops into COPD, it typically means the lungs have become irreversibly damaged and scarred from repeated, untreated asthma flares--the result of airway remodeling.

Claritin / Claritin D

Trade name for sustained-release loratadine (with pseudoephedrine sulfate for the D version,) it is a commonly prescribed long-acting antihistamine. It provides relief from symptoms of allergic rhinitis. An oral (tablet or syrup) medication, taken once daily.

Combivent

An aerosol inhaler (MDI) combination of both albuterol and ipatropium bromide. Albuterol (AKA Ventolin or Proventil) acts immediately but has a shorter lifespan than ipatropium bromide (Atrovent,) which takes longer to kick in but is longer-acting. Not FDA-approved for use in children, it's more commonly prescribed for adults with COPD.

Controller Medications

These medications work over the long-term to relieve the underlying inflammation associated with asthma, thus preventing or reducing the risk of an asthma attack. If asthma is left uncontrolled, there is risk for scarring of the lungs, which can lead to airway remodeling and more serious lung problems. They do nothing to provide immediate relief to an asthma attack already in progress.

Corticosteroids

The adrenal glands produce this steroid hormone that has various effects on the body, primarily reducing swelling and inflammation. Synthetic corticosteroids enhance the body's own production, to relieve the swelling, inflammation and mucus production that occurs when an asthmatic's lungs are irritated.

Systemic (oral) corticosteroids work long-term to prevent inflammatory reaction to irritants, but are not for immediate, short-term relief. They may be used to battle stubborn, serious flares, but ideally in short-term bursts of a week or so. Inhaled corticosteroids are also taken preventively, commonly on a daily basis, and also are no help for a flare in progress.

Cromolyn Sodium

A mast cell inhibitor that works to prevent bronchospasm and inflammation. It is usually only effective for asthma that is induced by allergens or exercise. It is a mild drug and for most people, carries few, if any, side effects. Sold as Intal, in MDI and nebulizer solution. Known as sodium cromoglycate outside the US.

Cystic Fibrosis (CF)

Disease where mucus production in the lungs is abnormal, both in quantity and consistency. Patients newly presenting asthma symptoms are usually tested for CF using a sweat test. This is standard procedure in order to rule out CF as a cause of the patient's symptoms. Cough-variant

asthma and CF present very similar symptoms. For more on CF, visit the Cystic Fibrosis Foundation.

■D■

Diskhaler
: Dry powder inhaler. A round disk holds a single-dose packet of the medication. Using the diskhaler punctures the pouch and the drug is inhaled through the mouthpiece. Currently available in Canada, South Africa, and UK; Serevent Diskus in U.S.

Dry Powder Inhaler
: Similar to an MDI in that it delivers a precisely-measured dose of medicine into the lungs, however it is the patient's inhalation that triggers the medicine's release rather than the press of the canister. The medicine itself is in the form of a dry powder; currently Intal is available in the US in this form.

■E■

Eczema
: Irritation of the skin that often plagues asthmatics although the link between the two is not known. Presents as an itchy rash; has been called the 'itch that rashes' since the itch usually occurs first and effective treatment may prevent or mitigate the rash. Look for small crusty scales or blisters on the head, face and neck, or the insides of elbows, wrists and knees.

ELISA test
: A test for allergens done using blood sample(s) from a patient, it's an acronym for Enzyme-Linked Immuno-Sorbent Assay. See also RAST as the same limitations apply.

■F.

Flonase
: Trade name for fluticasone, a nasal inhaler corticosteroid, prescribed for the relief of allergic rhinitis symptoms, which frequently attribute to asthma flares.

Flovent
: Trade name for fluticasone, a bronchial inhaled corticosteroid.

Flunisolide
: Inhaled (MDI) anti-inflammatory corticosteroid. It is similar to beclomethasone in that it helps prevent inflammation in the airways. It delivers a higher concentration of drug with each puff than beclomethasone, so it is often prescribed for more severe cases of asthma. Commonly sold under the AeroBid name.

Fluticasone

Inhaled corticosteroid sold as Flonase. Fluticasone is also available in a nasal preparation for sinusitis and rhinitis.

G

Gastroesophageal Reflux Disease
: Also referred to as GERD or reflux. See the entry under reflux for more information about its causal effect on asthma symptoms. More links on GERD in children.

GERD
: Acronym for Gastroesophageal Reflux Disease, which has a strong relationship with asthma in a large percentage of patients. More links on GERD in children. See also reflux.

