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Emergency Department Management of Bronchiolitis in the United States

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Abstract

Objective—To examine differences between general and pediatric emergency departments in adherence to AAP bronchiolitis management guidelines.

Methods—We conducted a nationally representative study of ED visits by infants <24 months of age with bronchiolitis from 2002–2011 using the National Hospital Ambulatory Medical Care Survey. Diagnostic testing (complete blood counts, radiographs) and medication use (albuterol, corticosteroids, antibiotics and intravenous fluids) in GEDs were compared with PEDs before and after 2006 AAP guideline publication. Weighted percentages were compared and logistic regression evaluated the association between ED type and resource use.

Results—Of over 2.5 million ED visits for bronchiolitis from 2002–2011, 77.3% occurred in GEDs. GEDs were more likely to use radiography (62.7% vs. 42.1%, aOR 2.4 [95%CI 1.4,4.1]), antibiotics (41.3% vs. 18.8%, aOR 2.8 [1.5,5.2]), and corticosteroids (24.3% vs. 12.5%, aOR 2.1 [1.0,4.5]) compared to PEDs. Compared to pre-guideline, after guideline publication PEDs had a greater decrease in radiography use (-19.7%, 95%CI -39.3,-0.03) compared with GEDs (-12.2%, 95%CI -22.3,-2.1) and PEDs showed a significant decline in corticosteroid use (-12.4%, 95%CI -22.1,-2.8%) whereas GEDs showed no significant decline (-4.6%, 95%CI -13.5, 4.3).

Conclusions—The majority of ED visits for bronchiolitis in the US occurred in GEDs, yet GEDs had increased use of radiography, corticosteroid, and antibiotics and did not show substantial declines with national guideline publication. Given that national guidelines discourage the use of such tests and treatments in the management of bronchiolitis, efforts are required to decrease ED use of these resources in infants with bronchiolitis, particularly in GEDs.

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Keywords

bronchiolitis; children; emergency department; clinical practice guideline; pediatrics; resource utilization; evidence-based guidelines; NHAMCS

Introduction

Bronchiolitis is the leading cause of lower respiratory tract infection in children up to 2 years of age and accounts for a considerable number of emergency department (ED) visits by infants each year in the United States (US).¹⁻⁶ In response to substantial practice variation, the American Academy of Pediatrics (AAP) published clinical practice guidelines in 2006 to provide evidence-based recommendations for the management of bronchiolitis to minimize variation and decrease use of therapies not shown to have benefit, including recommending against routine use of chest radiography, laboratory testing, bronchodilators, corticosteroids, and antibiotics.^{2,5} A nationally representative study of EDs in the US using National Hospital Ambulatory Medical Care Survey (NHAMCS) data from 2001-2009 found that after guideline introduction, there was a decrease in radiography, yet there was no change in ED utilization of non-recommended therapies, including bronchodilators, corticosteroids, and antibiotics, compared with before the guideline release.³ Updated AAP bronchiolitis guidelines were published in 2014 with stronger emphasis on avoiding therapies not shown to have benefit, particularly bronchodilators.⁷ Understanding the factors associated with non-adherence to published guidelines is critical to standardize and improve clinical care as newer guidelines are published. Practice setting, such as pediatric-specific emergency departments (PED) and general emergency departments (GED), is likely one such factor affecting resource utilization.

Most studies of practice patterns and outcomes for bronchiolitis focused on pediatric institutions and PEDs;⁸⁻¹⁰ however, the vast majority of children with bronchiolitis are managed in general emergency departments (GEDs) caring for adults and children.³ Practice differences exist between PEDs and GEDs for several common pediatric conditions, including fever, croup, asthma, and pneumonia.¹⁰⁻¹⁴ One regional study found differences in albuterol and corticosteroid use, in addition to hospitalization rates, in patients with bronchiolitis between GEDs and PEDs prior to the publication of the 2006 guidelines.¹⁵ A study from Taiwan suggested that compared to pediatricians, emergency medicine physicians are more likely to obtain diagnostic testing in children with bronchiolitis, with a discrepancy between what occurs in clinical care and local guideline recommendations.¹⁶ In the NHAMCS study cited above, while there was no change in non-recommended therapies after guideline publication, PEDs were less likely to use radiographs, steroids and antibiotics and more likely to use bronchodilators during the overall 9-year study period.³ Differences in care in PEDs and GEDs were not examined in detail, however, before and after guideline publication as a possible explanation for the study's overall findings. It is possible that PEDs may have shown a decrease in use of non-recommended therapies, while no overall decrease was observed due to either unchanged or increased use in GEDs. Therefore, the objective of this study was to evaluate the specific impact of ED type, PED or GED, on use of non-recommended tests and treatments on a national scale. We hypothesized that GEDs will have

