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ORIGINAL RESEARCH

Racial/Ethnic Differences in the Presentation and Management of Severe Bronchiolitis

Jonathan Santiago, MPH[1], Jonathan M. Mansbach, MD, MPH[2], Shih-Chuan Chou, MD[3], Carlos Delgado, MD[4], Pedro A. Piedra, MD[5], Ashley F. Sullivan, MS, MPH[6], Janice A. Espinola, MPH[6], Carlos A. Camargo Jr, MD, DrPH[6]*

[1]Yale School of Medicine, New Haven, Connecticut; [2]Department of Medicine, Boston Children's Hospital, Boston, Massachusetts; [3]Department of Emergency Medicine, Yale-New Haven Hospital, New Haven, Connecticut; [4]Department of Pediatric Emergency Medicine, Children's Healthcare of Atlanta at Egleston, Atlanta, Georgia; [5]Department of Molecular Virology and Microbiology, Baylor College of Medicine, Houston, Texas; [6]Department of Emergency Medicine, Massachusetts General Hospital, Boston, Massachusetts.

BACKGROUND AND OBJECTIVE: Bronchiolitis is the leading cause of hospitalization for US infants and is associated with increased risk of childhood asthma. Although studies have shown differences in the presentation and management of asthma across race/ethnicity, it is unclear if such differences are present for bronchiolitis. We examined if racial/ethnic differences exist in the presentation and management of severe bronchiolitis.

METHODS: We performed a 16-center, prospective cohort study from 2007 to 2010. Children <2 years old hospitalized with a diagnosis of bronchiolitis were included. A structured interview, chart review, and 1-week phone follow-up were completed. Multivariable logistic regression was used to examine the independent association between race/ethnicity and diagnostic imaging, treatment (eg, albuterol, corticosteroids, and continuous positive airway pressure/intubation), management (eg, intensive care unit admission and length of stay), discharge on inhaled corticosteroids, and bronchiolitis relapse.

RESULTS: Among 2130 patients, 818 (38%) were non-Hispanic white (NHW), 511 (24%) were non-Hispanic black (NHB), and 801 (38%) were Hispanic. Compared with all groups, NHB children were most likely to receive albuterol before admission (odds ratio [OR]: 1.58; 95% confidence interval [CI]: 1.20-2.07) and least likely to receive chest x-rays during hospitalization (OR: 0.66; 95% CI: 0.49-0.90). Hispanic children were most likely to be discharged on inhaled corticosteroids (OR: 1.92; 95% CI: 1.19-3.10).

CONCLUSION: We observed differences between NHW and minority children regarding preadmission albuterol use, inpatient diagnostic imaging, and prescription of inhaled corticosteroids at discharge, practices that deviate from the American Academy of Pediatrics guidelines. The causes of these differences require further study, but they support implementation of care pathways for severe bronchiolitis. *Journal of Hospital Medicine* 2014;9:565–572. © 2014 Society of Hospital Medicine

Bronchiolitis is the leading cause of hospitalization for infants in the United States, costs more than $500 million annually, and has seen a 30% increase ($1.34 billion to $1.73 billion) in related hospital charges from 2000 to 2009.[1–3] Almost all children <2 years old are infected with respiratory syncytial virus, the most common cause of bronchiolitis, with 40% developing clinically recognizable bronchiolitis and 2% becoming hospitalized with severe bronchiolitis.[4,5] Current American Academy of Pediatrics (AAP) guidelines state that routine use of bronchodilators, corticosteroids, and chest x-rays is not recommended, and supportive care is strongly encouraged.[6] However, a lack of consensus among clinicians persists regarding bronchiolitis management.[7–10]

*Address for correspondence and reprint requests: Carlos A. Camargo, MD, Department of Emergency Medicine, Massachusetts General Hospital, 326 Cambridge Street, Suite 410, Boston, MA 02114; Telephone: 617–726-5276; Fax: 617-724-4050; E-mail: ccamargo@partners.org