H

Hormones
: These are chemical messengers released by endocrine glands and carried through the bloodstream to specific target tissues, where they produce either rapid or long-term effects. For the purposes of asthma, hormones secreted by the adrenal glands (located atop the kidneys) known as corticosteroids are of concern.

Hypoxia
: Decreased concentration of oxygen in the tissues. While blood flow and pressure may be normal, a lowered oxygen saturation point can cause this condition in asthmatics. Comes from hypo (lower than normal) and oxygen. Normal oxygen concentration is called normoxia. The organ most critically affected by hypoxia is, of course, the brain. Not something we want to mess with in our little ones.

I

Inhalers
: Non-mechanical devices for delivering asthma medication into the airways. There are four types: metered dose (MDIs), breath actuated, dry powder, and Turbuhaler. Here's a terrific fact sheet about the different inhalers.

Intal
: Trade name for cromolyn sodium.

Integra
: MDI with compact spacer device. Available in UK.

Intubate / Intubation
: Procedure whereby an endotracheal tube is inserted through the nose or mouth into the trachea, through which oxygen is forcefully pumped by a ventilator. A cuff on the tracheal end inflates to create a tight seal in the trachea area (although the cuff isn't required with infants) and a

tight-fitting mask is placed over the nose and mouth. This differs from a tracheotomy, in which a small incision is made in the neck area, near the "Adam's Apple," through which a shorter, more rigid endotracheal tube and cuff are inserted. Intubation is required if an acute asthma attack is not responsive to medication. It's not pretty, for the patient or the parent.

Ipatropium bromide

Sold under the Atrovent name, it is a longer-acting, short-term bronchodilator than the more commonly used albuterol. Ipatropium bromide is not as fact-acting, however, and is generally not used in back-to-back treatments the way albuterol can be. A common use (especially in an hospital or ER/critical care setting) is to combine it with an albuterol dose administered via nebulizer as they are complementary in action: albuterol offers immediate relief while ipatropium bromide provides longer-lasting effects. There is also a medication sold as Combivent which similarly combines the two drugs in MDI form. Side effects with ipatropium bromide use may include dizziness, headache, nausea, dry mouth, cough, hoarseness, or blurred vision, although any incidence of these may likely disappear as the body adjusts to the drug. Not FDA-approved for use in children under 6 years old.

J

K

Ketotifen furoate

An antihistamine not available in the United States. Sold in Canada and the EC as Zaditen and is approved for use in children. Commonly prescribed as a preventive anti-allergy medication.

L

Leukotrienes

Natural substance produced by certain cells within the body as part of the inflammatory reaction to an irritant (asthma trigger.) In asthmatics, leukotrienes and their receptors cause the muscles in the airways to tighten and mucus to be produced. This mucus can block the smaller airways, which can result in coughing, wheezing, and breathing problems. Anti-leukotriene drugs get in the way of this process and may provide preventive relief in some asthmatics.

M

Metered Dose Inhaler (MDI)

Small hand-held aerosol canister used to deliver inhaled drugs. Surprisingly enough, about 80-90% of an MDI dose is left in the mouth and throat, meaning only 10-20% of the dose makes it to the lungs. This is taken into account when a dosage is prescribed, so do NOT increase the dosage on your own to accommodate this. The 90% left in the patient's mouth consists of the larger particles that are too heavy to make the long trip to the lungs. These particles dissolve,

are absorbed by tissue and then sent via the gastrointestinal system to the rest of the body. By using a spacer device such as an Aerochamber, you can reduce this effect since these larger particles are left in the Aerochamber rather than the mouth. Our spacer gets pretty well gunked up after a week or so - I clean it regularly.

It is vitally important that the number of sprays emitted from a canister be tracked. Numerous studies have shown that MDI's lose their efficacy long before the canister is truly empty.

Mometasone Furoate

Currently in Phase III trials in the US, this is an inhaled corticosteroid which shows promise for patients on long-term oral steroid therapy. Upon approval by the FDA, manufacturer Schering-Plough may market it under the name Asmanex. Mometasone furoate is currently sold as the nasal inhaler Nasonex, and also as a topical corticosteroid cream. More...

Montelukast

An anti-leukotriene, which works by suppressing the effects that leukotrienes have on their receptors in airways tissue.

■

Nebulizer

Device (small air compressor, typically) for transforming a liquid (medicine) into a vapor. The vapor is inhaled, usually by means of a face mask or mouthpiece, into the lungs. The nebulization of the medicine into extremely fine particles increases the absorption rate by the lungs, making this one of the most effective delivery techniques available for home use. Less expensive nebulizers use an air compressor; ultrasonic models are very portable, nearly silent and faster but quite a bit more expensive. Need more information on nebulizers? Read this great fact sheet and our tips page.

Nedocromil Sodium

See also cromolyn sodium. Nedocromil is very similar but is longer-acting, so prescribed frequency is usually once or twice per day, rather than 3-4 times daily like cromolyn sodium. Sold under the Tilade name.

■O■

Oximetry Meter

Also known as an oximeter or pulse oximeter, it monitors and reports the oxygen saturation of the blood. A lightweight finger clamp is usually placed on an adult's finger, while the big toe is generally monitored in small children. Saturation levels (O2 sats) should be in the high 90's.

Oxygen Saturation

The non-high-tech definition is simply the level of oxygen in your bloodstream, expressed as a percentage - 97% is optimal.

■P Q

Peak Flow Meter/Monitor

A device used to measure lung capacity, known as Peak Expiratory Flow (PEF). The patient exhales forcefully into a mouthpiece and the force of the exhalation triggers a measurement device to register a numeric value. Typically, an Asthma Management Program will specify appropriate steps/medications to adminster dependent on the patient's peak flow capacity. Individual treatment zones are outlined for each patient and take into consideration body weight and previous personal best peak flow readings. Small, lightweight and inexpensive, they are easily used at home and most physicans will require that the older asthmatic child track peak flow measurements on a daily basis.

Pediapred

Pediatric formulation of prednisolone. It comes in both syrup (clear) and liquid (cloudy) form. May be more easily tolerated by children that other formulations, which can cause vomiting.

Pneumonia

A lung infection that can be caused by different types of germs, including bacteria, viruses, fungi, and parasites. Although different types of pneumonia tend to affect children in different age groups, pneumonia is most commonly caused by viruses, like RSV. Symptoms include: fever, chills, cough, rapid breathing, breathing that makes a "grunting" or wheezing sound, labored breathing that makes a rib muscles retract, vomiting, chest pain, abdominal pain, decreased activity, loss of appetite (in older children) or poor feeding (in infants,) and bluish or gray color of the lips and fingernails.

Since an asthma parent is familiar with seeing many of those symptoms on a daily basis, pneumonia can sneak in unnoticed. (It's happened to Ed more than once.) It is important to consult your physican when your child is suffering from a respiratory virus.

Prednisone/Prednisolone

Oral systemic corticosteroid that acts upon the hypothalamic/pituitary/adrenal system to help prevent inflammation. Essentially, this steroid suppresses the immunological response asthmatics' lungs have toward various triggers and stimuli. It is a powerful drug, with strong

side effects when used long-term. Short-term bursts (10 days or less) are generally deemed safe, provided they are not administered too frequently. Common trade names are listed here.

Primatene Mist
: Over-the-counter bronchodilator. Can be dangerous if abused, as it is based on epinephrine.

Proventil
: Trade name for albuterol.

Pulmicort
: Trade name for budesonide, a corticosteroid.. Although delivered via an inhaler, Pulmicort is unique in that it is the first CFC-free inhaled steroid approved by the FDA. Using a Turbuhaler it dispenses a metered dose of dry powder using a with each inhaled breath, with no special timing required. It also clearly indicates when its 200 doses are running low.

■R.

Racemic (medication)
: This term racemic describes a drug which has two components, labeled R and S isomers. In racemic albuterol/salbutamol, it is thought that only one of these isomers is beneficial in the treatment of bronchoconstriction. The R isomer provides the bronchodilation while the S isomer lends the stimulative side-effects. Recent advances in technology have allowed the successful isolation of R isomers and, in the case of albuterol, led to the introduction of Xopenex.

RAST test
: Short for Radioallergosorbent Test, it uses blood samples to identify allergens capable of causing an allergic response. Some physicians feel it is not as accurate as skin testing for allergens because the person performing the test has to have a good idea about what allergies they are testing for—it's not good for blanket testing. It does, however, have the benefit of only one needle stick vs. the multiple, but slightly less invasive, sticks required for skin testing.

