Bronchiolitis Management Before and After the AAP Guidelines

WHAT’S KNOWN ON THIS SUBJECT: Bronchiolitis is a leading cause of hospitalization for children, yet variability in its management persists. To promote evidence-based care, the American Academy of Pediatrics published practice guidelines in 2006 that advocate primarily supportive care for this self-limited disease.

WHAT THIS STUDY ADDS: Since publication of the guidelines in 2006, few studies have evaluated their impact on diagnostic testing and treatment. This study documents positive changes in resource use among hospitalized patients with bronchiolitis over an 8-year period.

BACKGROUND AND OBJECTIVES: Evidence-based practice guidelines for bronchiolitis management published by the American Academy of Pediatrics in 2006 recommend supportive care with limited diagnostic testing and treatment. We sought to determine the impact of these guidelines on the treatment of hospitalized children.

METHODS: We analyzed data on inpatients with bronchiolitis aged 1 to 24 months from the Pediatric Health Information System, an administrative billing database, from November 1, 2004 to March 31, 2012. We compared trends in use of diagnostic and treatment resources before and after the publication of the guidelines by using segmented time series.

RESULTS: A total of 41 pediatric hospitals contributed data to yield 130,262 patients; 58% were male, and 59% were publicly insured. Median age was 4.0 months (interquartile range, 2–9). Unadjusted analysis showed improvement in utilization rates before and after guidelines for diagnostic tests and for medications; however, there was no decreased use of antibiotics. A segmented regression analysis also demonstrated differences in rates of change before and after guidelines, with significant improvement for chest radiography, steroids, and bronchodilators (P < .0001).

CONCLUSIONS: In a nationally representative cohort of pediatric hospitals, publication of the 2006 American Academy of Pediatrics bronchiolitis guidelines was associated with significant reductions in the use of diagnostic and therapeutic resources. Pediatrics 2014;133:1–7

AUTHORS: Kavita Parikh, MD, a Matthew Hall, PhD, a and Stephen J. Teach, MD, MPH b

aDivision of Hospitalist Medicine, and bDivision of Emergency Medicine, Children’s National Medical Center, Washington, District of Columbia, and cChildren’s Hospital Association, Overland Park, Kansas

KEY WORDS bronchiolitis, guidelines, resource utilization

ABBRévIATIONS
AAP—American Academy of Pediatrics
CBC—complete blood cell
CXR—chest radiography
ED—emergency department
NHAMCS—National Hospital Ambulatory Medical Care Survey
PHIS—Pediatric Health Information System
RSV—respiratory syncytial virus

Dr Parikh conceptualized the study, conducted the analysis, and drafted the manuscript; Dr Hall gathered the data and conducted the analysis and manuscript preparation; and Dr Teach helped with study conceptualization and manuscript preparation.

doi:10.1542/peds.2013-2005

Accepted for publication Oct 1, 2013

Address correspondence to Kavita Parikh, MD, Division of Hospitalist Medicine, 111 Michigan Ave NW, Washington, DC 20010.

Copyright © 2014 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: Supported by the Young Investigator Award through the Academic Pediatric Association.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.
Bronchiolitis is a common respiratory illness that predominantly affects infants and young children and accounts for $543 million annually in hospitalization charges.1 The mainstay of treatment of bronchiolitis is supportive care, with good evidence that most specific treatments are ineffective, including bronchodilators, corticosteroids, antibiotics, and chest physiotherapy.2–9 Nonetheless, significant variability persists in the care for patients with bronchiolitis,10–12 potentially generating unnecessary and costly resource use. With increasing concern of the quality and cost of health care delivered in the United States, there has been a focus on achieving higher-quality outcomes per dollar spent on health care.13

In an effort to achieve higher quality of care, numerous evidence-based clinical practice guidelines have been published to assist clinicians in making decisions about appropriate care in specific clinical circumstances.14 In 2006, the American Academy of Pediatrics (AAP),15 with the support of the Agency for Healthcare Research and Quality published a systematic review of the diagnosis and treatment of bronchiolitis titled “Diagnosis and Management of Bronchiolitis.” This clinical practice guideline emphasizes supportive care with oxygen and hydration (when necessary) and recommends limited use of diagnostic testing and medications, including bronchodilators, corticosteroids, and antibiotics.15

We aimed to determine the impact of the 2006 AAP bronchiolitis guidelines on the care of children hospitalized with bronchiolitis by comparing preguideline and postguideline use of diagnostic tests and treatments. We hypothesized that the use of diagnostic testing and medications would decrease after the publication of the guidelines.