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Although minority children and those with a lower socioeconomic status (SES) in the United States are more likely to present with bronchiolitis to the emergency department (ED) and be subsequently admitted when compared to the general population,[11–13] to our knowledge, no study has yet examined if race/ethnicity is independently associated with differences in the presentation and management of severe bronchiolitis (ie, bronchiolitis causing hospitalization). Although a prior bronchiolitis-related study reported that Hispanic children had a longer ED length of stay (LOS) than non-Hispanic white (NHW) and non-Hispanic black (NHB) children,[14] other studies concluded that race/ethnicity were not predictors of intensive care unit (ICU) admission or unscheduled healthcare visits post-ED discharge.[15,16]

Determining if race/ethnicity is independently associated with certain bronchiolitis management tendencies has implications from both a health disparities standpoint (ie, unequal care based on race/ethnicity) and from a clinical perspective (ie, the potential of certain practices, such as clinical pathways, to increase the likelihood of equitable treatment). To address this knowledge gap, we examined prospective data from a multicenter study designed to evaluate multiple factors related to bronchiolitis hospitalization.

METHODS

Study Design

We conducted a multicenter prospective cohort for 3 consecutive years (2007–2010) as part of the Multicenter Airway Research Collaboration (MARC), a division of the Emergency Medicine Network (EMNet) (www.emnet-usa.org). Sixteen hospitals in 12 states (see Appendix) participated from November 1st until March 31st in each study year. At the beginning of each month, site investigators used a standardized protocol to enroll a target number of patients from the inpatient wards and ICU.

All patients were treated at the discretion of their physician. Inclusion criteria were hospital admission with physician diagnosis of bronchiolitis, age <2 years, and ability of the child's guardian (eg, parent) to give informed consent. Patients were enrolled within 18 hours of admission. Physician diagnosis of bronchiolitis followed the AAP definition of a child with an acute respiratory illness with some combination of rhinitis, cough, tachypnea, wheezing, crackles, and/or retractions.[6] The exclusion criteria were previous enrollment and if a patient was transferred to a participating site hospital>48 hours after the initial admission. All consent and data forms were translated into Spanish. The institutional review board at each participating site approved the study.

Data Collection

Site investigators used a standardized protocol to enroll 2207 patients admitted with bronchiolitis. Investigators conducted a structured interview that assessed patients' demographic characteristics, medical and environmental history, duration of symptoms, and details of the acute illness. Race/ethnicity was assigned by report of the child's guardian to standard US Census groups. For the purpose of this analysis, mutually exclusive race/ethnicity categories were determined: NHW, NHB, or Hispanic. Non-Hispanic patients who identified as being both white and black were categorized as NHB. Patients were excluded from analysis if neither white or black race nor Hispanic ethnicity were reported (eg, if only Asian race was reported) because of small numbers (n = 67), as were patients missing all race/ethnicity data (n = 10). This resulted in a total of 2130 (97%) patients in our analytical dataset. SES was assessed with 2 variables: insurance status (public, private, none) and family income, estimated by matching patients' home ZIP codes and year of enrollment to ZIP code-based median household annual incomes obtained from Esri Business Analyst Desktop (Esri, Redlands, CA).[17]

ED and daily clinical data, including laboratory tests (eg, complete blood count, basic metabolic panel, urine analysis, blood culture), respiratory rates, oxygen saturation, medical management, and disposition were obtained by medical chart review. Additionally, in an attempt to evaluate bronchiolitis severity at presentation, a modified respiratory distress severity score (RDSS) was calculated based on 4 assessments made during the preadmission visit (ie, ED or office visit before hospital admission): respiratory rate by age, presence of wheezing (yes or no), air entry (normal, mild difficulty, or moderate/severe), and retractions (none, mild, or moderate/severe).[18] Each component was assigned a score of 0, 1, or 2, with the exception of wheeze, which was assigned either a 0 (no wheeze) or a 2 (wheeze), and then summed for a possible total score of 0 to 8.

Last, a follow-up telephone interview was conducted 1 week after hospital discharge for each enrolled patient. Interviews assessed acute relapse, recent symptoms, and provided additional end points for longitudinal analysis of specific symptoms. All data were manually reviewed at the EMNet Coordinating Center, and site investigators were queried about missing data and discrepancies identified.