increased utilization of non-recommended tests and treatments, including bronchodilators, corticosteroids, chest radiography, and antibiotics, compared with PEDs. Furthermore, we believe that PEDs will have a greater decrease in use of non-recommended resources after guideline introduction.

Materials and Methods

Study Design

This was a cross-sectional study using data from the NHAMCS from 2002-2011. NHAMCS is a publically available data set that contains de-identified patient information. The NHAMCS is conducted annually by the Centers for Disease Control and Prevention and the National Center for Health Statistics. The survey utilizes a four-stage probability multistage sample design to collect data from non-federal, general, short-stay hospitals. To ensure a nationally representative sample, the NHAMCS is administered after sampling geographic primary sampling units (PSUs), hospitals within PSUs, EDs within hospitals and patients within EDs.¹⁷ The survey sampling methodology, multistage estimation procedure, and implementation has been described elsewhere.^{17,18} This study was deemed to not be human subjects' research by our Institutional Review Board and, therefore, exempt from review.

Study Setting and Population

Data from the years 2002-2011 were analyzed to generate national estimates of ED visits for children with bronchiolitis and to examine ED practice patterns for children with bronchiolitis before and after the release of the 2006 AAP guidelines. The study population consisted of children less than 24 months of age who presented to the ED with a diagnosis of bronchiolitis. Bronchiolitis was defined as the presence of an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes beginning with 466.X in any of the 3 physician's diagnosis codes or the principal hospital discharge diagnosis captured by NHAMCS.

Variables

The primary variable of interest was ED type, dichotomized as PED or GED. Consistent with prior work, PEDs were defined as those in which 75% of patients evaluated were younger than 18 years of age.¹¹ Age was collected in NHAMCS as age in days for patients under 1 year of age and age in years for those 1 year. Patient visits were grouped into 2 time-based cohorts based on the publication of the guidelines. Pre-guidelines visits were classified as ED visits occurring before and during October 2006. Visits occurring after October 2006 were classified as post-guideline visits. Insurance status was categorized as private or non-private. Consistent with prior studies demonstrating that triage level is a reliable indicator of disease severity, triage level and triage vital signs were used as proxies for disease severity at presentation.¹⁹⁻²¹ Hospital-level covariates studied included geographic region and academic teaching status. Geographic region was coded as a 3-level variable representing census regions: Northeast, Midwest/West, and South. Midwest and West were combined due to small cell sizes that would not allow for accurate estimates. Consistent with prior studies, an academic-focused ED was defined as a site in which 10% of patients were seen by a resident physician.³

Outcome Measures

Outcomes of interest included utilization rates of diagnostic testing (complete blood counts (CBC), chest radiographs (CXR)), and medications (albuterol, corticosteroids, antibiotics, and intravenous (IV) fluids). Consistent with prior NHAMCS studies, hospitalized patients were defined as those admitted to the hospital ward, intensive care unit, or observation unit.^{3,11} In order to capture the intent to hospitalize, patients transferred to another institution from GEDs were considered as hospitalized since GEDs often do not have the ability to admit infants and must transfer infants to a pediatric institution for hospitalization. Up to 8 medications are recorded in NHAMCS for each patient visit. Receipt of albuterol was defined as administration of any nebulized albuterol administration in the ED or prescribed at discharge. Corticosteroid use was defined as systemic administration only; nebulized corticosteroids were excluded. Antibiotic use was defined as any systemic antibiotic administered in the ED or prescribed at discharge.³ Performance of a CBC, CXR, and administration of IV fluids was categorized dichotomously as yes or no.

Data Analysis

Weighted frequency distributions and means were calculated for patient, clinical, visit, and hospital characteristics; hospitalization; and use of diagnostic testing and medications. Chi-square tests and regression models were used to test for differences between PEDs and GEDs with respect to categorical and continuous variables, respectively. Logistic regression was used to develop adjusted odds ratios comparing GEDs to PEDs on the use of tests and medications during three time periods (entire study period, pre- and post-guideline). Odds ratios were adjusted for age, sex, race, hospital academic status, and triage level. The weighted change in percent use of tests and medications from pre- to post-guideline with 95% confidence intervals were calculated for all EDs, PEDs and GEDs. Similarly, adjusted odds ratios were developed to compare pre- and post- guideline use of diagnostic testing and medications.

To account for appropriate use of antibiotics for bacterial infection, a sensitivity analysis was performed to examine antibiotic use in infants with bronchiolitis excluding those with an ICD-9-CM code indicating bacterial infection using previously defined ICD-9-CM codes (Table, Supplemental Digital Content 1).^{11,22,23} Similarly, to account for bronchodilator and corticosteroid use in patients considered to have asthma, a sensitivity analysis was performed examining use of these medications excluding patients with an ICD-9-CM code indicating asthma (493.X). Analyses were performed using SAS v.3.

Due to the complex sampling design and clustering of observations within hospital, SAS survey procedures were used to analyze the data using the patient visit weight and variables denoting the sample stratum and cluster.²⁴ Comparisons were not made if the standard error exceeded 30%, unless otherwise specified, due to the instability of the estimates per NHAMCS instructions.²⁴

Results

There were 751 visits with bronchiolitis recorded in NHAMCS from 2002-2011, which represents a weighted national estimate of over 2.5 million visits for bronchiolitis in US emergency departments during the study period. Of those, 46.9% occurred during the pre-guideline period and 77.3% occurred in GEDs. Overall, infants seen with bronchiolitis were male (60.6%), White (65.2%), and had non-private insurance (70.1%). Mean vital signs at triage were appropriate for age and there were not significant differences in triage vital signs between PED and GED, with the exception of respiratory rate, where mean respiratory rate was 46 breaths per minute in PED compared with 36 in GED. 15.9% of infants were hospitalized. 81.2% were seen in a non-academic ED. Compared to GEDs, infants presenting to PEDs were younger, had a longer average length of stay, and were more likely to visit an academic-focused ED (Table 1).

Overall, in unadjusted analyses GEDs were significantly more likely than PEDs to use radiography, antibiotics and corticosteroids and less likely to use albuterol (Table 2). In adjusted analyses, these associations persisted, with the exception of corticosteroids. The point estimate for corticosteroid use in adjusted analyses remained similar, but the result not statistically significant using the conventional $p < 0.05$ threshold with $p = 0.052$. During both the pre- and post-guideline periods, GEDs had higher odds of using chest radiography and antibiotics and lower odds of using albuterol compared with PEDs. GEDs had significantly higher odds of corticosteroid use only after guideline publication compared with PEDs. This was not observed during the pre-guideline period (Table 2).

When considering both ED types together, only radiography use significantly decreased after guideline publication (pre- to post-publication difference -13.1%, 95% CI -23%, -3.2%) (Table 3). Compared to pre-guideline, infants with bronchiolitis had 40% decreased odds (OR 0.6, 95% CI 0.4, 0.9) of receiving radiography in US EDs after adjusting for age, race, sex, triage level, and hospital academic status (Table 3). Figures 1 and 2 illustrate the weighted percentages of resource utilization by GEDs and PEDs in the pre- and post-guideline periods. The use of radiographs declined significantly from pre- to post-guideline in both GEDs (-12.2%, 95% CI -22.3%, -2.1%) and PEDs (-19.7%, 95% CI -39.3%, -0.03%) (Table 3, Figure 1). In adjusted analyses, PEDs had 60% decreased odds (OR 0.4, 95% CI 0.2, 1.0) of radiograph use post-guideline while GEDs had 40% decreased odds (OR 0.6, 95% CI 0.4, 1.0). There was no significant change in hospital admissions or CBC use in PEDs or GEDs. With regards to treatments provided, there was a significant reduction in corticosteroid use in PEDs only (-12.4%, 95% CI -22.1%, -2.8%) with no significant changes in intravenous fluid, albuterol or antibiotic use after guideline publication (Table 3, Figure 2). Infants seen in PEDs had 80% decreased odds of receiving corticosteroids after guideline compared with before in adjusted analyses (OR 0.2, 95% CI 0.1, 0.9).