METHODS

Data Source
The study is a retrospective, observational cohort study using the Pediatric Health Information System (PHIS) database (Children’s Hospital Association, Overland Park, Kansas). The PHIS database contains deidentified administrative data, detailing demographics, diagnostics, procedures, and pharmacy billing, from 41 freestanding tertiary care children’s hospitals. This database accounts for ~20% of all annual pediatric hospitalizations in the United States. Data quality is ensured through a joint effort between the Children’s Hospital Association and participating hospitals.

Patient Population
PHIS data were used to evaluate hospital-level resource use for children 28 days to 730 days (2 years) of age discharged November 1, 2004 to March 30, 2012. Our goal was to identify uncomplicated bronchiolitis hospitalizations involving previously healthy children. All initial admissions of patients were included if they met both of the following criteria:

1. All Patient Refined Diagnosis-Related Groups version 24, Bronchiolitis and RSV Pneumonia (code 138)
2. Primary diagnosis of acute bronchiolitis (International Classification of Diseases, Ninth Revision code 466.11 or 466.19).

Exclusion criteria included presence of a chronic complex condition,16 a billing charge for mechanical ventilation, a length of stay >10 days, and any readmission during the study period. According to Feudtner et al,16 respiratory chronic complex conditions do not include asthma or reactive airway disease but include respiratory malformations, cystic fibrosis, and bronchopulmonary dysplasia or chronic lung disease. Subsequent bronchiolitis readmissions were excluded from the data set because of the assumption that these readmissions may be managed differently, so we included only the first admission.

Relationship of Guideline Publication and Resource Use
The measured exposure was the discharge date of the admission for bronchiolitis. For the unadjusted analysis, patients were grouped into 3 cohorts based on guideline publication in October 2006: preguideline (November 2004 to March 2005), postguideline early (November 2007 to March 2008), and postguideline late (November 2011 to March 2012). These time periods were selected for the unadjusted analysis because they represent 3 bronchiolitis seasons, before and after guideline publication; the 2006 to 2007 season was not included because this is the year the guideline was published and was a period of distribution and assimilation. For the adjusted segmented regression analysis, publication of the guidelines, October 2006, was considered the event point.

The measured outcomes were the rates of diagnostic and treatment resource use as determined from billing data. The diagnostic tests were complete blood cell (CBC) count, chest radiography (CXR), and respiratory syncytial virus (RSV) testing. The treatment modalities were bronchodilator usage (including any bronchodilator and days of bronchodilator), corticosteroid usage, and antibiotic usage.

Statistical Analysis
Because of their nonnormal distributions, continuous factors were summarized with medians and interquartile ranges and then compared with Mann–Whitney tests. Categorical factors were summarized by using frequencies with percentages and then
compared with $\chi^2$ tests for grouped analysis. Segmented regression analysis was used to control for hospital clustering and secular trends in variation. Monthly rates of resource utilization were used in the segmented regression analysis. All statistical analyses were performed with SAS version 9.3 (SAS Institute, Inc, Cary, NC), and $P$ values <.001 were considered statistically significant. Significance of <.001 was used to ensure strength of the relationship given the large sample. Institutional review board approval was obtained from the Children’s National Medical Center review committee.

RESULTS

There were 159,697 hospital admissions in the PHIS database meeting study inclusion criteria (Fig 1). Of these, 29,435 met exclusion criteria. Characteristics of the 130,262 patients in the final sample are included in Table 1. The median age was 4 months (interquartile range, 2–9 months); a majority were male (58%) and had public insurance (59%).

This analysis included a total of 37,907 patients divided into the 3 time cohorts: preguideline, $n = 9949$; postguideline early, $n = 13,741$; and postguideline late, $n = 14,217$. In this analysis, there was minimal change between the preguideline and postguideline early groups but a decrease in resource use in the postguideline late group (Fig 2). There were statistically significant decreases in use of diagnostic tests including CBC counts, CXRs, and RSV testing ($P < .001$). In regard to treatment modalities, there was a statistically significant decrease in usage of corticosteroids and bronchodilators ($P < .001$); the strength of the decrease for antibiotic use was not statistically significant by our predefined criterion ($P = .007$). Duration of bronchodilator days was also analyzed, and although the median days of use remained constant (1 day), the interquartile range was lower (0–1 days) in the postguideline late group than in the preguideline and postguideline early groups (0–2 days) ($P < .001$).