Outcome Measures

The major outcomes of this analysis were: albuterol and corticosteroid (inhaled or systemic) use during preadmission visit and hospitalization, chest x-rays performed at preadmission visit and hospitalization, need for intensive respiratory support (ie, receiving continuous positive airway pressure [CPAP], intubation, or ICU admission), hospital LOS ≥3 days, discharge on inhaled corticosteroids, and relapse of bronchiolitis requiring medical attention and a change of medication within 1 week of discharge.

Statistical Analysis

Stata 11.2 (StataCorp, College Station, TX) was used for all analyses. We examined unadjusted differences between racial/ethnic groups and clinical presentation, patient management, and outcomes using χ^2, Fisher exact, or Kruskal-Wallis test, as appropriate, with results reported as proportions with 95% confidence interval (CI) or median with interquartile range (IQR). Imputed values, calculated with the Stata impute command, were used to calculate the RDSS when 1 of the 4 components was missing; patients missing more than 1 component were not assigned an RDSS value. Multivariable logistic regression was conducted to evaluate the adjusted association between race/ethnicity and the outcomes listed above. Besides race/ethnicity, all multivariable models included the demographic variables of age, sex, insurance, and median household income. Other factors were considered for inclusion if they were associated with the outcome in unadjusted analyses ($P < 0.20$) or deemed clinically relevant. All models were adjusted for the possibility of clustering by site. Results are reported for the race/ethnicity factor as odds ratios with 95% CI.

RESULTS

Of the 2130 subjects included in this analysis, 818 (38%) were NHW, 511 (24%) were NHB, and 801

(38%) were Hispanic. The median age for children was 4.0 months (IQR, 1.8–8.5 months), and 60% were male. Most children were publicly insured (65%), 31% had private insurance, and approximately 4% had no insurance. The median household income defined by patient ZIP code was $51,810 (IQR, $39,916–$66,272), and nearly all children (97%) had a primary care provider (PCP). Approximately 21% of all children had relevant comorbidities and 17% of children were enrolled from the ICU. Overall, the median LOS was 2 days (IQR, 1–4 days).

The unadjusted associations between race/ethnicity and other demographic and historical characteristics are shown in Table 1. NHB and Hispanic children were more likely to have public insurance and less likely to have relevant major comorbidities when compared to NHW children. With regard to care received the week before hospitalization, NHW children were more likely to have visited their PCP, taken corticosteroids and/or antibiotics, and were least likely to have visited an ED when compared to NHB and Hispanic children.

The unadjusted associations between race/ethnicity and clinical characteristics at preadmission visit and hospital admission are shown in Table 2. RDSS values were calculated for 2130 children; 1,752 (82%) RDSS values contained all 4 components. Of those requiring imputed values, 234 (11%) were missing 1 component, and 139 (7%) were missing more than 1 component. Per RDSS scores, NHB children presented with a more severe case of bronchiolitis when compared to NHW and Hispanic children. During admission, minority children were more likely to receive nebulized albuterol and less likely to visit the ICU. NHB children received the least inpatient laboratory testing and were least likely to receive chest x-rays during hospital admission among all groups.

Discharge treatment and outcomes at 1-week follow-up are shown in Table 3. A total of 1771 patients (83%) were reached by telephone. No statistically significant differences between racial/ethnic groups were found regarding hospital discharge on corticosteroids and likelihood of bronchiolitis-related relapse.

Given the large potential for confounding regarding our initial findings, we examined multivariable-adjusted associations of race/ethnicity and bronchiolitis management (Table 4). Receiving albuterol during the preadmission visit and chest x-rays during hospitalization remained significantly associated with race/ethnicity in adjusted analyses, as NHB children were most likely to receive albuterol during the preadmission visit but least likely to receive chest x-rays during hospitalization. Several outcomes with statistically significant differences found during unadjusted analyses (eg, chest x-rays at preadmission visit, albuterol during hospitalization, CPAP/intubation use, ICU admission, and LOS) were not independently associated with race/ethnicity in multivariable models. By contrast, adjusted analyses revealed Hispanic children as significantly more likely to be discharged on inhaled corticosteroids when compared to NHW and NHB children; this association had borderline statistical significance ($P = 0.08$) in the unadjusted analysis. Last, we observed no significant racial/ethnic differences with respect to corticosteroids given at preadmission visit or hospitalization as well as no differences regarding bronchiolitis-related relapse in either unadjusted or adjusted analyses.