Sensitivity analyses were performed excluding patients with asthma and with bacterial infections. When comparing GEDs with PEDs in use during the entire period, use during the pre-guideline period and use during the post-guideline period, the results were consistent with the exception of corticosteroid use post-guidelines. After guideline publication, the odds ratio of corticosteroid use in GEDs compared with PEDs increased from 4.8 to 11.2

after children with asthma diagnosis codes were removed from the analysis (Table, Supplemental Digital Content 2). Sensitivity analyses revealed no substantive differences in the change of use from the pre- to post-guideline periods from the original analyses. (Table, Supplemental Digital Content 3)

Discussion

This nationally representative study demonstrates that GEDs used more radiography, antibiotics and corticosteroids and less albuterol compared with PEDs for infants with bronchiolitis from 2002-2011. All of these tests and treatments were not recommended for routine use by the AAP bronchiolitis guidelines in 2006.^{5,7} Furthermore, although radiography use decreased in both PEDs and GEDs before and after guideline publication, the relative decrease in radiography was greater in PEDs. Corticosteroid use declined only in PEDs from pre- to post-guideline periods, with no significant change in GEDs. These results suggest that there is a substantial need to disseminate and increase adherence to national evidence-based guidelines for bronchiolitis in the ED setting, particularly in GEDs where the majority of infants with bronchiolitis receive ED care in the United States.

Johnson and colleagues examined the impact of the 2006 AAP guidelines on ED resource utilization for bronchiolitis using NHAMCS from 2001-2009.³ This study found a decrease in radiography after guideline publication, but no significant change in the use of bronchodilators, corticosteroids, and antibiotics. From 2001-2009, PEDs were significantly less likely to use chest radiography, corticosteroids, and antibiotics overall; however, the relationship between guideline publication on use of non-recommended tests and medications in different ED types was not specifically examined. Our results expand upon this study with more recent data and an examination of resource use by ED type before and after guideline publication. Our findings elaborate on the previous study by suggesting that GEDs use more overall and that pediatric guideline publication is not associated with significant practice change in GEDs. We found that PEDs significantly decreased corticosteroid use after guideline publication, while use of corticosteroids in GEDs did not change. Considering their side effects, continued use of corticosteroids when not routinely recommended by evidence and national guidelines is concerning.

Our finding of decreased radiography use is consistent with two other studies that examined resource utilization for bronchiolitis before and after guidelines in pediatric-specific populations.^{10,25} Our results demonstrate that while both GEDs and PEDs had statistically significant decreases in radiograph use after guideline publication, the relative decrease in PEDs was almost double that of GEDs. In addition, despite the statistically significant decline, approximately 60% of infants with bronchiolitis received a radiograph in GEDs during the five years after guideline publication. This degree of utilization is troubling given that chest radiography has not been shown to be beneficial in the vast majority of patients, increases cost, increases ionizing radiation exposure and increases unnecessary antibiotic use.²⁶

Pediatric EDs had increased use of albuterol in our study, consistent with Johnson's study. Given data suggesting that albuterol is largely ineffective in bronchiolitis, the reason for this

is unclear. Regardless, albuterol use did not appear to change significantly before and after guideline publication and use remained high (>50%) in both PED and GED settings after guideline recommendations against routine use. One possible explanation for the lack of change is that the 2006 guideline allows for an objectively measured “trial” of albuterol to assess effectiveness.⁵ The 2014 revised guideline makes a stronger statement against the use of any trial of bronchodilators; it is yet to be determined if this firmer stance has greater effect on albuterol use in the ED.⁷

There are several explanations for increased utilization and apparent decreased guideline adoption in GEDs compared with PEDs. Different training backgrounds between pediatric and general emergency physicians likely result in differences in the care of pediatric patients. Overall, 30-60% of physicians report lack of awareness of published clinical guidelines.²⁷⁻²⁹ General emergency physicians may not be aware of pediatric specific guidelines or guidelines published in pediatric journals.¹⁶ In addition, guidelines are often more readily available and disseminated in an academic setting.²⁸ Although more PEDs were academic (41.9%) compared with GEDs (21.1%) in our study, differences between PEDs and GEDs persisted after adjustment for hospital academic status.