Relief (rescue) Medications
: Classed as bronchodilators, these short-term medications provide immediate relief to the airways during asthma attack in progress. They do nothing to address the underlying inflammation which causes asthma flares.

Reflux
: Short for Gastroesophageal Reflux Disease, also commonly known as GERD, it is a chronic condition which afflicts many asthmatics. The esophageal flap which seals the stomach from the lower esophagus does not remain closed when it should, particularly when the patient is reclining, and this allows stomach acid and its fumes, and partially-digested contents to escape

upwards through the esophagus. This material can be aspirated into the lungs, triggering an asthma attack. Another relationship exists whereby the processes that work the muscles in the lower esophagus to move the regurgitated contents back into the stomach, also stimulate bronchoconstriction. Effective treatment of GERD in non-allergic asthmatics can significantly improve or even eliminate their asthma symptoms. Clues that GERD may be aggravating asthma include: 1) asthma that occurs for the first time during adulthood 2) asthma that gets worse after meals, lying down or exercise and 3) asthma which gets worse at night. More info on reflux in children.

Respihaler
: Aerosol inhaler exclusively for Decadron.

Respules (Pulmicort)
: Trade name for Pulmicort inhaled corticosteroid in nebulizer solution form.

Respiratory Syncytial Virus (RSV)
: A virus that affects the upper and lower respiratory tracts, it is most prevalent in lower respiratory illnesses such as pneumonia and bronchiolitis. Most frequently seen in children from birth to age three, RSV is also a common cause of pneumonia in children. The RSV Info Center is a great resource for more about this virus.

Rhinitis
: This is a clinical term for the following symptoms: nasal blockage (congestion), nasal discharge (runny nose), nasal itching and sneezing. The cause is typically infection (viral, mostly), allergy, structural, or the all-important 'other'. For more on rhinitis, read this fact sheet. Rhinitis often triggers flares in susceptible asthmatics, like my son for one. Ed has vasomotor rhinitis, which means he gets a runny nose for no explicable reason. :/

Rotahaler
: A dry powder inhaler used with Rotacaps. Very similar to the Spinhaler. Available in the US, Canada, and UK for Ventolin. In Canada, Beclovent Rotacaps are also available; Becotide Rotacaps in the UK.

■S.

Salbutamol
: Sold as Ventolin in the US, salbutamol is the World Health Organization's preferred name for albuterol, a bronchodilator.

Saline Wash, Nasal
: The use of an over-the-counter saline spray to flush mucus out of the sinus cavities, helping to prevent sinus infections and relieve symptoms. Here's how to do it.

Salmeterol

Inhaled (MDI) timed-release bronchodilator sold under the Serevent name. It may be prescribed as a maintenance drug, particularly for those with a need for its long-lasting effect. It may be helpful for schoolchildren, as many school systems restrict or prohibit the use of inhalers without the student visiting the school nurse/office first. As it is very slow acting, it would be wise to keep a faster-acting bronchodilator, such as albuterol, on the school premises as well. Salmeterol does not stop an attack once it's started - it is preventive in nature. Dry mouth, irritated throat, dizziness, headache, lightheadedness, heartburn, loss of appetite, altered taste sensation, restlessness, anxiety, nervousness, trembling, and sweating may occur but should subside as the body adjusts to the medication.

Serevent

Trade name for salmeterol, a long-acting bronchodilator.

Singulair

Trade name for montelukast, an anti-leukotriene drug taken daily in pill form. FDA-approved in the US for use in children age 6 and over. Results indicate it works very well in about 1/3 of patients, moderately well in another 1/3 and not helpful in the last third. Successful use of Singulair can help reduce or mitigate entirely the use of inhaled or oral steroids. Side effects can include headache, fatigue and gastric upset although the incidence rate is low. For real-world feedback on Singulair, this link will search our Discussion Forums to hear what parents of kids taking Singulair have to say: Singulair search.

Sinusitis

Inflammation of the sinus cavities. Its symptoms include headache (particularly upon waking,) nasal drainage (rhinorrhea,) jaw and/or teeth sensitivity, swelling around the eyes, nasal congestion and loss of smell. Causes can be infection (viral, bacterial or fungal,) medicines (their side-effects,) and allergies, specifically, when allergic or chronic rhinitis causes sinusitis. Allergies are the leading cause of chronic (long-term) sinusitis; structural abnormalities are also a contributor.

Solumedrol

Intravenous (IV) formulation of methylprednisolone, corticosteroid. Also, Medrol.