DISCUSSION

It is unclear if management and treatment differences found in children with severe bronchiolitis are associated with race/ethnicity. We sought to determine if such differences exist by analyzing data from a prospective multicenter cohort study. Differences in management and treatment are discussed in the context of AAP guidelines, as they are widely used in clinical practice.

The RDSS was used to help assess severity of illness across race/ethnicity. NHB children had the highest RDSS score (ie, most severe bronchiolitis presentation) compared to NHW and Hispanic children. The reason for this difference in severity is unclear, but a potential explanation may be that minority communities lack access to care and as a result delay care and treatment for respiratory disease until care seems absolutely necessary.[19] Indeed, in our sample, minority children were less likely to visit their PCP and take corticosteroids the week before hospitalization when compared with NHW children. Our finding runs counter to a similar study by Boudreaux et al. that found no association between race/ethnicity and the clinical presentation of children with acute asthma during the preadmission setting.[20] The more severe bronchiolitis presentation among NHB children may have suggested that these children would require a longer hospital LOS ($\geq$3 days). However, our multivariable analysis found no difference in LOS across racial/ethnic groups. This LOS finding is intriguing given previous studies suggesting that minorities, of diverse ages and with diverse diagnoses, were more likely to have a shorter LOS (as well as less likely to be admitted to the ICU with a similar diagnosis) when compared to nonminorities.[21,22] Additionally, because our study sampled 16 sites, variation in clinical judgment and pediatric ICU protocol may have also played a role.[23]

Our findings also shed light on how differences in bronchiolitis management relate to AAP guidelines. According to the AAP, corticosteroid medications should not be used routinely in the management of bronchiolitis. Despite this recommendation, previous reports indicate that up to 60% of infants with severe bronchiolitis receive corticosteroid therapy.[24,25] Our finding that Hispanic children with severe bronchiolitis were most likely to be discharged on inhaled

TABLE 1. Demographic and Clinical Characteristics of Subjects Before the Preadmission Visit by Race/Ethnicity*

	White, Non-Hispanic, n = 818, %	Black, Non-Hispanic, n = 511, %	Hispanic, n = 801, %	*P*
Demographic characteristics				
Age, months, median (IQR)	3.2 (1.5–7.4)	5.0 (1.9–9.2)	4.4 (2.0–9.1)	<0.001
Female	39.7	40.9	40.4	0.91
Insurance				<0.001
Private	56.7	17.0	13.1	
Medicaid	32.8	70.9	77.5	
Other public	6.8	7.6	4.2	
None	3.7	4.6	5.3	
Median household income by ZIP code, US$, median (IQR)	$60,406 ($48,086–$75,077)	$44,191 ($32,922–$55,640)	$50,394 ($39,242–$62,148)	<0.001
Has primary care provider	98.5	97.3	95.4	0.001
History				
Gestational age at birth				0.002
<32 weeks	4.5	9.2	6.6	
32–35 weeks	5.7	8.8	6.0	
35–37 weeks	13.3	10.0	9.7	
≥37 weeks	76.0	71.4	76.9	
Missing	0.4	0.6	0.7	
Weight when born				<0.001
<3 pounds	3.3	6.9	5.8	
3–4.9 pounds	6.8	11.9	6.2	
5–6.9 pounds	33.4	39.7	33.2	
>7 pounds	55.8	40.3	53.6	
Missing	0.7	1.4	1.4	
Kept in an ICU, premature nursery, or any type of special-care facility when born	24.5	29.7	24.9	0.07
Breast fed	62.3	49.1	65.5	<0.001
Attends daycare	20.7	25.2	13.3	<0.001
Number of other children (<18 years old) living in home				<0.001
1	24.2	25.6	17.0	
2	42.7	29.2	28.3	
≥3	33.1	45.2	54.7	
Neither parent has asthma	66.1	56.6	77.7	<0.001
Maternal smoking during pregnancy	21.8	21.3	6.0	<0.001
Secondhand smoke exposure	12.9	20.2	8.7	<0.001
History of wheezing	21.1	25.9	21.8	0.12
Ever intubated	9.5	13.2	9.2	0.05
Major relevant comorbidities†	23.6	21.1	18.2	0.03
Received palivizumab (respiratory syncytial virus vaccine)	8.7	12.7	8.9	0.04
Received influenza vaccine this year	20.2	24.7	21.2	0.15
In past 12 months, admitted overnight to hospital for bronchiolitis/wheezing/reactive airway disease	45.0	57.9	55.9	0.06
In past 12 months, admitted overnight to hospital for pneumonia	16.1	14.9	25.0	0.049
Current illness (before index visit)				
Any primary care provider or clinic visits during past week	75.0	44.1	58.3	<0.001
Any ED visits during past week	29.1	30.3	34.6	0.049
Over the past week used inhaled bronchodilator	40.6	36.2	37.0	0.18
Over the past week used inhaled/nebulized corticosteroids	8.7	8.1	7.7	0.76
Over the past week taken any steroid liquids or pills or shots for bronchiolitis	12.8	11.7	8.3	0.012
Over the past week taken antibiotics	21.9	17.0	17.9	0.045
Onset of difficulty breathing before admission				0.03
None	2.0	2.2	2.4	
<24 hours	28.8	27.2	25.1	
1–3 days	41.1	41.6	45.9	
4–7 days	22.1	19.1	21.2	
>7 days	6.0	9.9	5.3	
Over the past 24 hours, the level of discomfort or distress felt by the child because of symptoms				<0.001
Mild	15.5	21.3	18.5	
Moderate	47.8	39.3	37.2	
Severe	36.1	37.6	42.6	

