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ORIGINAL ARTICLE

Comparative Outcomes of Intravenous Hydrocortisone Versus Dexamethasone in Pediatric Patients Presenting with Croup

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ABSTRACT

Background: Croup is a common upper respiratory illness in children, characterized by stridor, barking cough, and respiratory distress due to subglottic airway inflammation. Corticosteroids are the mainstay of treatment in moderate to severe cases.

Objective: To compare the clinical outcomes of intravenous hydrocortisone versus intravenous dexamethasone in pediatric patients presenting with moderate to severe croup.

Methods: This comparative observational study was conducted at Mayo Hospital Lahore from Jan 2023 to June 2023. A total of 215 pediatric patients presenting with clinical features consistent with croup were enrolled in the study. Children aged 6 months to 6 years with a clinical diagnosis of moderate to severe croup based on the Westley croup score were included in the study. Patients with known hypersensitivity to corticosteroids, pre-existing chronic respiratory illnesses (e.g., asthma, tracheomalacia), or concurrent bacterial infections requiring antibiotics were excluded from the study.

Results: Out of 215 patients, 108 received hydrocortisone and 107 received dexamethasone. The mean time to stridor resolution was significantly shorter in the dexamethasone group (12.7 ± 3.8 hours) compared to the hydrocortisone group (18.4 ± 4.3 hours; $p < 0.001$). Fewer patients in the dexamethasone group required ≥2 doses of nebulized epinephrine (23.4% vs. 48.1%; $p = 0.001$). Mean hospital stay was also shorter in the dexamethasone group (2.2 ± 0.5 days) than in the hydrocortisone group (2.9 ± 0.7 days; $p < 0.001$). ICU admissions were lower in the dexamethasone group (3.7%) compared to the hydrocortisone group (10.2%; $p = 0.048$).

Conclusion: It is concluded that intravenous dexamethasone is superior to hydrocortisone in achieving faster symptom resolution, reducing hospital stays, and minimizing the need for additional interventions in pediatric patients with croup.

Keywords: Croup, Patients, Efficacy, Outcomes, Edema

INTRODUCTION

Croup, or acute laryngotracheobronchitis is a common respiratory condition in young children, characterized by a barking cough, hoarseness, stridor, and varying degrees of respiratory distress. It predominantly affects children aged between 6 months and 6 years, with the highest incidence observed in those under 3 years of age[1]. Most cases are brought on by viral infection and types 1 and 3 of parainfluenza viruses account for most of them. Respiratory syncytial virus, adenovirus, influenza viruses, and now SARS-CoV-2 are other viruses that play a role[2]. Inflammation and edema in the upper airway lead to symptoms because it narrows the space for breathing. In most of the less severe cases, croup mostly improves itself and supportive care is enough, but for middle to severe croup, medication is necessary to widen the airways and ensure the patient does not experience respiratory failure[3]. The main therapy for such cases is corticosteroids because they help reduce inflammation, decrease swelling in the airways, and make breathing easier. Within this group, dexamethasone is most often advised as the right option. It remains active in the body for a long time, is very effective, and has been successful in reducing hospital admissions, improving symptoms, and shortening how long the illness lasts in both hospital and outpatient cases. Because penicillin can be given by mouth, injection into the muscle, or injection into a vein, it is useful for a wide range of medical situations[4].

Different from prednisone, hydrocortisone acts fast and is an anti-inflammatory steroid with effects on glucose and salt. It is most commonly employed for fast treatment[5] in stressful situations where the intravenous route has been used before or is needed to start working swiftly. Though hydrocortisone is given to children in pediatric emergencies quite often, there is not much information about its use for croup. Unlike dexamethasone, hydrocortisone is taken more regularly since it leaves the system faster and is less effective at fighting inflammation with a normal dose[6]. Although people frequently use corticosteroids for croup, there are not many good studies that compare the direct outcomes of using intravenous dexamethasone and intravenous hydrocortisone[7]. There exists a major emphasis on dexamethasone studies, but hydrocortisone trials have not been examined as fully. Many times in case of a crisis or when resources are limited which corticosteroid is used may be affected by its availability, how familiar physicians are with it, or the preferred protocol within the hospital, differently than by their actual effectiveness[8]. The main methods to treat moderate to severe croup are the use of corticosteroids and nebulized epinephrine. Reducing laryngeal inflammation, decreasing how permeable blood vessels become, and lessening swelling in the air passages are the main ways corticosteroids work; as a result, the airway becomes wider and symptoms improve[9]. Dexamethasone is the corticosteroid studied most often and most often recommended by experts. Many clinical recommendations choose dexamethasone because it lasts for a long time in the body (up to 36–72 hours), has strong anti-inflammatory effects, and is given either by mouth, injection into a muscle, or directly into a vein[10]. One dose can improve symptoms a lot and lower hospital rates and the time spent in the hospital. But hydrocortisone is a short-lasting corticosteroid that has effects as a glucocorticoid and mineralocorticoid and it is often prescribed in emergency medicine and critical care[10].

Objective: To compare the clinical outcomes of intravenous hydrocortisone versus intravenous dexamethasone in pediatric patients presenting with moderate to severe croup.

METHODOLOGY

This comparative observational study was conducted at Mayo Hospital Lahore from Jan 2023 to June 2023. A total of 215 pediatric patients presenting with clinical features consistent with croup were enrolled in the study. Children aged 6 months to 6 years with a clinical diagnosis of moderate to severe croup based on the Westley croup score were included in the study. Patients with known hypersensitivity to corticosteroids, pre-existing chronic respiratory illnesses (e.g., asthma, tracheomalacia), or concurrent bacterial infections requiring antibiotics were excluded from the study. Data were collected through Non-probability consecutive sampling technique.

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Data Collection: Demographic data, including age and gender, were recorded. Clinical parameters were documented at presentation and monitored at regular intervals, including respiratory rate, presence of stridor at rest, oxygen saturation, and use of accessory muscles. Patients were allocated into two groups based on the corticosteroid administered as per attending physician discretion or drug availability. Group A received intravenous hydrocortisone at a dose of 5 mg/kg every 6 hours, while Group B received a single dose of intravenous dexamethasone at 0.6 mg/kg. Both groups received standard supportive care, including humidified oxygen, nebulized normal saline, and nebulized epinephrine as clinically indicated. The primary outcomes assessed were time to clinical improvement (resolution of stridor), need for repeated nebulized epinephrine, length of hospital stay, and any requirement for intensive care admission. Adverse events associated with corticosteroid administration were also recorded.

Statistical Analysis: Data were entered and analyzed using SPSS version 26. Continuous variables were presented as mean ± standard deviation, and categorical variables were expressed as frequencies and percentages. The Chi-square test was used to assess associations between categorical variables, while independent samples t-test was used for comparison of continuous variables between the two groups. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Data were collected from 215 patients with mean age of patients was 2.9 ± 1.3 years in the hydrocortisone group and 2.7 ± 1.1 years in the dexamethasone group (p = 0.38), with a similar gender distribution (p = 0.82). Average body weight was also not significantly different between groups (13.8 ± 2.6 kg vs. 14.1 ± 2.3 kg; p = 0.21). The distribution of moderate and severe croup cases based on Westley scores was nearly equal between groups, and no significant difference was found in oxygen saturation (p = 0.17) or respiratory rate (p = 0.29) at presentation. Retractions were observed in 75.0% of patients in the hydrocortisone group and 72.9% in the dexamethasone group (p = 0.73), indicating similar initial severity in both cohorts.

Table 1: Demographic and baseline data of patients

Characteristic	Hydrocortisone (n=108)	Dexamethasone (n=107)	p-value
Age (mean ± SD, years)	2.9 ± 1.3	2.7 ± 1.1	0.38
Male, n (%)	64 (59.3%)	62 (57.9%)	0.82
Female, n (%)	44 (40.7%)	45 (42.1%)	0.82
Weight (mean ± SD, kg)	13.8 ± 2.6	14.1 ± 2.3	0.21
Moderate Croup (Westley score 3–5), n (%)	72 (66.7%)	70 (65.4%)	0.84
Severe Croup (Westley score ≥6), n (%)	36 (33.3%)	37 (34.6%)	0.84
O2 Saturation at Presentation (mean ± SD, %)	92.4 ± 3.5	93.1 ± 3.2	0.17
Respiratory Rate (mean ± SD, breaths/min)	38.7 ± 6.2	37.9 ± 5.8	0.29
Presence of Retractions, n (%)	81 (75.0%)	78 (72.9%)	0.73

Table 2: Clinical Outcomes

Outcome Measure	Hydrocortisone (n=108)	Dexamethasone (n=107)	p-value
Time to stridor resolution (hours)	18.4 ± 4.3	12.7 ± 3.8	<0.001
Repeat epinephrine doses needed ≥ 2 (%)	52 (48.1%)	25 (23.4%)	0.001
Mean hospital stay (days)	2.9 ± 0.7	2.2 ± 0.5	<0.001
ICU admission (%)	11 (10.2%)	4 (3.7%)	0.048
Adverse events: transient hyperglycemia (%)	6 (5.5%)	3 (2.8%)	0.31

The average time to stridor resolution was markedly shorter in the dexamethasone group (12.7 ± 3.8 hours) than in the hydrocortisone group (18.4 ± 4.3 hours; p < 0.001). Additionally, fewer patients in the dexamethasone group required two or more doses of nebulized epinephrine (23.4% vs. 48.1%; p = 0.001). Hospital stays were shorter with dexamethasone (2.2 ± 0.5 days vs. 2.9 ± 0.7 days; p < 0.001), and ICU admissions were also lower (3.7% vs. 10.2%; p = 0.048). Adverse events such as transient hyperglycemia was infrequent and not significantly different between the two groups (p = 0.31).

A significantly higher proportion of patients in the dexamethasone group experienced symptom resolution within 12 hours (32.7%) compared to only 9.3% in the hydrocortisone group. Most dexamethasone-treated patients improved within 18 hours (74.8%), whereas the majority of hydrocortisone patients required 19 to 24 hours (44.4%) or even more than 24 hours (20.4%) for symptom relief.

