



High rates of subglottic stenosis seen in African-American children admitted with severe croup to hospitals in the United States between 2003 and 2013

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ABSTRACT

Background: To assess whether differences exist in the epidemiology and the treatment of croup with respect to gender, race, income and geographical location.

Methods: Retrospective weighted analysis of patients under 19 admitted with a diagnosis of croup with a sub-cohort of patients requiring intubation or diagnostic bronchoscopy from the National Inpatient Sample and Kids' Inpatient Database from 2003 to 2013. ICD-9 codes and demographics were analyzed; cross tabulations and linear regression modeling were performed.

Results: Between 2003 and 2013, 202,188 pediatric patients were admitted with a diagnosis of croup, equivalent to 1-per-100 pediatric admissions. Males were more likely to be admitted for croup than females [OR 2.13 (2.08–2.17)]. Incidence of croup is highest in Caucasians and lowest in Asian and African-American patients. African-American children are more likely to undergo diagnostic bronchoscopy or require intubation [OR 1.23 (1.08–1.401)] than other races. A higher rate of subglottic stenosis was seen in African-American children who required bronchoscopy than expected (39.1% vs 26.7%). After controlling for subglottic stenosis, African-American patients were no longer more likely to undergo diagnostic bronchoscopy or require intubation than other races [OR 1.129 (0.959–1.33)].

Conclusion: African-American children admitted with a diagnosis of croup appear to have an increased rate of intubation or bronchoscopy. This may be related to the high incidence of subglottic stenosis in this population. After controlling for subglottic stenosis, no difference in intervention rates was seen.

1. Introduction

Croup is a common pediatric disease characterized by the triad of inspiratory stridor, a barking cough, and hoarseness. The etiology of croup is viral, with the majority of cases caused by Human Parainfluenza Virus Type-1 (HPIV-1), though other viruses can be involved [1–3]. It primarily affects patients under the age of six, with a peak incidence in the second year of life, preferentially affecting males [4–8]. Croup represents a significant expenditure, costing the health-care system between \$36 M and \$44 M [5,9]. While advances in care have improved outcome such as number of intubations and rates of admission in patients with croup, no study has evaluated whether any racial disparities exist in the management of croup [10].

A hallmark of racial disparities is their persistence over time [11]. Studies on other viral respiratory infections has demonstrated multiple

disparities between racial groups including higher rates of hospitalization among non-white patients under the age of five years as compared to their Caucasian peers, disproportionately high mortality rates of Hispanic patients related to influenza infections, and higher hospitalization rates of African-American children as compared to Caucasian children for acute respiratory infections [12–14]. Previous research specific to croup has shown a disproportionate number of patients admitted are Caucasian [5,9]. However, amongst those admitted for croup, African-American patients are more likely to receive certain interventions such as chest x-rays, antibiotics, and steroids [15,16]. This suggests a disparity in the diagnosis and treatment of croup amongst different demographics.

Differences in croup severity between inpatients of various races has not been demonstrated. Narayanan and Funkhouser (Hosp Pediatr, 2014) found no link between race and administration of racemic-

ABBREVIATIONS: HPIV-1, Human Parainfluenza Virus Type-1; ICD-9/ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification; KID, Kids' Inpatient Database; NEC, Not elsewhere classified; NIS, National Inpatient Sample

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Table 1
Demographics of pediatric patients in the United States based on the HCUP's KID and NIS databases.

	All Pediatric Admissions		Croup		Croup requiring Bronchoscopy		Croup requiring Intubation	
	N	%	N	%	N	%	N	%
Gender								
Male	10,157,088	50.01%	135,430	66.98%	1875	66.18%	2743	67.53%
Female	9,985,709	49.16%	63,826	31.57%	939	33.16%	1298	31.96%
Race								
Caucasian	8,246,856	40.60%	86,645	42.85%	1000	35.29%	1723	42.43%
African-American	2,569,076	12.65%	16,850	8.33%	501	17.69%	426	10.49%
Hispanic	3,702,678	18.23%	38,893	19.24%	427	15.08%	684	16.84%
Asian	614,916	3.03%	3830	1.89%	37	1.30%	71	1.74%
Native American	133,740	0.66%	1353	0.67%	12	0.43%	26	0.63%
Other	910,481	4.48%	8761	4.33%	137	4.83%	183	4.50%
Total	20,142,797	–	199,256	–	2814	–	4041	–

epinephrine or multiple days of corticosteroids [17]. Despite this, circumstantial evidence for an association between race and croup severity exists. While HPIV-1 is the most common etiological agent, other viruses are important to the disease's epidemiology; in particular, Influenza-A is known to cause an especially severe form of croup, and black infants are overrepresented among croup patients who test positive for this virus [18,19].