NOTE: **Abbreviations:** ED, emergency department; ICU, intensive care unit; IQR, interquartile range.
*Preadmission visit is the ED or office visit preceding hospital admission.
†Major relevant comorbid disorders included reactive airway disease or asthma, spastic di/quadriplegia, chronic lung disease, seizure disorder, immunodeficiency, congenital heart disease, gastroesophageal reflux, and other major medical disorders.

TABLE 2. Clinical Characteristics at Preadmission Visit and During Admission by Race/Ethnicity

	White, Non-Hispanic, n = 818, %	Black, Non-Hispanic, n = 511, %	Hispanic, n = 801, %	*P*
Preadmission clinical findings and treatments				
Reason brought to the hospital				
Fever	29.7	30.2	40.7	<0.001
Fussy	32.6	31.6	28.4	0.18
Ear Infection	6.0	4.3	4.4	0.23
Not drinking well	35.0	27.5	27.2	0.001
Cough	54.1	55.5	61.3	0.009
Other reasons	29.0	27.6	23.5	0.04
Apnea	8.5	6.2	6.1	0.11
Respiratory rate (breaths/minute)				0.001
<40	23.8	18.2	28.1	
40–49	30.8	30.7	29.3	
50–59	17.6	15.5	16.0	
≥60	27.8	35.6	26.6	
Presence of cough	83.0	88.0	87.0	0.045
Presence of wheezing	63.0	69.0	63.0	0.42
Fever (temperature ≥100.4°F)	22.7	28.5	35.4	<0.001
Retractions				0.002
None	22.9	19.0	23.0	
Mild	39.4	41.7	44.4	
Moderate/severe	28.4	31.1	28.1	
Missing	9.4	8.2	4.5	
Air entry on auscultation				0.01
Normal	39.6	31.7	33.6	
Mild difficulty	31.4	33.5	36.3	
Moderate difficulty	11.0	14.3	14.1	
Severe difficulty	2.0	2.3	2.6	
Missing	16.0	18.2	13.4	
Oxygen saturation on room air <90	12.2	9.8	11.8	0.37
Given nebulized albuterol	53.0	65.0	63.0	<0.001
Given nebulized epinephrine	15.4	20.4	18.4	0.06
Given steroids, inhaled or systemic	16.0	20.5	19.4	0.08
Given antibiotics	25.5	22.6	27.8	0.12
Oral Intake				<0.001
Adequate	41.3	50.7	40.8	
Inadequate	43.5	32.5	47.7	
Missing	15.2	16.8	11.5	
IV placed	56.9	51.5	61.9	0.001
Any laboratory tests	86.3	91.3	88.0	0.02
Chest x-ray	59.0	64.0	65.0	0.03
RDSS, tertiles				<0.001
1 (≤3.00)	36.0	24.0	34.0	
2 (3.011–5.00)	30.0	33.0	34.0	
3 (>5)	25.0	36.0	27.0	
Not calculated	9.0	6.0	4.0	
Virology results				
Respiratory syncytial virus	75.9	67.5	71.0	0.003
Human rhinovirus	23.8	30.1	25.0	0.03
Human metapneumovirus	6.1	6.8	8.4	0.20
Inpatient clinical findings and treatments				
Length of stay ≥3 days	46.5	39.3	45.4	0.03
Ever in observation unit	8.6	7.8	4.0	0.001
Ever in regular ward	89.4	93.0	94.5	0.001
Ever in step-down unit	5.0	3.2	7.8	0.002
Ever in ICU	20.3	15.0	15.9	0.02
Required CPAP or intubation	7.7	4.6	8.8	0.02
Given nebulized albuterol	37.6	48.0	46.7	<0.001
Given nebulized epinephrine	10.7	14.9	13.0	0.07
Given steroids, inhaled or systemic	21.3	27.3	23.5	0.047
Given antibiotics	38.9	34.3	38.6	0.19
Received IV fluids	53.1	45.6	57.1	<0.001
Any laboratory tests	52.2	41.6	51.7	<0.001
Chest x-ray	27.1	18.6	22.9	0.002