Spinhaler

Dry powder inhaler used with Intal capsules; each holds one dose. In one movement, the inhaler opens the capsule and the powder may be inhaled through the mouthpiece. Available in Canada, the UK, and the Netherlands.

Status Asthmaticus

Extremely serious, life-threatening condition where an asthma flare is not responding to treatment. Can be fatal, often requires intubation.

Sweat (Chloride) Test

Common test for Cystic Fibrosis, whose symptoms can be very similar to asthma. When a child begins to present asthma symptoms a sweat test is typically done to rule out CF as a cause. The child's forearm or shin is electrically stimulated to produce perspiration, which is then measured for salt (chloride) content using a special digital machine. Too much salt in the sweat indicates CF. A borderline reading will usually result in retesting. It is not painful and usually takes about an hour or less from start to finish. Sometimes two locations are tested (left and right forearms) for quality control. For more information on sweat testing, visit www.cff.org.

Sympathetic Nervous System

This part of the nervous system regulates involuntary reactions to stress such as increased heart and breathing rates, and other physiological reactions. Ever felt an 'adrenalin rush?' That was your sympathetic nervous system at its finest. Many asthma drugs, such as albuterol, mimic this system in attempting to relieve an asthma flare.

Syncroner / Synchroner

MDI with elongated mouthpiece, used as training device to see if medication is being inhaled properly. Available in Canada and UK.

T

Terbutaline

A short-term bronchodilator sold under the trade name, Breathaire.

Terbuterol

A short-term bronchodilator.

Theophylline

A derivative of caffeine, this long-term bronchodilator has lost much of its popularity with the introduction of corticosteroids. Theophylline's potential side effects such as decreased appetite, nausea, diarrhea, vomiting, headache, nervousness, irritability, insomnia and palpitations, along with the very thin margin between theraputic dose and toxicity make it a last-resort choice for use in children. It is best taken on an empty stomach in its complete form (capsule or tablet) and not opened, chewed, or crushed and mixed with food. Doing so may reduce its long-acting effectiveness and increase the risk of side effects. Since small children usually can't swallow pills, there is a form available that can be sprinkled on food and also a liquid suspension formula, but both tend to increase the incidence of side effects. Frequent arterial blood testing is required to ensure optimum dosing. Trade names for theophylline are included here.

Tilade
: An anti-inflammatory; see nedocromil sodium.

Triamcinolone
: Sold as Azmacort, it is an inhaled corticosteroid.

Thrush
: Candida (yeast) infection in the mouth, generally caused by residue from MDI's, particularly steroid inhalers. Use of a spacer device and rinsing immediately after an inhaler dose can help reduce incidence of thrush.

Turbulaher/Turbohaler
: Metered dose inhalation device used for delivery of Pulmicort (budesonide.) It involves rotating the inhaler, causing the release of the medication into an integral holding chamber, from which the medicine is inhaled.

U V W

Vanceril
: Trade name for beclomethasone, a corticosteroid.

Ventilator
: Machine that breathes for patient when patient's lungs can no longer inhale/exhale on their own. Requires intubation. It is generally the last resort when a patient is in status asthmaticus.

Ventolin
: Trade name for albuterol, a bronchodilator. Available in MDI and solution (for nebulization) forms.

X Y Z

Xopenex
: Trade name for levalbuterol HCI, which is a sub-component of racemic albuterol/salbutamol. The stated benefit of bronchodilation with Xopenex is reduced incidence of stimulative side-effects such as heart palpitations, tremors and nervousness. It is currently available in the US in nebulizer solution and is not yet FDA-approved for use in children under age 12, which is not to say that it is unsafe for use in children, just that anough testing has not yet been completed to justify the FDA's approval.

Zaditen
: Trade name for ketotifen, an antihistamine sold outside the US.

Zafirlukast
: Sold as Accolate, zafirlukast is a member of the class of asthma drugs known as anti-leukotrienes. Specifically, it is a leukotriene-receptor antagonist, or blocker.

Zyflo

A trade name for zileuton, an anti-leukotriene.

Zyrtec

Brand name for cetirizine HCI, Zyrtec is an antihistamine prescribed for allergic rhinitis symptoms. Taken once daily in tablet or syrup form.

RSV Post-Test

Select the best answer to each of the following items. Mark your responses on the Answer Form.

1. The goal of this guideline is to provide an evidence-based approach to the _____ of bronchiolitis in children from 1 month to 2 years of age.

a. diagnosis
b. management
c. prevention
d. All of the above

2. Bronchiolitis is a disorder most commonly caused in infants by viral lower respiratory tract infection (LRTI). It is the most common lower respiratory infection in this age group.

a. True
b. False

3. It is characterized by edema and necrosis of epithelial cells lining small airways, _____.

a. acute inflammation
b. increased mucus production
c. bronchospasm
d. All of the above

4. Signs and symptoms are typically _____, cough, crackles, use of accessory muscles, and/or nasal flaring.

a. rhinitis
b. tachypnea
c. wheezing
d. All of the above

5. The most common etiology is the respiratory syncytial virus (RSV), with the highest incidence of RSV infection occurring between December and March.

a. True
b. False

6. Ninety percent of children are infected with RSV in the first 2 years of life,and up to _____% of them will have lower respiratory infection.

a. 20
b. 30
c. 40
d. 70

7. Infection with RSV does not grant permanent or long-term immunity. Reinfections are common and may be experienced throughout life.

a. True
b. False

8. RSV infection leads to more than _____ hospitalizations annually.

a. 25,000
b. 40,000
c. 65,000
d. 90,000

9. Other viruses identified as causing bronchiolitis are _____, and parainfluenza.

a. human metapneumovirus,
b. influenza
c. adenovirus
d. All of the above

10. Mortality resulting from RSV has decreased from _____ deaths annually in 1985 in the United States to an estimated 510 RSV-associated deaths in 1997, and 390 in 1999.

a. 2500
b. 4500
c. 7500
d. None of the above

11. The cost of hospitalization for bronchiolitis in children less than 1 year old is estimated to be more than $_____ million per year.

a. 250
b. 550
c. 700
d. 900

12. Several studies have shown a wide variation in how bronchiolitis is diagnosed and treated.

a. True
b. False

13. In addition to morbidity and mortality during the acute illness, infants hospitalized with bronchiolitis are more likely to have respiratory problems as older children, especially recurrent wheezing, compared with those who did not have severe disease.

a. True
b. False

14. Severe bronchiolitis disease is characterized by _____ .

a. apnea
b. persistently increased respiratory effort
c. the need for intravenous hydration

d. All of the above

15. It is unclear whether severe viral illness early in life predisposes children to develop recurrent wheezing or if infants who experience severe bronchiolitis have an underlying predisposition to recurrent wheezing.

a. True
b. False

16. As used in the guidelines seen in this course, bronchiolitis is: a disorder most commonly caused in infants by viral LRTI; it is the most common lower respiratory infection in this age group and is characterized by _____, and, increased mucus production, and bronchospasm.

a. acute inflammation
b. edema
c. necrosis of epithelial cells lining small airways
d. All of the above

17. CLD, also known as bronchopulmonary dysplasia, is defined as: an infant less than 32 weeks' gestation evaluated at 36 weeks' postmenstrual age or one of more than 32 weeks' gestation evaluated at more than 28 days but less than 56 days of age who has been receiving supplemental oxygen for more than 28 days

a. True
b. False

18. According to the guidelines, a severe bronchiolitis disease is defined as: signs and symptoms associated with poor feeding and respiratory distress characterized by _____ .

a. tachypnea
b. nasal flaring
c. hypoxemia
d. All of the above

19. According to the guidelines, Hemodynamically significant congenital heart disease is defined as: children with congenital heart disease who are receiving medication to control congestive heart failure, have moderate to severe pulmonary hypertension, or have cyanotic heart disease.

a. True
b. False

20. One recommendation of the guidelines is that: Clinicians should diagnose bronchiolitis and assess disease severity on the basis of history and physical examination. Clinicians should not routinely order laboratory and radiologic studies for diagnosis.

a. True
b. False

21. Another recommendation of the guidelines is that: Clinicians should assess risk factors for severe disease such as age less than 12 weeks, a history of prematurity, underlying cardiopulmonary disease, or immunodeficiency when making decisions about evaluation and management of children with bronchiolitis

a. True
b. False

22. The 2 goals in the history and physical examination of infants presenting with cough and/or wheeze, particularly in the winter season, are the differentiation of infants with probable bronchiolitis from those with other disorders and the estimation of the severity of illness.

a. True
b. False

23. Most clinicians recognize bronchiolitis as a constellation of clinical symptoms and signs including _____.

a. a viral upper respiratory prodrome
b. followed by increased respiratory effort
c. and followed by wheezing in children less than 2 years of age
d. All of the above

24. Overall, results of the meta-analysis indicated that, at most, 1 in 4 children treated with bronchodilators might have a transient improvement in clinical score of unclear clinical significance. This needs to be weighed against _____.

a. the potential adverse effects
b. the cost of these agents
c. the fact that most children treated with bronchodilators will not benefit from their use

d. All of the above

25. Overall, the studies reviewed did not show the use of albuterol in infants with bronchiolitis to be beneficial in shortening duration of illness or length of hospital stay.

a. True
b. False

26. The Cochrane report concluded: "There is insufficient evidence to support the use of epinephrine for the treatment of bronchiolitis among inpatients. There is some evidence to suggest that epinephrine may be favorable to salbutamol (albuterol) and placebo among outpatients."

a. True
b. False

27. Extrapolation from the studies discussed above suggests that epinephrine may be the preferred bronchodilator for this trial in the emergency department and in hospitalized patients. In the event that there is documented clinical improvement, there is justification for continuing the nebulized bronchodilator treatments. In the absence of a clinical response, the treatment should not be continued.

a. True
b. False

28. Because of _____, epinephrine is usually not used in the home setting. Therefore, it would be more appropriate that a bronchodilator trial in the office or clinic setting use albuterol/salbutamol rather than racemic epinephrine.

a. a lack of studies
b. short duration of action
c. potential adverse effects
d. All of the above

29. Anticholinergic agents such as ipratropium have not been shown to alter the course of viral bronchiolitis.

a. True
b. False

30. According to the guidelines, a “Routine” is a set of customary and often-performed procedures such as might be found in a routine admission order set for children with bronchiolitis.

a. True
b. False

31. Respiratory rate in otherwise healthy children changes considerably over the first year of life, decreasing from a mean of approximately _____ breaths per minute in term newborns to approximately 40 breaths per minute at 6 months of age and 30 breaths per minute at 12 months

a. 70
b. 60
c. 50
d. None of the above

32. The course of bronchiolitis is variable and dynamic, ranging from transient events such as apnea or mucus plugging to progressive respiratory distress from lower airway obstruction. Important issues to assess include the impact of respiratory symptoms on feeding and hydration and the response, if any, to therapy.

a. True
b. False

33. The physical examination reflects the variability in the disease state and may require serial observations over time to fully assess the child's status. Physical examination findings of importance include _____.

a. respiratory rate
b. increased work of breathing as evidenced by accessory muscle use or retractions
c. auscultatory findings such as wheezes or crackles
d. All of the above

34. The evidence relating the presence of specific findings in the assessment of bronchiolitis to clinical outcomes is limited. Most studies are retrospective and lack valid and unbiased measurement of baseline and outcome variables.

a. True
b. False

35. Pulse oximetry has been rapidly adopted into clinical assessment of children with bronchiolitis on the basis of data suggesting that it can reliably detect hypoxemia that is not suspected on physical examination. Few studies have assessed the effectiveness of pulse oximetry to predict clinical outcomes.

a. True
b. False

36. Clinical signs and symptoms of bronchiolitis consist of _____, and increased respiratory effort manifested as grunting, nasal flaring, and intercostal and/or subcostal retractions.

a. rhinorrhea
b. cough
c. wheezing and tachypnea
d. All of the above

37. Radiography may be useful when the hospitalized child does not improve at the expected rate, if the severity of disease requires further evaluation, or if another diagnosis is suspected.

a. True
b. False

38. Virologic tests for RSV, if obtained during peak RSV season, demonstrate a high predictive value.

a. True
b. False

39. The use of bronchodilator agents continues to be controversial. RCTs have failed to demonstrate a consistent benefit from α-adrenergic or ß-adrenergic agents.

a. True
b. False

40. According to the guideline's recommendations, Bronchodilators should not be used routinely in the management of bronchioliti.

a. True
b. False

41. One of the guideline's recommendations is that: "A carefully monitored trial of α-adrenergic or ß-adrenergic medication is an option. Inhaled bronchodilators should be continued only if there is a documented positive clinical response to the trial using an objective means of evaluation (option: evidence level B; RCTs with limitations and expert opinion; balance of benefit and harm).

a. True
b. False

42. According to the guidelines, Corticosteroid medications should be used routinely in the management of bronchiolitis.

a. True
b. False