



# Variation in the Management of Infants Hospitalized for Bronchiolitis Persists after the 2006 American Academy of Pediatrics Bronchiolitis Guidelines

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**Objective** To describe variation across US pediatric hospitals in the utilization of resources not recommended for routine use by the American Academy of Pediatrics guideline for infants hospitalized with bronchiolitis and to examine the association between resource utilization and disposition outcomes.

**Study design** We conducted a cross-sectional study of infants  $\leq 12$  months hospitalized for bronchiolitis from 2007-2012 at 42 hospitals contributing data to the Pediatric Health Information System. Patients with asthma were excluded. The primary outcome was hospital-level variation in utilization of 5 resources not recommended for routine use: albuterol, racemic epinephrine, corticosteroids, chest radiography, and antibiotics. We also examined the association of resource utilization with length of stay (LOS) and readmission.

**Results** In total, 64 994 hospitalizations were analyzed. After adjustment for patient characteristics, albuterol (median, 52.4%; range, 3.5%-81%), racemic epinephrine (20.1%; 0.6%-78.8%), and chest radiography (54.9%; 24.1%-76.7%) had the greatest variation across hospitals. Utilization of albuterol, racemic epinephrine, and antibiotics did not change significantly over time compared with small decreases in corticosteroid (3.3%) and chest radiography (8.6%) use over the study period. Utilization of each resource was significantly associated with increased LOS without concomitant decreased odds of readmission.

**Conclusions** Substantial use and variation in 5 resources not recommended for routine use by the American Academy of Pediatrics bronchiolitis guideline persists with increased utilization associated with increased LOS without the benefit of decreased readmission. Future work should focus on developing processes that can be widely disseminated and easily implemented to minimize unwarranted practice variation when evidence and guidelines exist. (*J Pediatr* 2014;165:786-92).

See editorial, p 655

Acute bronchiolitis is the most frequent lower respiratory infection in infants, and the most frequent cause of hospitalization in this age group.<sup>1-3</sup> At a cost of more than \$500 million annually, bronchiolitis is one of the most expensive diseases of hospitalized children and costs appear to be increasing.<sup>4,5</sup> Despite numerous evaluations of potential management strategies, effective therapies for bronchiolitis remain elusive.

When evidence is lacking for effective management of a common condition, the result is unwarranted variability in care, the variation in medical care due to differences in health system performance.<sup>6</sup> Clinical practice guidelines aim to decrease this unwarranted practice variation and optimize resource utilization. Several studies performed before the availability of a national bronchiolitis guideline in the US found considerable variation in the management of bronchiolitis in the emergency department (ED) and inpatient settings, including substantial use of diagnostic tests and therapies without strong evidence to support routine use.<sup>7-10</sup> In October 2006, the American Academy of Pediatrics (AAP) published clinical practice guidelines to provide an evidence-based approach to the diagnosis, management, and prevention of bronchiolitis.<sup>11</sup> This guideline recommends against routine use of chest radiography and corticosteroids, and suggested that antibiotics be used only in children with bacterial co-infection. In addition, it recommends against routine use of bronchodilators, but allows for an option of a trial of albuterol or racemic epinephrine to be continued only if the patient demonstrates objective improvement. Since guideline publication, 2 studies, including one using Pediatric Health Information System (PHIS) data, have

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AAP	American Academy of Pediatrics
APR-DRG	All patient refined-diagnosis related group
ED	Emergency department
LOS	Length of stay
PHIS	Pediatric Health Information System

documented modest declines in overall utilization of resources not routinely recommended by the AAP guideline for inpatients with bronchiolitis.<sup>12,13</sup> Another nationally representative study of ED utilization of these resources found a decline in chest radiography, but no decrease in nonrecommended therapies.<sup>14</sup> These post-guidelines studies did not address practice variation, and to our knowledge, no studies have examined variation in care for infants with bronchiolitis subsequent to the publication of the national guidelines.

Our primary objective was to describe the variation across pediatric hospitals in the use of resources not routinely recommended by the AAP guideline for infants hospitalized with bronchiolitis. We also sought to examine the association between resource utilization and disposition outcomes, including length of stay (LOS) and hospital readmissions.