NOTE: **Abbreviations:** CPAP, continuous positive airway pressure; ICU, intensive care unit; IV, intravenous; RDSS, respiratory distress severity score.

corticosteroids is potentially concerning, as it exposes a subset of children to treatment that is not recommended. On the other hand, given the increased risk of future asthma in Hispanic communities, a higher use of inhaled corticosteroids might be seen as appropriate. Either way, our findings are inconsistent with related studies concluding that racial minority pediatric patients with asthma were less likely to receive inhaled corticosteroids.[26–29] Similarly, NHB children were most likely to receive albuterol during the preadmission visit on multivariable analysis. Although a trial dose of albuterol may be common practice in treating severe bronchiolitis, AAP recommendations do not support its routine application. Increased albuterol during preadmission may have been related to an elevated bronchiolitis severity at presentation among NHB children (as indicated by the RDSS). Potential reasons for these 2 differences in treatment remain unclear. They may represent medical management efforts by discharging physicians to prescribe: (1) corticosteroids to racial/ethnic communities with a higher risk of childhood asthma; (2) albuterol to children presenting with a more severe case of bronchiolitis. These possibilities merit further study.

The AAP also recommends diagnosis of bronchiolitis on the basis of history and physical examination; laboratory and radiologic studies should not be routinely used for diagnostic purposes. Although it is possible for chest radiograph abnormalities to be consistent with bronchiolitis, there is little evidence that an abnormal finding is associated with disease severity.[30] The clinical value of diagnostic testing in children with bronchiolitis is not well supported by evidence, and limiting exposure to radiation should be a priority.[31,32] Our analysis found that NHW and Hispanic children were more likely to receive chest x-rays while hospitalized when compared with NHB children. Unnecessary and increased radiation exposure in children is potentially harmful and warrants intervention to minimize risk.

Establishing systematic clinical pathways in bronchiolitis management may address the practice variation found nationwide and across race/ethnicity in this study. Although clinical guidelines provide general recommendations, clinical pathways are defined

treatment protocols aiming to standardize and optimize patient outcomes and clinical efficiency. The incorporation of clinical pathways into healthcare systems has increased recently as a result of their favorable association with medical complications, healthcare costs, and LOS.[33] With respect to bronchiolitis, implementation of clinical pathways has proven to reduce use of inappropriate therapies, decrease risk of bronchiolitis-related hospital readmission, and help with discharge planning.[30,34,35]

Notwithstanding the differences found in this study, management of children with bronchiolitis was, in many respects, comparable across racial/ethnic groups. For example, our multivariable analysis found no significant differences across racial/ethnic groups with respect to chest x-rays and corticosteroid use during the preadmission visit, administration of albuterol or corticosteroids during hospitalization, use of CPAP/intubation, ICU admission, hospital LOS, or likelihood of a bronchiolitis-related relapse. The general lack of race/ethnic differences is consistent with similar research on inpatient management of acute asthma.[36]