Use of testing and treatments that have not been shown to be beneficial and are not routinely recommended by evidence-based guidelines results in unnecessary and costly resource use. Many strategies have been explored to raise awareness and improve efforts to disseminate guidelines.^{27,28} Despite these efforts, even when physician awareness is high, simple dissemination has been ineffective in creating and maintaining lasting changes in clinical practice.³⁰⁻³⁴ Although awareness of a clinical practice guideline was 69% amongst physicians in one study, only 17% used the guidelines in practice and 18% changed clinical behavior.²⁷ An integrated implementation team is often needed to reinforce and promote guideline adherence.^{35,36}

Successful implementation of guidelines has been demonstrated on a local level through the use of local and multicenter improvement collaboratives.^{11,35,37-41} In a single bronchiolitis season, Kotagal et al were able to successfully implement and extend an evidence-based bronchiolitis clinical practice guideline from one site to multiple sites with significant changes in practice.³⁵ In both the ED and inpatient settings, implementation of a bronchiolitis clinical practice guideline resulted in reduced use of radiography, bronchodilators and corticosteroids.⁴¹ Using quality improvement methodology, a collaborative of 21 community and children's hospitals successfully reduced bronchodilator, corticosteroid, radiography and length of stay in hospitalized children with bronchiolitis, illustrating the power of a multisite collaboration in improving resource utilization.⁴² Often times, a combination of interventions, including 1) local education outreach visits and marketing to raise awareness; 2) effective local guidelines implementation; 3) local consensus process to provide feedback and resolve any challenges and barriers; 4) computerized decision tools; 5) physician champions at specific sites; and 6) continued reinforcement through a dedicated team, have been effective at promoting adherence to clinical guidelines.^{28,32,43}

Limitations

This study has several limitations. First, since this is an analysis of an existing data set, historical, examination, and management variables may not be captured or may be inadequate. Thus, additional confounders, such as illness severity, necessary to understand potential differences in resource utilization are not fully explored. We used triage level and vital signs as a proxy for severity, as prior studies have demonstrated this to be a valid measure to define the immediacy with which the patient should be seen.^{10,19-21} Second, we classified children transferred from GEDs as hospitalized to ensure maximum case ascertainment. In some of these transfers, patients could be discharged from PEDs, which would falsely categorize these patients as admissions from GEDs. However, GEDs often do not have the ability to admit children and thus the transfer to pediatric hospitals indicates the intent to admit. Third, more sophisticated analyses, such as an interrupted time series analysis, is not possible using NHAMCS data given restrictions on making national estimates with small annual numbers. Fourth, although revised AAP bronchiolitis guidelines were published in 2014, NHAMCS data after 2011 was not available at time of this analysis. Our results suggest that GEDs have more challenges implementing pediatric guidelines and we do not believe that an evaluation after publication of revised pediatric guidelines would have substantially different results. Finally, NHAMCS did not specify anatomic site of radiography since 2005. As all patients in our study had a diagnosis of bronchiolitis, consistent with prior studies, we assumed that all radiographs obtained were chest radiographs.^{3,11}

Conclusions

In this nationally representative study, GEDs demonstrated increased use of non-recommended tests and medications, namely radiography, corticosteroids, and antibiotic use, compared to PEDs both before and after publication of the 2006 AAP bronchiolitis clinical practice guideline. The relative decrease in radiography use was greater in PEDs, and corticosteroid use declined only in PEDs from pre- to post-guideline periods, with no significant change in GEDs. These data update and expand upon prior work suggesting that improved implementation of guideline-recommended testing and treatment is needed in the ED, but particularly in GEDs, where the majority of children with bronchiolitis are treated. Revised 2014 bronchiolitis guidelines present stronger recommendations against the routine use of radiography, antibiotics, bronchodilators and corticosteroids than the 2006 guidelines, further emphasizing the need to decrease utilization of these tests and treatments. Local and national quality improvement efforts and future research should focus on implementation of evidence-based recommendations to standardize care and improve health care outcomes for infants with bronchiolitis, particularly in GEDs.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1a: Hospital Admission¹

Figure 1b: CBC Use

Figure 1c: Chest Radiography Use

Figure 1. Weighted Percent Change in Hospital Admissions, CBC, and Chest Radiography between PEDs and GEDs Before (January 2002-October 2006) and After (November 2006-December 2011) Guideline Publication

*Exhibited a significant decline ($p < 0.05$) from pre- to post- guideline publication.

¹The relative standard error of the estimated percentages for PEDs both pre- and post-guideline is 0.37 for hospital admission.

Figure 2. Weighted Percent Change in Medication Use between PEDs and GEDs Before (January 2002-October 2006) and After (November 2006-December 2011) Guideline Publication

*Exhibited a significant decline ($p < 0.05$) from pre- to post- guideline publication

¹The relative standard error (RSE) of the estimated percentages for antibiotic use in PEDs is 0.30 and 0.38 for pre- and post- guideline periods, respectively. RSE for intravenous fluid use is 0.35 pre- and post-guideline periods.

²The RSE for the use of steroids in PEDs post-guideline was 0.64. This was due to the small percentage of patients in the sample receiving steroids post-guideline after the significant decrease in use among PEDs.

Table 1
Characteristics of Emergency Department Visits for Bronchiolitis in Children < 2 Years
Old in the United States, 2002-2011

	All (n=751)	PED (n=174)	GED (n=577)	p-value **
ESTIMATED WEIGHTED NUMBER OF VISITS	2,550,000	580,000	1,970,000	
PATIENT CHARACTERISTICS *				
Age (months)				
0-3	16.6	25.2	14.1	0.002
3-6	21.0	20.9	21.1	
6-12	31.8	37.9	30.0	
12-24	30.5	16.1	34.8	
Male Sex	60.6	59.7	60.8	NS
White Race	65.2	65.4	65.1	NS
Insurance Status				
Non-private Insurance	70.1	68.0	70.8	NS
Private Insurance	25.5	28.6	24.5	
Unknown	4.4	3.4	4.7	
CLINICAL CHARACTERISTICS *				
Triage Level				
Immediate/Emergent	12.5	14.4	11.9	NS
Urgent	40.3	34.6	42.0	
Semi/Non-Urgent	33.8	41.4	31.6	
No Triage/Unknown	13.4	9.7	14.5	
Hospital Admission ***	15.9	20.4	14.6	NS
Triage Vital Signs, mean				
Respiratory Rate (breaths per minute)	38	46	36	<0.001
Oxygen Saturation (%)	97	97	97	NS
Heart Rate (beats per minute)	147	151	146	NS
Blood Pressure (mmHg)	104/63	102/63	106/63	NS
Temperature (Fahrenheit)	98.2	97.7	98.3	NS
VISIT CHARACTERISTICS *				
ED LOS (minutes), mean	198	234	188	<0.001
Time of Arrival				
Day (8a-4p)	35.9	39.4	34.8	NS
Evening (4p-12a)	46.2	41.5	47.6	
Night (12a-8a)	17.9	19.1	17.6	
HOSPITAL CHARACTERISTICS *				
Academic-focused ED ****	18.8	32.2	14.9	0.024

	All (n=751)	PED (n=174)	GED (n=577)	p-value **
US Census Region				
Northeast	12.1	10.6	12.5	NS
Midwest/West	42.1	29.4	45.8	
South	45.8	60.0	41.7	

PED=Pediatric Emergency Department; GED=General Emergency Department

* All numbers reflect percentages unless otherwise stated

** Represents the difference between PED and GED

*** Hospital admission includes the proportion of patients admitted to the hospital from PED or the proportion of patients admitted to the hospital or transferred from GED (see text)

**** Defined as a site in which 10% of patient visits were seen by a resident physician (see text)

Table 2
Hospitalization, Diagnostic Testing and Medication Use in Patients with Bronchiolitis: General Emergency Departments Compared to Pediatric Emergency Departments (2002-2011)

