RESEARCH ARTICLE

Predictors of Symptom Rebound in Critically Ill Patients With Croup

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ABSTRACT

OBJECTIVES: There are no data to inform the ideal length of in-hospital observation after symptom improvement or to inform the ideal dexamethasone dose in critically ill children with croup. We describe a cohort of critically ill children with croup who rebound (have return of symptom(s) after meeting hospital discharge criteria) and examine the association between the cumulative dexamethasone dose before PICU discharge and both the odds and timing of rebound.

METHODS: In this single-center retrospective cohort study of subjects 6 months to 13 years of age admitted to the PICU with a primary diagnosis of croup, we employed multivariable logistic regression to evaluate the association between cumulative pre-PICU discharge dexamethasone dose and rebound. In the model, we controlled for subject age and sex, insurance, season, and history of prematurity, croup, or intubation. Kaplan-Meier curves were used to compare time to rebound between subjects receiving ≤2 standard (0.6 mg/kg) doses and those receiving >2 standard doses of dexamethasone before PICU discharge.

RESULTS: Data were analyzed over 69 months (January 2011–October 2016), and 275 unique subjects met inclusion criteria. The median cumulative dose of dexamethasone in the hospital was 1.57 mg/kg (interquartile range 0.98–2.63). Thirty-seven percent (n = 102) of subjects developed rebound croup symptoms after meeting hospital discharge criteria. The median time to rebound was 13.1 hours (interquartile range 6.1–23.7). There was no association between cumulative pre-PICU discharge dexamethasone dose and the odds (odds ratio = 1.00; 95% confidence interval 0.83–1.19; P = .96) or timing of rebound.

CONCLUSIONS: A clinically significant number of critically ill patients with croup rebounded. Total pre-PICU discharge dexamethasone dose did not predict either the odds or timing of rebound.

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Croup is a common acute respiratory illness of childhood. It is the most common cause of airway obstruction in children, and in severe cases, leads to respiratory failure and arrest.[1] Systemic corticosteroids are the mainstay of treatment in croup, and there is strong evidence to support a single dose of dexamethasone in all patients with croup.[2] However, these data are limited in scope because the research on corticosteroids in croup has been focused on outpatient and emergency department (ED) management of mild-to-moderate croup and has been used to compare a single dose of dexamethasone with placebo to prevent outcomes such as return visits and hospital admission.[2,3] Patients who are hospitalized represent a distinct patient population often with associated morbidity, with 9% of patients admitted requiring intensive care services.[4,5] Outside of 1 study in which placebo was compared with prednisolone for children intubated for croup, there are no published studies on the optimal corticosteroid regimen for critically ill patients hospitalized with croup; thus, dosing regimens for dexamethasone in our PICU vary.[6–8]

Our institutional clinical care pathway recommends PICU admission for patients with severe or life-threatening croup, patients with moderate croup that is not improving with dexamethasone, patients requiring hourly racemic epinephrine, and/or patients requiring ≥4 doses of racemic epinephrine.[9] Most patients admitted to the PICU at our institution receive more than a single standard dose (0.6 mg/kg per dose) of dexamethasone. The long half-life of dexamethasone combined with varying dosing regimens in the PICU makes it difficult to determine the appropriate length of in-hospital observation after PICU discharge for these patients. It is not uncommon for patients who are moderately or severely ill to have a recurrence of respiratory distress, or rebound, after an initial improvement in their symptoms. There is currently no established or agreed on period of in-hospital observation for rebound after PICU discharge.

In this study, we used a retrospective chart review to describe the type and timing of rebound in croup. We defined rebound as the return of symptom(s) requiring medical intervention or in-hospital observation after all discharge criteria were met on the basis of our clinical care pathway.[9] In this study, we had 3 specific aims. First, to describe the cohort of critically ill patients with croup who rebounded and the time to rebound. We hypothesized that a clinically significant number of subjects would experience rebound and that most subjects would rebound within 24 hours of meeting discharge criteria. Our second aim was to examine the association between cumulative pre-PICU discharge dexamethasone dose and rebound among critically ill patients with croup. We hypothesized that cumulative pre-PICU discharge dexamethasone dose would be associated with rebound. Our final aim was to compare time to croup rebound among subjects in the PICU receiving 1 or 2 standard (0.6 mg/kg) doses and those receiving >2 standard doses (>1.2 mg/kg) of dexamethasone before PICU discharge. We hypothesized that subjects receiving >2 standard doses of dexamethasone before PICU discharge would have a longer time to rebound.

METHODS

This study was a single-center retrospective cohort study of subjects with a primary diagnosis of croup admitted to the PICU. Subjects were identified for inclusion by using the Virtual Pediatric Systems, LLC data set, and chart review was used for data collection. We included subjects 6 months to 13 years old[10] with an index PICU admission between January 1, 2011, and September 30, 2016, an *International Classification of Disease, Ninth Revision* code for croup at discharge (464.4, 464.20, 464.21, 464.50, and 464.5), and record of intravenous or oral dexamethasone administration at our institution during their index visit. Subjects were excluded for complex chronic conditions, as defined by Feudtner et al,[11] because these subjects' comorbidities may mandate deviation from croup standards of practice. We also excluded subjects with an alternative primary diagnosis, subjects with a missing discharge time stamp, and those who did not receive dexamethasone at our institution (consort diagram in Supplemental Fig 3). This study was approved by the Colorado Multiple Institutional Review Board.

Study Definitions

For each member of our cohort, demographic information (age, sex, weight, race and/or ethnicity, and insurance status), season of discharge, and past medical history pertinent to croup (prematurity, episodes of croup, and history of intubation) were obtained by chart review. Index hospitalization specific data included clinical setting of origin, antibiotic use, racemic epinephrine use, mechanical ventilation, noninvasive positive pressure ventilation, heated high-flow nasal canula use, viral pathogen testing results, length of stay (LOS) in the PICU in hours, and total cumulative intravenous and oral dexamethasone dose in milligrams per kilogram. Total cumulative dexamethasone dose was measured in 2 parts: total milligrams per kilogram before PICU discharge and total milligrams per kilogram after PICU discharge. The total milligrams per kilogram before PICU discharge included dexamethasone given in the ED or inpatient unit before transfer to the PICU and the total milligrams per kilogram given in the PICU. Total milligrams per kilogram after PICU discharge included dexamethasone given after discharge from the PICU before hospital discharge. Although we report whether subjects transferred from other institutions had documentation of treatment with dexamethasone or other steroids before transfer to our hospital, dexamethasone or other steroids administered before transfer to our hospital were not included in our analyses because the documentation was inconsistent in our electronic health record.

Outcome Measure

Our primary explanatory variable was milligrams per kilogram of dexamethasone before PICU discharge. Our primary outcome measure was the occurrence of any rebound. A patient was classified as having rebound if they met 1 or more definitions of rebound either in the hospital or after hospital discharge. For subjects in the hospital, rebound was defined as having ≥1 of the

following after meeting hospital discharge criteria per our institution's clinical care pathway: (1) the return of moderate to severe croup symptoms requiring in-hospital observation, (2) treatment with racemic epinephrine, or (3) transfer back to the PICU.[9] Subjects were considered to have return of moderate or severe croup symptoms if they had documentation of ≥1 of the following: return of stridor at rest, retractions (other than suprasternal), tachypnea for age, tachycardia for age, declining mental status, or declining oral intake after meeting hospital discharge criteria (Supplemental Table 4). Although tachypnea or tachycardia for age may be conservative criteria for rebound in typical patients with croup, such as those seen in the ED or outpatient setting, these criteria reflect usual practice for the study population. Tachycardia and tachypnea may be related to fever. However, unlike typical patients with croup, patients treated for severe or refractory croup in the PICU with ongoing fever and vital sign alterations despite large doses of dexamethasone would likely not be discharged from the hospital. After hospital discharge, rebound was defined as the following: hospital readmission for croup within 7 days, return to clinic for recurrence of croup symptoms outside of normal hospital follow-up within 7 days of discharge, or return to the ED within 2 weeks of discharge for treatment of croup symptoms.

Time to rebound was defined as the time in hours from when a subject was ready for hospital discharge to the first documented time of any rebound criterion. Subjects were considered ready for hospital discharge when all hospital discharge criteria (no stridor at rest, no retractions (other than suprasternal), normal respiratory rate for age, normal heart rate for age, normal mental status, adequate oral intake, and 12 hours since last dose of racemic epinephrine) were met.[9] In cases in which all hospital discharge criteria were met in the PICU, the time of PICU discharge was used to define readiness for hospital discharge.

In addition, to understand the impact of rebound and in-hospital monitoring for rebound on hospital LOS, we compared time to meet hospital discharge criteria during daytime hours (ideal length of stay [iLOS]) with actual hospital LOS in hours (Supplemental Fig 4). For the purposes of calculating iLOS, discharge criteria could not be met between 8:01 PM and 8:00 AM because patients are rarely discharged from the hospital between 8:01 PM and 8:00 AM at our institution. If a subject met all discharge criteria between 8:01 PM and 8:00 AM, then 8:01 AM was used to define "ready for hospital discharge" for the iLOS calculation.

Statistical Analysis

Descriptive statistics were used to describe the types of rebound. The cohort was stratified by whether subjects met discharge criteria on PICU discharge and by whether subjects received additional doses of dexamethasone after PICU discharge. Descriptive statistics were then used to describe the cohort by these strata. We used a bivariate analysis to compare subjects who rebounded with subjects who did not rebound using χ^2 or Fisher's exact test and Wilcoxon rank test for categorical and continuous variables, respectively. A multivariable logistic regression model was used to evaluate the association between the total dexamethasone dose before PICU discharge and rebound. Covariates in the model were determined a priori. Collinearity between the a priori covariates was assessed by using Spearman and Pearson correlation coefficients. PICU LOS was removed from consideration in the multivariable model because of its collinearity with total pre-PICU discharge dexamethasone dose. The model was adjusted for all other a priori covariates.

Kaplan-Meier curves and the log-rank test were then used to compare time to rebound for subjects receiving >1.2 mg/kg of dexamethasone in the PICU with time to rebound for those receiving a smaller total dose. The dose 1.2 mg/kg was chosen because it is equal to 2 standard (0.6 mg/kg) doses of dexamethasone.

Data were analyzed by using SAS version 9.4 software (SAS Institute, Inc, Cary, NC).

All statistical tests were performed as 2-sided tests, with a level of significance of 0.05.

RESULTS

Two hundred seventy-five unique subjects met inclusion criteria. Subjects' median age was 20 months (interquartile range [IQR] 14.4–33.6). Two subjects were >6 years. Sixty-five percent were boys, 63% were white, 22% were Hispanic, 4% were African American. Eight percent had a history of prematurity, 20% had a previous episode of croup, and 4% had a history of previous intubation. Thirty-two percent received antibiotics during their hospitalization, and 11% were mechanically ventilated. The median dexamethasone dose prescribed before PICU discharge was 1.31 mg/kg (IQR 0.7–2.4), and the median cumulative hospital dose was 1.57 mg/kg (IQR 1.0–2.6). The median PICU LOS was 21 hours (IQR 14.9–32.8). The median time to meet all hospital discharge criteria was 24.9 hours (IQR 16.92–38.98). The median iLOS was 26.9 hours (IQR 17.6–41.5), and the median actual hospital LOS was 46.7 hours (IQR 35.4–72.1). In the bivariate analysis, the median age for subjects who rebounded was 1.5 years (IQR 1.1–2.4), compared with 1.9 years (IQR 1.2–3.1) in the no rebound group ($P = .02$). The median hospital LOS was 60.3 hours (IQR 39.8–94.4) in the rebound group, compared with 43.8 hours (IQR 32.6–62.0) in the no rebound group ($P \leq .001$). There were no other differences between groups (Table 1).

Thirty-seven percent of subjects ($n = 102$) developed rebound croup symptoms after meeting hospital discharge criteria. The median time to rebound after meeting hospital discharge criteria was 13.1 hours (IQR 6.1–23.7). Of the 102 subjects who developed rebound, 82% rebounded while still in the hospital, and 8% were readmitted for croup symptoms within 7 days (Table 2). Of those subjects with in-hospital rebound, approximately one-third required treatment with racemic epinephrine. Sixty-five percent ($n = 180$) of subjects met hospital discharge criteria on PICU discharge. Of those 180 subjects, 21% ($n = 38$) received additional dexamethasone after PICU discharge. A total of 71 subjects both meeting and not meeting hospital discharge criteria at the time of PICU discharge were treated with dexamethasone after PICU

TABLE 1 Cohort Characteristics by No Rebound Versus Rebound

	Total Cohort ($N = 275$)	No Rebound ($n = 173$)	Rebound ($n = 102$)	*P*
Age, y, median (IQR)	1.69 (1.2–2.8)	1.90 (1.2–3.1)	1.50 (1.1–2.4)	.018
Boys, *n* (%)	178 (65)	111 (64)	67 (66)	.80
Race and/or ethnicity, *n* (%)				.54
White	173 (63)	104 (60)	69 (68)	
African American	11 (4)	7 (4)	4 (4)	
Hispanic	61 (22)	40 (23)	21 (21)	
Other	30 (11)	22 (13)	8 (8)	
Season of discharge *n* (%)				.53
Fall (September–November)	92 (33)	62 (36)	30 (29)	
Winter (December–February)	106 (39)	63 (36)	43 (42)	
Spring (March–May)	48 (17)	28 (16)	20 (20)	
Summer (June–August)	29 (11)	20 (12)	9 (9)	
History of prematurity, *n* (%)	23 (8)	18 (10)	5 (5)	.11
Previous episode(s) of croup, *n* (%)	54 (20)	33 (19)	21 (21)	.76
Previous intubation, *n* (%)	11 (4)	7 (4)	4 (4)	.97
Antibiotics prescribed, *n* (%)	89 (32)	51 (29)	38 (37)	.18
Mechanical ventilation, *n* (%)	31 (11)	21 (12)	10 (10)	.55
Noninvasive positive pressure ventilation, *n* (%)	5 (2)	2 (1)	3 (3)	.29
Heated high-flow nasal cannula, *n* (%)	9 (3)	6 (3)	3 (3)	.81
PICU LOS, median (IQR), h	21 (14.9–32.8)	22.1 (14.5–33.9)	20.5 (15.5–31.7)	.90
Total hospital LOS, median (IQR), h	46.7 (35.4–72.1)	43.8 (32.6–62.0)	60.3 (39.8–94.4)	$<.001$
Time from admission to meeting discharge criteria, median (IQR), h	24.9 (16.92–38.98)	25.65 (16.83–41.05)	23.03 (17.25–37.1)	.338
Total iLOS (admission to meeting discharge criteria during the d), median (IQR), h	26.9 (17.6–41.5)	27.6 (17.5–42.4)	26.1 (17.8–38.7)	.43
Total dexamethasone in PICU, median (IQR), mg/kg	1.31 (0.7–2.4)	1.30 (0.7–2.4)	1.40 (0.7–2.2)	.85
Total dexamethasone in hospital, median (IQR), mg/kg	1.57 (1.0–2.6)	1.5 (0.9–2.6)	1.7 (1.1–2.7)	.14
Total racemic epinephrine doses in hospital, *n* (%)				.25
0	33 (12)	23 (13)	10 (10)	
1	27 (10)	21 (12)	6 (6)	
2	40 (15)	27 (16)	13 (13)	
3	57 (21)	32 (18)	25 (25)	
4	43 (16)	28 (16)	15 (15)	
5	33 (12)	21 (12)	12 (12)	
≥6	42 (15)	21 (12)	21 (21)	
Respiratory virus panel obtained, *n* (%)	168 (61)	101 (58)	67 (66)	.23
>1 virus[a]	80 (48)	50 (50)	30 (45)	.55
Influenza A	17 (10)	7 (7)	10 (15)	.09
Influenza B	5 (3)	3 (3)	2 (3)	.99
Parainfluenza 1	53 (32)	33 (33)	20 (30)	.70
Parainfluenza 2	42 (25)	26 (26)	16 (24)	.79
Parainfluenza 3	16 (10)	10 (10)	6 (9)	.84
Rhinovirus or enterovirus	72 (43)	45 (45)	27 (40)	.59

—, not applicable.

[a] Subjects could be positive for >1 virus; therefore, column percentages total >100.

TABLE 2 Type of Rebound for Patients With Return of Symptoms After Meeting Hospital Discharge Criteria, $n = 102$

Type of Rebound	*n* (%)
Rebound in hospital[a]	84 (82)
Return of stridor at rest	53 (63)
Retractions	20 (24)
Tachycardia	42 (50)
Tachypnea	21 (25)
Declining oral intake	1 (1)
Declining mental status	2 (2)
Racemic epinephrine treatment	24 (29)
Transfer back to PICU	4 (5)
ED visit for worsening croup symptoms within 2 wk of discharge	17 (17)
Clinic visit for worsening croup symptoms within 7 d of discharge	5 (5)
Readmitted for worsening croup symptoms within 7 d of discharge	8 (8)

[a] Patients in this category may meet 1 or multiple in-hospital rebound criteria, including documentation of any of the following: return of stridor at rest, retractions (other than suprasternal), tachypnea for age, tachycardia for age, declining mental status, declining oral intake, treatment with racemic epinephrine, or transfer back to the PICU.

discharge. The rebound rate for subjects treated with dexamethasone after PICU discharge was 54% ($n = 38$), compared with a 31% ($n = 64$) rebound rate for subjects not treated with dexamethasone after PICU discharge ($P \leq .001$). Dexamethasone administration after PICU discharge was most often scheduled (eg, every 8 hours) rather than performed as needed (Fig 1).

In the multivariable logistic regression total pre-PICU discharge dexamethasone dose did not predict odds of rebound (adjusted odds ratio [OR] = 1.00 [95% confidence interval (CI) 0.83–1.19]; $P = .96$). None of the measured patient factors were associated with rebound (Table 3).

In comparing time to rebound for subjects receiving ≤1.2 mg/kg versus >1.2 mg/kg of dexamethasone in the PICU, there was no association between dexamethasone dosing groups and time to rebound (Fig 2).

DISCUSSION

In this single-center, retrospective chart review study of 275 children admitted to the PICU with croup, subjects received cumulative hospital dexamethasone doses up to >4 times the typically prescribed outpatient dose of 0.6 mg/kg. A clinically significant number of children (37% of subjects) developed rebound after meeting hospital discharge criteria. The cumulative dexamethasone dose before PICU discharge was associated with neither the odds of rebound nor the timing of rebound. Researchers have not examined the odds of, or risk factors for, rebound in previous studies. Authors of previous studies have cited patient characteristics (eg, prematurity and previous intubation) as predictors of abnormal endoscopic findings and recurrent croup; however, the same characteristics did not change the odds of rebound in our study so may not be useful in making hospital discharge decisions.[12,13]

Our findings have important implications for both in-PICU and post-PICU care for critically ill children with croup. The lack of association between cumulative PICU dexamethasone dosing and rebound reveals that larger cumulative doses of dexamethasone in the PICU do not protect against symptom recurrence after PICU discharge, although the effect of higher steroid doses on preventing disease progression and/or preventing or shortening intubation in children with severe croup remains unclear. Furthermore, our results indicate that neither the amount of dexamethasone prescribed in the PICU nor individual patient characteristics can reliably inform decisions regarding the appropriate length of in-hospital observation after PICU discharge.

Subjects developed rebound symptoms a median of 13 hours after meeting hospital discharge criteria. The majority of subjects had rebound of symptoms while in the hospital. Approximately one-third of subjects with in-hospital rebound required a medical intervention such as racemic epinephrine and/or transfer back to the PICU. This reveals that a period of in-hospital observation may be warranted for critically ill patients with croup and for those discharged without in-hospital observation, hospital or phone follow-up within 12 to 24 hours of hospital discharge may be indicated. Although prediction of symptom rebound remains difficult, we also observed that many patients with croup met hospital discharge criteria at the time of transfer out of the PICU and did not develop rebound symptoms, suggesting that better tools for prediction of rebound could lead to reductions in-hospital stays and costs for many children with severe croup.

Subjects treated with dexamethasone after PICU discharge were more likely to rebound than subjects not treated with dexamethasone after PICU discharge. It is possible that additional steroids were given in response to rebound symptoms rather than to prevent rebound or that treatment with additional dexamethasone after ICU discharge reflects hospitalist clinician judgment regarding severity of illness. Most patients treated with additional dexamethasone after PICU discharge received scheduled (eg, ordered every 8 hours) dexamethasone. One might expect that if dexamethasone was prescribed in response to symptom recurrence, it would be ordered as as-needed or 1-time doses. Therefore, it is also possible that treatment with additional dexamethasone after ICU discharge reflects practice variability at the inpatient provider level rather than differences in patients' illness progression or severity.

Our study has several limitations. First, it is a single-center retrospective study. Subjects were not prospectively randomly assigned to receive small versus large doses of dexamethasone. Local care practices such as dexamethasone prescribing practices and hospital and PICU admission and

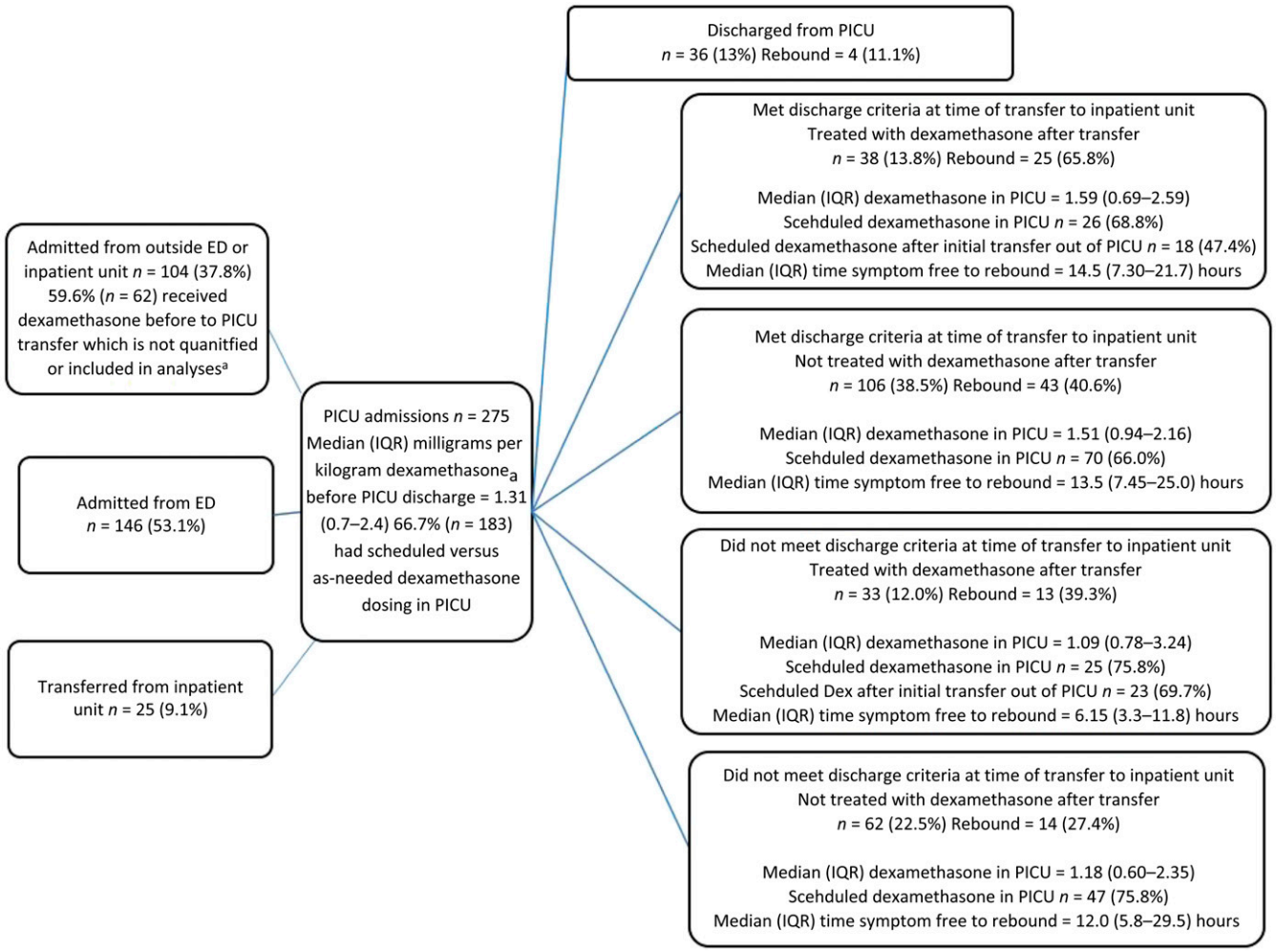

FIGURE 1 Dexamethasone treatment patterns and rebound incidence stratified by patient readiness for hospital discharge at time of PICU discharge. [a] Median (IQR) milligrams per kilogram dexamethasone before PICU discharge includes steroids given in the ED or inpatient unit before PICU admission.

discharge criteria may not be generalizable to other centers; therefore, our study outcomes may not be representative of other settings.

Thirty-eight percent of subjects were admitted directly to our PICU from outside of our hospital system; of those, more than half had documentation of receiving dexamethasone or another steroid before transfer. Although we report the proportion of subjects directly admitted who received steroids before transfer, documentation was not complete or accurate enough to include before-transfer steroid doses in our analyses. Therefore, we may have underestimated the cumulative dose of dexamethasone prescribed before PICU discharge in these patients, limiting our ability to detect an association between dexamethasone dose and rebound. We did not find an association between patient characteristics and rebound. The exclusion of subjects with complex chronic conditions may have limited our ability to identify associations between rebound and prematurity and/or previous intubation given these patient characteristics may have been more common in the excluded subjects.

It is plausible that illness severity is associated with the likelihood of rebound. Although all the subjects in our cohort were considered to be critically ill with croup, the decision to treat with smaller or larger doses of dexamethasone in the PICU may have been associated with a range of severity among the critically ill cohort. Our inability to control for severity may have limited our ability to find an association between pre-PICU discharge dexamethasone dose and rebound. Furthermore, although we controlled for season in our analysis, there are seasonal variations in the severity of viral-induced croup, which may alter severity of patient presentations and outcomes.[14,15]

We may not have captured all patients who returned to care after discharge because patients may have been seen in clinics, urgent care centers, or EDs outside of our hospital system. This was partially mitigated

TABLE 3 Mixed-Effects Logistic Regression Model Used to Compare No Rebound With Any Rebound

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[a]	*P*
Total dexamethasone before PICU discharge, mg/kg	1.01 (0.86–1.20)	1.00 (0.83–1.19)	.96
Age	0.96 (0.84–1.08)	0.94 (0.81–1.09)	.41
Boys	0.94 (0.60–1.56)	0.89 (0.52–1.52)	.67
Insurance			
Public	Reference	Reference	—
Private or other	1.24 (0.74–2.08)	1.22 (0.70–2.11)	.48
Season			
Fall (September–November)	Reference	Reference	—
Winter (December–February)	1.41 (0.79–2.53)	1.32 (0.73–2.4)	.34
Spring (March–May)	1.48 (0.72–3.04)	1.43 (0.69–2.98)	.95
Summer (June–August)	0.93 (0.38–2.29)	0.97 (0.38–2.45)	.36
History of prematurity			
No	Reference	Reference	—
Yes	0.44 (0.16–1.23)	0.31 (0.09–1.04)	.06
History of croup			
No	Reference	Reference	—
Yes	1.10 (0.60–2.03)	1.27 (0.65–2.50)	.48
History of intubation			
No	Reference	Reference	—
Yes	0.98 (0.28–3.43)	1.66 (0.38–7.19)	.5

—, not applicable.
[a] Adjusted OR includes all covariates in the model.