This paper aims to better quantify croup in its present-day incidence across demographic groups. Using intubation and diagnostic bronchoscopy, invasive therapies reserved for patients with compromised airways, as surrogate markers for disease severity, we analyze which populations are vulnerable to more severe forms of croup and discuss the various reasons behind these differences.

2. METHODS

Given that a national, de-identified, public database was utilized for this study, this study was exempt from our institutions' Institutional Review Boards. We reviewed discharge data for patients under 19 years of age from the National Inpatient Sample (NIS) and Kids' Inpatient Database (KID) from 2003 to 2013, amounting to over 20 million discharges in total. The KID database was used instead of the NIS for the years it was available (2003, 2006, 2009, 2012). By utilizing both the NIS and KID databases, we sought to account for sample size variation. International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes were used for assessment. The KID and NIS do not include patient identifiers but contain patient demographics, admission-related data, hospital costs, and information on the type of institution and do not allow reporting of results with a sample size less than 11 to protect privacy.

The number of pediatric patients with a diagnosis of croup was determined using ICD-9 code 464.4. A subcohort of patients with 'severe' croup was created to capture patients with croup who required more than medical management; patients admitted with croup who undergo a diagnostic bronchoscopy, defined by ICD-9 procedure codes 33.21, 33.22, 33.23, or intubation, defined by ICD-9 procedure codes 76.97, 96.71, 96.72, 97.39 during the admission were placed in this subcohort. All discharge data was weighed and stratified. Total population in the United States under 19 years of age was obtained from the US Census Bureau [20].

Differences in gender, race, socioeconomic status, and insurance type were assessed. Socioeconomic status was based on quartile classification of the estimated median household income in the patient's zip code. Insurance status was determined by the expected primary payer. Race was based on the five racial categories (White, Black, American Indian or Alaskan Native, Asian, and Native Hawaiian and other Pacific Islander) and one ethnic category (Hispanic) recognized by the U.S. Government's Office of Management and Budget (OMB) and coded into the KID and NIS [21]. A multivariate analysis was performed to control for confounding variables.

The length of stay and cost of admission for all patients were

analyzed to identify factors that may influence these variables. The cost of admission was determined by applying cost-to-charge ratios calculated from data reported to the Centers for Medicare and Medicaid Services, thereby providing an estimate of the all-payer inpatient cost-to-charge ratio by hospital.

2.1. Statistical analysis

Statistical analyses were performed using SAS 9.4 (SAS Institute Inc, Cary, NC). Discharge counts under 11 observations were masked per the HCUP data-use agreement. Data were weighted. All means and medians are reported with their 95% CI. Z-tests were performed to make pairwise proportional comparisons, and Pearson χ^2 tests were used to test the hypothesis of random distribution of statistical events across multinomial coding. Multivariate analysis was performed using binary logistic and linear regression models.

3. RESULTS

During the 10-year study period between 2003 and 2013, a total of 20,311,254 patients under the age of 19 were admitted to hospitals in the United States; croup was diagnosed in 202,188 of those patients or 1 per 100 pediatric admissions. The average age of admission was 1.73 years old. Caucasian infants have the higher incidence of croup (1 per 89 pediatric admissions, $p < 0.001$) while Asian patients (1 per 154 pediatric admissions, $p < 0.001$) and African-American patients (1 per 146 pediatric admissions, $p < 0.001$) have the lowest incidence (Table 1).

The average length of stay for patients with croup is 1.86 days (1.83–1.88) (Median 0.88 days [0.87–0.88]). The average cost of admission is \$2912 (2846–2977) (Median \$1747 [\$1734 – \$1760]). On average, African-American patients had a longer length of stay ($p < 0.001$) and higher cost of care ($p < 0.001$) than other races (Table 2).

Multivariate analysis to control for race, gender, insurance type and socioeconomic status was performed; this showed that males are more

Table 2
Mean and median estimates for length of stay (LOS) and cost of admission for patients diagnosed with croup by race.

LOS	Mean	95% CI	Median	95% CI
African-American	2.47	(2.36–2.59)	1.16	(1.11–1.20)
Caucasian	1.72	(1.69–1.75)	0.81	(0.80–0.81)
Average	1.86	(1.83–1.88)	0.88	(0.87–0.88)
Cost	Mean	95% CI	Median	95% CI
African-American	\$3943	(3648–4239)	\$2009	(1951–2067)
Caucasian	\$2649	(2541–2756)	\$1616	(1598–1634)
Average	\$2912	(2846–2977)	\$1747	(1734–1760)

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