abstract

OBJECTIVES: Croup is a common childhood respiratory illness that can result in hospitalization and significant morbidity. This study reviewed records of patients hospitalized with croup to determine characteristics associated with increased inpatient treatment and length of stay (LOS).

METHODS: Eligible patients were admitted between January 2006 and December 2010 and had discharge diagnosis of croup. Patients were included if they received either racemic epinephrine or systemic corticosteroids during their emergency department or hospital treatment. Patients were excluded for incomplete data on medication or vital signs timing. Hospitalization and treatment decisions were at the discretion of the treating physician.

RESULTS: The study analyzed 365 hospitalizations involving 327 patients, 72% male, 62% white, with median age of 16.7 months. Median LOS was 31.7 hours. Patients required racemic epinephrine treatments after hospitalization in 179 cases (49%; mean, 1.33 treatments; range, 0–13; median, 0), and 176 patients (48%) received a dose of systemic corticosteroids after hospital admission. Patients who required racemic epinephrine treatments after hospitalization were indistinguishable from those who did not, based on demographics, past history, or presenting vital signs. Patients with history of croup, history of intubation, or with oxygen saturation <95% on presentation all had increased LOS compared with those without these findings (P < .05).

CONCLUSIONS: Fifty-one percent of patients hospitalized with croup did not require inpatient racemic epinephrine treatments. Those with lower oxygen saturations on presentation or past history of croup or intubation were more likely to have prolonged or complicated hospital course.

Croup (laryngotracheobronchitis) is a common cause of upper airway obstruction in children and is characterized by hoarseness, a barking cough, and inspiratory stridor.¹

The use of systemic corticosteroids early in the disease process has been shown to reduce hospitalization rates from the emergency department (ED),² but 6% to 10% of patients seen in an ED still require hospitalization,³ with 3% to 10% of admitted patients requiring critical care services.³,⁴

Increased rates of hospitalization have been correlated with younger age⁴ and with seasonal outbreaks of parainfluenza virus,⁵ but there are few data on predictors for receiving inpatient treatment with racemic epinephrine or systemic corticosteroids. A 2008 review recommended against multiple doses of dexamethasone to
treat most cases of croup, but did not suggest specific therapy for those who did not respond to standard ED care.6

The purpose of this study is to collect data on inpatients with croup to determine which demographic and clinical characteristics are predictive of (1) administration of racemic epinephrine after hospitalization, (2) administration of repeat doses of systemic corticosteroids, and (3) increased length of hospital stay.

METHODS

This is a retrospective chart review of inpatients aged 0 to 18 years, discharged from Children’s of Alabama, a university-affiliated tertiary-care children’s hospital, between January 2006 and December 2010 with an International Classification of Diseases, Ninth Revision, Clinical Modification diagnosis code for acute laryngitis/tracheitis (464.x), which includes acute croup (464.4). Patients were included in the analysis if they received either a dose of systemic corticosteroids or a dose of nebulized racemic epinephrine at any time during their ED or inpatient care. We excluded patients whose charts had incomplete data on vital signs or on timings of doses of racemic epinephrine and systemic corticosteroids. There were no exclusions based on past medical history or severity of illness. The study was approved by the institutional review board at the University of Alabama at Birmingham.

Charts were manually reviewed by the primary investigator with a data extraction checklist. We collected a number of demographic and clinical variables to determine whether they were predictive of inpatient administration of racemic epinephrine or systemic corticosteroids. The effect of these variables on length of stay (LOS) was assessed by using logistic regression analysis.

Demographic data were obtained on age, gender, self-reported ethnicity, insurance status, weight, and BMI z score, defined as the number of SDs away from the mean BMI (measured as weight in kilograms over the square of the height in meters) after a normalization transformation to more closely fit a standard distribution. BMI z scores were obtained from the World Health Organization Web site7 for children under 24 months of age and the Centers for Disease Control and Prevention Web site for children 24 months of age and older.8 Medical history data were collected on chronic comorbid conditions, medications, family history of croup, and history of and reason for intubation. A positive history of intubation was defined as any endotracheal intubation required for shock or respiratory failure.

ED care was defined as the ED, primary care provider, or subspecialty clinic visit that preceded the hospitalization. Data were obtained on ED care registration and evaluation times, presentation vital signs, and time from evaluation to receipt of racemic epinephrine and systemic corticosteroid treatments. Hospitalization was at the discretion of the treating physician.

Inpatient hospitalization data were obtained on the following: vital signs upon arrival to the admitting unit, total doses of racemic epinephrine, total patient-days of systemic corticosteroids, results of nasopharyngeal or endotracheal viral cultures, endotracheal intubation, and LOS. Readmissions to the hospital were followed for 7 days from the date of discharge.

Data were analyzed by using the SPSS (IBM SPSS Statistics, IBM Corporation) statistical package.9 Fisher’s exact tests were used to characterize any differences between groups as measured by nominal variables. Continuous variables (age, BMI z score, and vital signs) were assessed in nonparametric fashion by Mann-Whitney U test due to nonnormal distribution. Impact of variables was assessed by calculating odds ratios with 95% confidence intervals. Effect of clinical variables on LOS was assessed by logistic regression analysis, adjusting for age, race, gender, and history of prematurity.

RESULTS

Among 407 records screened for eligibility, 365 met criteria for inclusion. There were 32 charts with incomplete medical records and 10 charts that indicated that the patient received neither systemic steroids nor racemic epinephrine. Of the 327 patients in the study, 31 (10%) had more than 1 hospitalization in the study period; 26 patients had 2 separate admissions, 3 patients had 3 admissions, and 2 patients had 4 admissions.