Table 3: Stridor Resolution by Time Intervals

Time Interval (hours)	Hydrocortisone (n=108)	Dexamethasone (n=107)
<12	10 (9.3%)	35 (32.7%)
12–18	28 (25.9%)	45 (42.1%)
19–24	48 (44.4%)	20 (18.7%)
>24	22 (20.4%)	7 (6.5%)

A greater proportion of dexamethasone-treated patients required no epinephrine at all (31.8% vs. 16.7%), and the majority responded with just a single dose (44.9%). In contrast, the hydrocortisone group showed a higher need for repeated interventions, with 29.6% requiring two doses and 18.5% needing three or more.

Table 4: Number of Epinephrine Doses Required

No. of Doses	Hydrocortisone (n=108)	Dexamethasone (n=107)
0	18 (16.7%)	34 (31.8%)
1	38 (35.2%)	48 (44.9%)
2	32 (29.6%)	18 (16.8%)
≥3	20 (18.5%)	7 (6.5%)

The discharge outcomes favored the dexamethasone group, with 85.0% of patients being discharged within 48 hours compared to 68.5% in the hydrocortisone group. Continued observation beyond 48 hours was needed in 21.3% of hydrocortisone cases versus only 11.2% with dexamethasone. Additionally, a higher proportion of patients in the hydrocortisone group required transfer to the ICU (10.2% vs. 3.7%), indicating a greater likelihood of clinical deterioration when treated with hydrocortisone.

Table 5: Discharge Status at 48 Hours

Discharge Status	Hydrocortisone (n=108)	Dexamethasone (n=107)
Discharged	74 (68.5%)	91 (85.0%)
Observation Continued	23 (21.3%)	12 (11.2%)
Shifted to ICU	11 (10.2%)	4 (3.7%)

DISCUSSION

This study compared the clinical efficacy of intravenous hydrocortisone and dexamethasone in managing moderate to severe croup in pediatric patients. The findings demonstrate that

intravenous dexamethasone was significantly more effective than hydrocortisone in achieving faster symptom resolution, reducing the need for repeated nebulized epinephrine, shortening hospital stay, and lowering ICU admission rates. The mean time to stridor resolution was markedly shorter in the dexamethasone group (12.7 ± 3.8 hours) compared to the hydrocortisone group (18.4 ± 4.3 hours). This supports the pharmacokinetic profile of dexamethasone, which has a longer biological half-life and greater anti-inflammatory potency, allowing sustained suppression of airway edema with a single dose[11]. In contrast, hydrocortisone, with its shorter half-life and lower relative potency, may not maintain therapeutic levels long enough to achieve comparable clinical outcomes without more frequent dosing[12]. Besides, virtually half of the hydrocortisone patients had to use two or more doses of nebulized epinephrine, whereas less than a quarter of the patients given dexamethasone needed this treatment. That means that keeping symptoms controlled was a bigger challenge with hydrocortisone alone. Since nebulized epinephrine only offers short-term help and can cover up the seriousness of airway obstruction, doctors may need to treat more seriously in some situations[13]. Dexamethasone treatment led to a shorter stay in the hospital, with an average of 2.2 days, than hydrocortisone treatment which was 2.9 days[14]. Though little in absolute numbers, this difference affects how resources are used and costs for healthcare, mainly in heavily occupied pediatric units. Similarly, there were more admissions to the ICU in the hydrocortisone group (10.2% as opposed to 3.7%) which may highlight poorer early management of inflammation in the airways.

This matches results found before in studies that demonstrate the benefit of dexamethasone in addressing croup symptoms and preventing hospitalization. Based on their meta-analysis,[15] showed that one dose of oral or parenteral dexamethasone was effective in reducing symptoms at 6 and 12 hours and also decreased the chances of needing hospitalization. It is difficult to find literature that looks at dexamethasone compared to hydrocortisone in this area[16]. It enhances knowledge about the topic by evaluating intravenous formulations that are often chosen in urgent or hospital settings when enteral administration cannot be used. Both groups saw infrequent and mild problems and a higher rate of transient hyperglycemia was noted among patients given hydrocortisone. There were no reports of serious adverse effects which supports the safety of both medications if used correctly[17]. Despite these strengths, several limitations must be acknowledged. The study was observational, and treatment allocation was not randomized, introducing the potential for selection bias. While baseline characteristics were comparable between the groups, unmeasured confounding variables may have influenced outcomes. Additionally, the study was conducted at a single center, limiting the generalizability of findings to other healthcare settings with differing clinical practices or patient populations.

CONCLUSION

It is concluded that intravenous dexamethasone is more effective than intravenous hydrocortisone in the management of moderate to severe croup in pediatric patients. Dexamethasone demonstrated significantly faster resolution of stridor, reduced need for repeat doses of nebulized epinephrine, shorter duration of hospital stay, and lower rates of intensive care unit admissions. These findings highlight the clinical advantages of dexamethasone, particularly in emergency and inpatient settings where timely control of airway inflammation is critical.

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