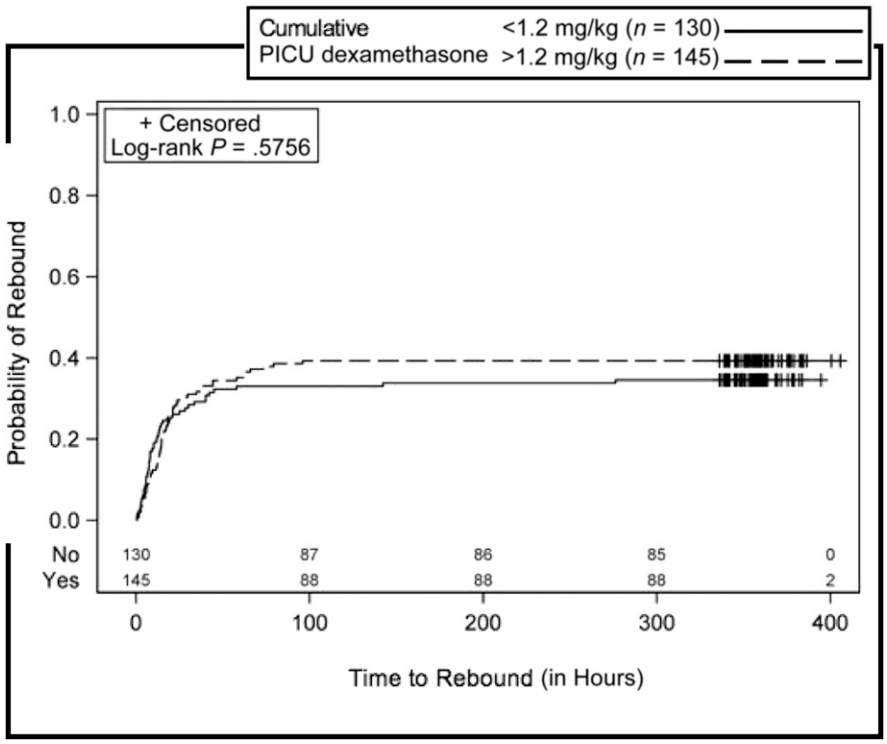

FIGURE 2 Time to rebound by cumulative PICU dexamethasone dosage.

by our ability to review clinic visit notes for several local primary care practices within our electronic health record.

Finally, we included treatment with racemic epinephrine after meeting hospital discharge criteria in our definition of in-hospital rebound. On the basis of the literature and per our clinical care pathway, racemic epinephrine is only indicated for treatment of respiratory distress.[9,16] However, this may have overestimated rebound given that some providers may prescribe racemic epinephrine for stridor with activity or other indications aside from respiratory distress. In addition, using the measures of tachycardia and decreased oral intake as measures of rebound may overestimate the number of children who have recurrence of respiratory distress or clinically significant rebound because these are also signs of fever or viral illness.

CONCLUSIONS

Critically ill children with croup in our study received cumulative hospital dexamethasone doses up to >4 times the typically prescribed outpatient dose of 0.6 mg/kg. More than one-third (102 of 275 subjects) of subjects experienced rebound of symptoms after meeting hospital discharge criteria, with a median time to rebound of 13 hours. The cumulative pre-PICU discharge dexamethasone dose did not predict odds of rebound and was not associated with time to rebound. Additional studies are needed to determine the minimally effective dosing regimen for dexamethasone for critically ill children with croup. Future research is also needed to identify reliable predictors of rebound that can be used to determine which patients may benefit from in-hospital observation and for what length of time after PICU admission for croup.

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