Segmented regression analysis was done to account for hospital clustering and to compare rates of change before and after the publication of the guidelines in 2006 (Figs 3 and 4). This analysis includes the whole study population ($n = 130,262$) over the entire study period (November 2004 to March 2012) and calculates the rate of change over the specified period by using October 2006, year of guideline.

![Study Population](image)

**FIGURE 1**
publication, as the event point. In the adjusted analysis, the monthly rate of change for CXR use before guideline publication was +0.39, and after guideline publication, the monthly rate of change for CXR use was −0.52 (P < .0001 for comparison). This represents an increasing rate of use before the guidelines were published, compared with a significantly different and decreasing rate of use afterward. A similar trend was noted for CBC count use (preguideline rate of change = 0.14, postguideline rate of change = −0.28, P = .0061) and treatment options, including corticosteroids (preguideline rate of change = 0.42, postguideline rate of change = −0.48, P < .0001) and bronchodilators (preguideline rate of change = 0.40, postguideline rate of change = −0.46, P < .0001). The change in CBC count use was not statistically significant by the predefined criteria of P < .001, but it does approach significance. Although there was a trend toward similar findings with antibiotic usage (preguideline rate of change = 0.10, postguideline rate of change = −0.16, P = .08), this change was not statistically significant. Counter to the results of the unadjusted analysis, RSV testing use was actually decreasing before guideline publication and increasing after guideline publication (preguideline rate of change = −0.5, postguideline rate of change = 0.23, P = .047); however, this relationship is not as statistically strong as the other factors.

To analyze results with a longer pre-guideline period, additional analysis was run by using the same inclusion and exclusion criteria over a longer time interval, from January 2002 to December 2012. Over this study period, only 26 hospitals contributed data for the entire time period, yielding a final study population of 112,637. Segmented regression analysis revealed similar results, with statistically significant decreased use of CXR and bronchodilators; however, although they were decreasing, rates of CBC count and steroid use were no longer significant.

**DISCUSSION**

For hospitalized patients with bronchiolitis aged 1 to 24 months, we show a temporal association between publication of the 2006 AAP bronchiolitis guidelines and a decrease in resource use, including both diagnostic tests (CBC count and CXR) and therapies (corticosteroids and bronchodilators). We did not see a strong change in utilization patterns for RSV testing and antibiotic use. It is possible that hospitals continued to use RSV testing to cohort patients for admission, which may explain why we did not see a statistically significant decrease in usage. Although we cannot demonstrate a causal relationship, this reduction of
diagnostic testing and treatment resources for bronchiolitis after guideline publication is striking and may be reducing costs associated with this common respiratory illness.

A recent publication evaluated the impact of the AAP guidelines on management of bronchiolitis in the emergency department (ED). By using the National Hospital Ambulatory Medical Care Survey (NHAMCS), a nationally representative sample of ED visits, the authors found a decrease in diagnostic imaging with CXR but no decrease in nonrecommended therapies, such as bronchodilators, corticosteroids, and antibiotics. In contrast, our study showed a reduction of diagnostic tests, both CXR and CBC count, and nonrecommended medications. This discrepancy may reflect the differences in the NHAMCS and PHIS databases. NHAMCS includes ED encounters from a diversity of hospitals, including general ED and children's facilities, whereas PHIS captures only encounters at children's hospitals. In the ED study, when the data were stratified by ED type, there was reduction in the use of CXRs, steroids, and antibiotics in children's facilities after the guidelines’ publication but no reduction in bronchodilators. This may suggest better adoption of national guidelines at children's hospitals compared with general hospitals. In addition, the difference in the ED patients compared with the admitted patients may reflect the training differences between ED clinical staff (eg, physician assistants and nonpediatric trained ED clinicians) and pediatric hospitalists.

Although this study seeks only to evaluate the impact of the national guidelines, some studies suggest that local clinical practice guidelines are what drive change at the local level. Local guidelines have been reported to be effective in reducing the use of diagnostic testing and non-recommended medication use in patients with other respiratory illnesses, such as pneumonia. Another factor that has been shown to drive adherence to the evidence-based diagnostic and treatment options for bronchiolitis for inpatients is hospitalist care compared with nonhospitalist care. In a retrospective chart review of children admitted to 2 different academic centers, researchers

![FIGURE 3](image_url)

**FIGURE 3**

Time series analysis for diagnostic testing over 41 hospitals from November 2004 to March 2012 (n = 130,262). A, CBC utilization: Preguideline slope is 0.14, and Postguideline slope is −0.26, *P < .001*. B, CXR utilization: Preguideline slope is 0.40, and Postguideline slope is −0.52, *P < .0001*. C, RSV utilization: Preguideline slope is −0.50, and Postguideline slope is 0.23, *P < .001*, implying statistical significance.