	Weighted Percentage			Entire Study Period (2002-2011)		Pre-Guideline Period (2002-2006)		Post-Guideline Period (2007-2011)	
	Pediatric ED (95% CI)	General ED (95% CI)	p-value	Adjusted OR* (95% CI)	p-value	Adjusted OR* (95% CI)	p-value	Adjusted OR* (95% CI)	p-value
Hospital Admission	20.4 (8.8, 31.9)	14.6 (10.6, 18.6)	NS	0.9 (0.5, 1.7)	NS	1.6 (0.6, 4.1)	NS	0.5 (0.2, 1.2)	NS
Testing									
Complete Blood Count	19.8 (12.2, 27.5)	24.3 (19.1, 29.5)	NS	1.4 (0.9, 2.3)	NS	1.3 (0.6, 2.7)	NS	1.6 (0.7, 3.6)	NS
Chest Radiography	42.1 (30.3, 53.9)	62.7 (56.9, 68.6)	<0.001	2.4 (1.4, 4.1)	0.001	2.2 (1.1, 4.7)	0.035	3.4 (1.7, 7.0)	<0.001
Medications									
Intravenous Fluids	17.4 (8.3, 26.6)	13.6 (9.3, 17.9)	NS	0.8 (0.4, 1.5)	NS	0.8 (0.4, 1.8)	NS	0.8 (0.3, 1.8)	NS
Antibiotics	18.8 (11.0, 26.6)	41.3 (35.3, 47.3)	<0.001	2.8 (1.5, 5.2)	<0.001	2.5 (1.0, 6.3)	0.042	3.7 (1.3, 10.5)	0.014
Albuterol	69.0 (58.4, 79.5)	48.6 (43.7, 53.5)	0.003	0.4 (0.2, 0.7)	<0.001	0.4 (0.2, 0.7)	0.002	0.5 (0.2, 0.9)	0.027
Corticosteroids	12.5 (4.7, 20.3)	24.3 (19.5, 29.0)	0.008	2.1 (1.0, 4.5)	.052	1.5 (0.7, 3.1)	NS	4.8 (1.2, 19.7)	0.029

* Pediatric ED type is the referent group: odds ratios represent the odds of receiving the intervention in a general ED compared with a pediatric ED. Analyses are adjusted for age, race, sex, triage level, and hospital academic status.

Table 3
Hospitalization, Diagnostic Testing and Medication Use in Patients with Bronchiolitis: Before Guideline Publication Compared with After Guideline Publication

	All EDs		Pediatric EDs		General EDs	
	Change in % Use from Pre- to Post- (95% CI)	Adjusted Odds Ratios* (95% CI)	Change in % Use from Pre- to Post- (95% CI)	Adjusted Odds Ratios* (95% CI)	Change in % Use from Pre- to Post- (95% CI)	Adjusted Odds Ratios* (95% CI)
Hospital Admission	-0.5 (-9.4, 8.4)	1.1 (0.5, 2.1)	10.3 (-10.0, 30.6)	6.9 (1.0, 49.6)	-3.4 (-12.1, 5.3)	0.8 (0.4, 1.6)
Testing						
Complete Blood Count	-1.5 (-10.1, 7.0)	0.9 (0.6, 1.5)	0.5 (-16.0, 17.0)	1.0 (0.3, 3.5)	-2.4 (-12.9, 8.2)	0.9 (0.5, 1.6)
Chest Radiography	-13.1 (-23.0, -3.2)	0.6 (0.4, 0.9)	-19.7 (-39.3, -0.03)	0.4 (0.2, 1.0)	-12.2 (-22.3, -2.1)	0.6 (0.4, 1.0)
Medications						
Intravenous Fluids	0.4 (-7.0, 7.8)	1.1 (0.6, 2.1)	2.5 (-13.0, 18.0)	1.7 (0.5, 6.2)	0.0 (-8.2, 8.1)	1.1 (0.6, 2.2)
Antibiotics	-9.5 (-20.7, 1.6)	0.7 (0.4, 1.2)	-11.1 (-30.1, 7.8)	0.5 (0.2, 1.6)	-10.2 (-22.1, 1.7)	0.7 (0.4, 1.1)
Albuterol	-0.1 (-9.6, 9.3)	1.0 (0.7, 1.6)	-5.0 (-22.6, 12.7)	0.8 (0.4, 1.9)	2.3 (-7.4, 12.0)	1.2 (0.8, 1.8)
Corticosteroids	-5.9 (-13.4, 1.6)	0.7 (0.4, 1.1)	-12.4 (-22.1, -2.8)	0.2 (0.1, 0.9)	-4.6 (-13.5, 4.3)	0.7 (0.5, 1.2)

* Pre-Guideline period is the referent group; odds ratios represent the odds of receiving the intervention post-guideline compared to the pre-guideline time period. Analyses are adjusted for age, race, sex, triage level, and hospital academic status.