This study has potential limitations. The hospitals participating in the study are predominantly urban, academically affiliated hospitals. This may result in findings that are less generalizable to rural and community hospitals. Second, the race/ethnicity classification used does not take into consideration the diversity and complexity of defining race/ethnicity in the United States. Third, bronchiolitis is defined as a clinical diagnosis that can encapsulate multiple lower respiratory infection diagnoses. As a result, there may have been variability in clinical and institutional practice. An additional limitation was utilizing RDSS to

TABLE 3. Discharge Treatment and Outcome Measures at 1-Week Follow-up by Race/Ethnicity

	White, Non-Hispanic, n = 818, %	Black, Non-Hispanic, n = 511, %	Hispanic, n = 801, %	*P*
Discharged on inhaled corticosteroids	9.5	11.1	13.3	0.08
Discharged on oral corticosteroids	9.8	12.4	8.5	0.11
Child's condition at 1-week follow-up compared to on discharge				0.001
Much worse/worse	1.8	0.7	0.4	
About the same	3.4	6.4	2.5	
Better	38.2	39.1	34.2	
All better	56.6	53.7	62.9	
Child's cough at 1-week follow-up compared to on discharge				0.10
Much worse/worse	2.1	1.2	1.0	
About the same	5.0	8.4	5.2	
Better	29.4	31.2	28.6	
All better	63.5	59.2	65.2	
Bronchiolitis relapse	10.7	11.9	10.3	0.81

TABLE 4. Multivariable Results of Clinical Decisions and Outcomes Among Children Admitted for Bronchiolitis by Race/Ethnicity

	White, Non-Hispanic		Black, Non-Hispanic		Hispanic	
	OR	95%CI	OR	95%CI	OR	95%CI
Preadmission visit						
Chest x-ray*	1.00	(Reference)	1.06	(0.83–1.36)	1.09	(0.74–1.60)
Albuterol use†	1.00	(Reference)	1.58‡	(1.20–2.07)‡	1.42	(0.89–2.26)
Steroid use, inhaled or systemic§	1.00	(Reference)	1.05	(0.72–1.54)	1.11	(0.75–1.65)
During hospitalization						
Chest x-ray‖	1.00	(Reference)	0.66‡	(0.49–0.90)‡	0.95	(0.60–1.50)
Albuterol use¶	1.00	(Reference)	1.21	(0.82–1.79)	1.23	(0.63–2.38)
Steroid use, inhaled or systemic#	1.00	(Reference)	1.13	(0.72–1.80)	1.19	(0.79–1.79)
ICU care**	1.00	(Reference)	0.74	(0.42–1.29)	0.87	(0.63–1.21)
Required CPAP/intubation††	1.00	(Reference)	0.72	(0.36–1.41)	1.84	(0.93–3.64)
Length of stay >3 days‡‡	1.00	(Reference)	0.77	(0.58–1.03)	1.05	(0.76–1.47)
Discharge						
Discharged on inhaled steroids§§	1.00	(Reference)	1.31	(0.86–2.00)	1.92‡	(1.19–3.10)‡
Bronchiolitis relapse‖‖	1.00	(Reference)	1.08	(0.62–1.87)	0.96	(0.55–1.65)

NOTE: All models control for age, sex, median household income by ZIP code, and insurance status. **Abbreviations:** CI, confidence interval; CPAP, continuous positive airway pressure; ICU, intensive care unit; NICU, neonatal intensive care unit; OR, odds ratio; RDSS, respiratory distress severity score.

*Also control for gestational age, parental asthma, past pneumonia or bronchiolitis admission, discomfort and dyspnea at home, chief complaint, virology.

†Also control for birth weight, medications and dyspnea before preadmission, virology. ‡Values are considered statistically significant with $P < 0.05$.

§Also control for birth weight, NICU, children at home, parental asthma, comorbidity, flu shot, medications at home, virology.

‖Also control for gestational age, birth weight, prenatal smoking, palivizumab, past pneumonia admission, steroids before preadmission, preadmission oral intake, O_2 saturation, RDSS, apnea, virology, antibiotics, labs.

¶Also control for gestational age, wheezing history, flu shot, discomfort at home, chief complaint, preadmission medications, labs and virology, RDSS.

#Also control for breast feeding, parental asthma, wheezing history, comorbidities, flu shot, past pneumonia admission, medications before preadmission, preadmission fever, O_2 saturation, RDSS, apnea, virology, medications, and labs.

**Also control for family history, birth weight, breast feeding, prenatal smoking, antibiotics and discomfort before preadmission, chief complaint, preadmission apnea, O_2 saturation, RDSS, antibiotics, intravenous line, and labs.

††Also control for birth weight, prenatal smoking, past bronchiolitis admission, steroids before preadmission, preadmission O_2 saturation, RDSS, apnea, intravenous line, and antibiotics.

‡‡Also control for birth weight, NICU, other children at home, prenatal smoking, palivizumab, discomfort and dyspnea before preadmission, chief complaint, preadmission oral intake, O_2 saturation, RDSS, virology, and epinephrine.

§§Also control for prenatal smoking, wheezing history, palivizumab, medications before preadmission, chief complaint, oral intake, step down, ICU, inpatient steroids, and labs.

‖‖Also control for parental asthma, intubation history, past bronchiolitis admission, virology, and length of stay.

assess bronchiolitis severity. Although there is currently no validated, universally accepted score to assess bronchiolitis severity, several scores are available in the literature with varying performance. Last, the ZIP code-based median household incomes used to assess SES are higher than federal data in similar geographic locations, potentially resulting in findings that are less generalizable.

CONCLUSION

This multicenter prospective cohort study found several differences in bronchiolitis presentation and management among children stratified by race/ethnicity in 16 geographically dispersed sites after controlling for multiple factors including SES. Our analysis showed that, when compared to NHW children, NHB children were more likely to be given albuterol during the preadmission visit and less likely to receive chest x-rays as inpatients; Hispanic children were more likely to be discharged on inhaled corticosteroids. These differences are concerning for 2 reasons: (1) based on current evidence, race/ethnicity should not affect care in children with severe bronchiolitis; and (2) the observed differences in diagnostic testing and treatment are not recommended by the evidence-based AAP guidelines. It is also important to note that these differences do not demonstrate that a specific race/ethnicity received better or worse clinical care. The goal of this analysis was not to determine the effectiveness of certain management tendencies in children with severe bronchiolitis, but rather to examine differences in the presentation and management of children from different racial/ethnic groups. The causes for the observed findings require further study. In the meantime, we suggest increasing the number of hospitals that incorporate clinical care pathways for severe bronchiolitis to control variation in practice and limit the impact that race/ethnicity may have in the provision of services.

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APPENDIX

Principal Investigators at the 16 Participating Sites in MARC-30

Besh Barcega, MD	Loma Linda University Children's Hospital, Loma Linda, CA
John Cheng, MD and Carlos Delgado, MD	Children's Healthcare of Atlanta at Egleston, Atlanta, GA
Dorothy Damore, MD and Nikhil Shah, MD	New York Presbyterian Hospital, New York, NY
Haitham Haddad, MD	Rainbow Babies & Children's Hospital, Cleveland, OH
Paul Hain, MD and Mark Riederer, MD	Monroe Carell Jr. Children's Hospital at Vanderbilt, Nashville, TN
Frank LoVecchio, DO	Maricopa Medical Center, Phoenix, AZ
Charles Macias, MD, MPH	Texas Children's Hospital, Houston, TX
Jonathan Mansbach, MD, MPH	Boston Children's Hospital, Boston, MA
Eugene Mowad, MD	Akron Children's Hospital, Akron, OH
Brian Pate, MD	Children's Mercy Hospital & Clinics, Kansas City, MO
M. Jason Sanders, MD	Children's Memorial Hermann Hospital, Houston, TX
Alan Schroeder, MD	Santa Clara Valley Medical Center, San Jose, CA
Michelle Stevenson, MD, MS	Kosair Children's Hospital, Louisville, KY
Erin Stucky Fisher, MD	Rady Children's Hospital, San Diego, CA
Stephen Teach, MD, MPH	Children's National Medical Center, Washington, DC
Lisa Zaoutis, MD	Children's Hospital of Philadelphia, Philadelphia, PA

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