![FIGURE 4](image_url)

**FIGURE 4**

Time series analysis for medication use over 41 hospitals from November 2004 to March 2012 (n = 130,262). A, Bronchodilator utilization: Preguideline slope is 0.40, and Postguideline slope is −0.46, *P < .0001*. B, Steroid utilization: Preguideline slope is 0.42, and Postguideline slope is −0.48, *P < .0001*. C, Antibiotic utilization: Preguideline slope is 0.10, and Postguideline slope is −0.16, *P < .001*, implying statistical significance.
found that hospitals were more likely to discontinue bronchodilator, corticosteroid, and antibiotic use than non-hospitals.\textsuperscript{10} These results are similar to those of another study, which used a national survey administered to hospitalists and community pediatricians and found that hospitalists were significantly more likely to report rarely or never using therapies of unproven benefit for bronchiolitis, namely levosalbuterol and steroid therapy (both inhaled and oral).\textsuperscript{12} Overall, local clinical practice guidelines and hospitalist care have been shown to increase adherence to bronchiolitis guidelines and to increase guideline adherence in a diversity of hospitals throughout the country.

This study had several limitations. First, it used an administrative and billing database, which did not include detailed clinical information related to the encounter. The establishment of our patient sample was based strictly on diagnosis and procedure codes. For example, we included children from 1 month to 2 years of age because of the guideline parameters, and it is possible that as children approached 2 years of age, we included patients with reactive airway disease or asthma. Furthermore, although we saw a decrease in the use of steroids and bronchodilators, it is possible that there was a greater effect in the younger children, and we will be evaluating this in future analysis. In addition, we cannot exclude the possibility that specific tests or therapies were used for reasons not addressed by the guidelines. For example, we do not know which PHIS hospitals continued to use RSV testing to cohort patients. Second, the PHIS database includes only freestanding children’s hospitals and does not reflect practice patterns of non-PHIS hospitals, namely community hospitals. More than 70% of infants and toddlers presenting with bronchiolitis are seen at community hospitals, and therefore this study evaluated practice patterns for a minority of total inpatients. Third, although there was a decrease in resource use after the publication of the AAP guidelines, we are unable to determine a causal relationship. However, by using a segmented regression analysis, we are able to account for hospital clustering and to evaluate change in utilization patterns by evaluating monthly rates of use. Although it cannot establish a causal relationship, this analysis strengthens the association of improvement with guideline publication.

Fourth, this study did not evaluate other factors or cointerventions that may have contributed to the changes in resource use, such as hospital-based clinical practice guidelines or order sets, professional training of the provider, or the region of the hospital. Finally, 2 of our measured outcomes (bronchodilator and antibiotic use) present unique limitations. The AAP guidelines recommend initiating a trial of bronchodilators and discontinuing use if there is no benefit. In our analysis, we tried to account for this limitation by incorporating a measure of bronchodilator duration in days. In addition, although antibiotics are not recommended for the treatment of bronchiolitis, there are comorbid bacterial illnesses, such as otitis media and urinary tract infection, for which antibiotics are needed. Our study does not account for appropriate antibiotic usage in patients with bronchiolitis and a concomitant bacterial infection.

**CONCLUSIONS**

The AAP’s publication of its 2006 evidence-based guidelines for bronchiolitis was associated with a reduction of non-evidence-based diagnostic testing and medication use for inpatients in a representative sample of children’s hospitals. These trends may demonstrate a benefit of nationally developed guidelines to reduce variations in care and unnecessary costs. However, future studies should focus on factors associated with implementation and adherence, and should include a greater diversity of hospitals.

**ACKNOWLEDGMENTS**

Dr Parikh is a recipient of the Young Investigator Award from the Academic Pediatric Association. This research was supported by an Academic Pediatric Association Young Investigator Award supported by The Aetna Foundation, a national foundation based in Hartford, CT that supports projects to promote wellness, health, and access to high-quality health care for everyone. The views presented here are those of the author and not necessarily of the Aetna Foundation, its directors, officers, or staff.

**REFERENCES**


Bronchiolitis Management Before and After the AAP Guidelines
Kavita Parikh, Matthew Hall and Stephen J. Teach

Pediatrics; originally published online December 2, 2013;
DOI: 10.1542/peds.2013-2005

The online version of this article, along with updated information and services, is located on the World Wide Web at:
/content/early/2013/11/26/peds.2013-2005