Bronchiolitis Management Before and After the AAP Guidelines

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

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

**ABBREVIATIONS**
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.

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Address correspondence to Kavita Parikh, MD, Division of Hospitalist Medicine, 111 Michigan Ave NW, Washington, DC 20010.
E-mail: kparikh@childrensnational.org

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**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.

**abstract**

**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
Bronchiolitis is a common respiratory illness that predominantly affects infants and young children and accounts for $543 million annually in hospitalization charges. 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. Nonetheless, significant variability persists in the care for patients with bronchiolitis, 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.

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. In 2006, the American Academy of Pediatrics (AAP), 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.

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, a billing charge for mechanical ventilation, a length of stay >10 days, and any readmission during the study period. According to Feudtner et al, 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
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 = −0.26, 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 preguideline 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...
found that hospitals were more likely to 
discontinue bronchodilator, cortico-
steroid, and antibiotic use than non-
hospitals. These results are similar 
to those of another study, which used a 
national survey administered to hos-
pitals and community pediatricians 
and found that hospitalists were signifi-
cantly more likely to report rarely or 
ever using therapies of unproven ben-
efit for bronchiolitis, namely leve-lbuterol 
and steroid therapy (both inhaled and 
oral). 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 de-
tailed 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. Further-
more, 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 thera-
pies were used for reasons not 
addressed by the guidelines. For ex-
ample, 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 re-
fect practice patterns of non-PHIS 
hospitals, namely community hospi-
tals. 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 inpa-
tients. Third, although there was a de-
crease in resource use after the 
publication of the AAP guidelines, we 
are unable to determine a causal re-
lation. However, by using a seg-
mented regression analysis, we are 
able to account for hospital clustering 
and to evaluate change in utilization 
between hospitals. Although it cannot 
establish a causal relationship, this analysis 
strengthens the association of im-
provement 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 pro-
vider, 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 broncho-
dilator duration in days. In addition, 
although antibiotics are not recom-
mended for the treatment of bron-
chiolitis, there are comorbid bacterial 
ilnesses, such as otitis media and 
urinary tract infection, for which anti-
biotics are needed. Our study does not 
account for appropriate antibiotic us-
age 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 repre-
sentative sample of children’s hospitals. 
These trends may demonstrate a benefit 
of nationally developed guidelines to re-
duce variations in care and unnecessary 
costs. However, future studies should 
focus on factors associated with imple-
mentation and adherence, and should 
include a greater diversity of hospitals.

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