## Methods

This multicenter cross-sectional study included inpatient visits of children diagnosed with bronchiolitis. Data were from the PHIS, an administrative database of 43 not-for-profit, tertiary care pediatric hospitals in the US affiliated with the Children's Hospital Association, Shawnee Mission, Kansas. This database accounts for ~20% of annual pediatric hospitalizations in the US. Data quality and reliability are assured through a joint effort between Children's Hospital Association and participating hospitals. Forty-two PHIS hospitals that submitted resource utilization data (eg, pharmaceuticals, imaging, and laboratory tests) were included in this study. Data are de-identified, but encrypted medical record numbers permit identification of patients across multiple visits to the same hospital.<sup>15</sup> For the current study, data were included from 5 respiratory seasons, beginning in October 2007, 1 year after the guidelines were published, through March 2012, which was the most recent data available at time of analysis.

Patients 12 months and younger who were hospitalized with a diagnosis of bronchiolitis were eligible for inclusion. Bronchiolitis was defined by the presence of both a primary *International Classification of Diseases, 9th Revision* code (466.11, 466.19) and an all patient refined-diagnosis related group (APR-DRG) code of bronchiolitis (138) to minimize misclassification.<sup>7</sup> Given that the majority of patients with bronchiolitis at PHIS hospitals are hospitalized for 3 days or less, the study population was limited to those with a LOS 7 days or less to capture patients with typical bronchiolitis that are the target of the AAP guideline. If a patient had multiple hospitalizations over the study period, we included only the first hospitalization, as patients with recurrent hospitalizations for bronchiolitis may be treated differently than those who present with their first episode. Finally, because patients with a diagnosis of asthma would be managed differently, patients with an *International Classification of Diseases, 9th Revision* code of asthma listed in any diagnosis position were excluded.

Utilization was examined for 5 resources not routinely recommended by the AAP guideline for bronchiolitis care—albuterol, racemic epinephrine, systemic corticoste-

roids, chest radiography, and antibiotics. All resource use was determined using PHIS-specific Clinical Transaction Classification codes.

## Outcome Measures

The primary outcome was hospital-level variation in rates of resource utilization of albuterol, racemic epinephrine, systemic corticosteroids, chest radiography, and antibiotics. As secondary outcomes, we examined the association of utilization of these five resources with inpatient LOS and hospital readmission within 3, 7, and 14 days for bronchiolitis after the index hospitalization.

## Covariates

The following patient-level covariates were included to account for differences in demographics and case-mix across hospitals: age, sex, race/ethnicity, primary source of payment, and admission season and year. As a measure of patient severity, we utilized the APR-DRG severity subscore. This score represents the illness severity of hospitalized patients taking into account their entire hospitalization, separated into 4 categories from mild to extreme. They are calculated from computer algorithms on the basis of age, sex, diagnoses, procedures, and discharge status.<sup>16,17</sup> The following hospital-level covariates were included to account for the effects of individual hospital traits in the outcomes: geographic location, average daily census, percent uninsured, average APR-DRG severity score of all patients cared for at the hospital for the study period, and average annual number of bronchiolitis hospitalizations at each hospital.

## Statistical Analyses

Unadjusted distributions for each resource were determined by calculating the rate of subjects at each hospital who received the resource and summarizing these rates across hospitals. Unadjusted rates of utilization over time were explored using the test for linear trend. Adjusted rates were obtained by adjusting hospital-level utilization rates for patient-level characteristics. We employed a mixed-effects logistic regression model for the subject-level binary outcome of resource use (eg, chest radiography, yes/no), adjusted for patient age, race/ethnicity, year and season of presentation, insurance status, and APR-DRG severity score, with hospital-specific random intercepts. Each random intercept represented the degree to which a hospital's resource use departed from what would be expected on average for a hospital with similar case-mix. We used this model to estimate population-averaged rates of resource use expected at each hospital based on its patients' characteristics. These expected rates were compared with observed rates at each hospital, and an adjusted rate was obtained by standardizing the unadjusted rate by this ratio of observed to expected rates of resource use.<sup>18</sup> To examine resource utilization at the hospital level, we assigned utilization quartiles for each resource within each hospital based on their use. We then developed a total rank score based on the quartile and sorted hospitals by that score.

The association of resource utilization with LOS and readmission was determined using hierarchical models of

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