Males made up 72% of the patient encounters, and median age was 16.7 months (range, 1.8–210.3 months). The majority of patients were non–Hispanic white (62%). Study patients had a median BMI z score of 0.50, with 21% having a z score >2, corresponding to 95th percentile for age, which meets the Centers for Disease Control and Prevention definition of obesity.10

There were biennial variations in the number of patients admitted, and more cases were seen in the fall (114 of 365, 31%) than in any other season (Fig 1). Of the 103 nasopharyngeal swabs sent for viral studies, 58 had a positive
result, 70% of which were parainfluenza. The next most common viruses were influenza A and B (15.5%) and respiratory syncytial virus (8.6%). No patient tested positive for more than 1 virus. Other data on demographics, past medical history, and ED vital signs are summarized in Table 1.

Most cases (259 of 365, 71%) were admitted to a general pediatric floor, whereas 75 of 365 (20%) went to a critical care step-down unit, and 31 of 365 (9%) were admitted to the PICU. Median LOS was 31.7 hours (interquartile range, 22.7–51.4 hours). There were 10 intubations of 365 cases (3%); 9 of 10 were male and 4 of 10 had had a previous hospitalization for croup.

Cases requiring inpatient racemic epinephrine (186 of 365, 51%) were not significantly different from the remainder of cases in any element of demographic data, triage vital signs, or past medical history (Table 2). A family history of croup was more frequent in patients receiving inpatient racemic epinephrine (odds ratio, 2.7), but the data did not reach statistical significance.

Multiple days of steroids were given to 48% of patients. Patients who received multiple days of steroids were more likely to have required 3 or more doses of racemic epinephrine (P < .001), but no other demographic or clinical factors were predictive (Table 2). There was a mild association between total number of racemic epinephrine treatments and total patient days of systemic corticosteroids (Fig 2).

After adjusting for age, race, gender, and prematurity, increased LOS was associated with oxygen saturation <95% in the prehospital setting, a previous history of croup, and a previous history of intubation (P < .05 for all; Table 3). There were 13 readmissions within 1 week of discharge (4%). There were no deaths.

**DISCUSSION**

In this retrospective study, we found no associations between a number of patient demographic and clinical factors and receipt of inpatient racemic epinephrine. Increased length of hospital stay was correlated with ED oxygen saturation <95%, which has previously been associated with increased length of ED observation. Past history of croup or of intubation was also associated with a prolonged hospital course, but patients with this past history did not have higher odds of receiving inpatient racemic epinephrine. The possibility exists that practitioners may have elected to observe them in the hospital longer despite resolution of stridor.

Four of the 10 intubated patients in this study did have a past history of hospitalization for croup; this association is interesting and deserves further study. Recurrent disease and life-threatening disease may have similar underlying mechanisms, or previous disease may predispose to life-threatening disease.

Many patients in this study received a second day of steroids, and requiring multiple inpatient doses of racemic epinephrine was associated with the decision to give repeat steroid doses. This study could not answer whether a repeat dose of steroids for patients requiring inpatient racemic epinephrine could reduce subsequent LOS or recurrence of stridor.
There were several limitations to this study. The retrospective nature of the review prevented us from determining causation of repeat dexamethasone dosing or increased LOS. The diagnosis of croup is also often subjective, and our use of only 7 diagnosis codes may not have been broad enough and could have eliminated those patients with milder illness who were coded as an unspecified viral respiratory illness. However, previous large epidemiologic studies on the illness have used the single International Classification of Diseases, Ninth Revision diagnosis code of 464.4 in their inclusion criteria.\textsuperscript{3,4,11} The criteria for hospitalization and discharge at our institution were not uniform, so individual physicians could have had more or less comfort discharging a patient who had not received racemic epinephrine for 8 to 12 hours, depending on the time of day, for example. In addition, inpatient racemic epinephrine treatment was not based on an objective scoring system or protocol, and the administration of repeat corticosteroid doses could also have been subjective and physician-dependent. Rates of readmission were not high enough to calculate a possible preventive role of multiple doses of steroids, and severity of illness is a strong confounding variable in that analysis.

**CONCLUSIONS**

Nearly half of patients who are admitted with croup do not require racemic epinephrine after ED treatment. Among hospitalized patients, most of whom received 2 racemic epinephrine treatments before admission, we did not find statistically significant predictors for requiring inpatient racemic epinephrine. Patients with a history of croup, history of intubation, or with ED triage oxygen saturations <95%...
on room air all had statistically significant increase in LOS compared with those without these criteria. There is a strong association between receiving inpatient racemic epinephrine and receiving repeat doses of systemic corticosteroids, but larger studies would be helpful to determine patient outcomes for repeat dexamethasone dosing by using objective criteria for inpatient racemic epinephrine administration.

**REFERENCES**


**TABLE 3 LOS Determinants**

<table>
<thead>
<tr>
<th>Factor</th>
<th>LOS (hours) if Positive</th>
<th>LOS (hours) if Negative</th>
<th>P</th>
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<tr>
<td>History of intubation</td>
<td>57.7 +/- 175</td>
<td>40.7 +/- 4.1</td>
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<tr>
<td>Triage O₂ saturation &lt;95%</td>
<td>51.4 +/- 12.9</td>
<td>40.7 +/- 4.1</td>
<td>.02</td>
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<tr>
<td>History of croup</td>
<td>53.4 +/- 11.3</td>
<td>39.2 +/- 4.0</td>
<td>.03</td>
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</tbody>
</table>

**TABLE 3 LOS Determinants**

After logistic regression analysis, adjusting for age, race, gender, and history of prematurity, the following factors were associated with increased LOS: