Single-Dose Dexamethasone Is Not Inferior to 2 Doses in Mild to Moderate Pediatric Asthma Exacerbations in the Emergency Department

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Objective: The purpose of this study was to compare the efficacy of a single dose of dexamethasone to 2 doses of dexamethasone in treating mild to moderate asthma exacerbations in pediatric patients. We anticipated that there would not be a difference in the rate of return visits to the emergency department (ED), urgent care, or primary care physician for continued asthma symptoms.

Methods: This was a prospective, randomized, single-center, unblinded, parallel-group randomized clinical trial of patients 2 to 20 years old presenting to a pediatric ED with mild to moderate asthma exacerbations. The patients were randomized to receive 1 or 2 doses of dexamethasone (0.6 mg/kg per dose, maximum of 16 mg). Telephone follow-up interviews were performed on the sixth day after ED visit. The primary outcome measures were return visits to either primary care physician or ED for continued asthma symptoms. Secondary outcomes were days of symptoms, missed school days, and adverse effects.

Results: Of the 318 children initially enrolled, 308 patients met the enrollment criteria. These patients were randomized into 2 groups. There were 116 patients in group 1 and 116 patients in group 2. There was no significant difference between groups regarding return visits (group 1, 12.1%; group 2, 10.3%; odds ratio [OR], 0.892 [95% confidence interval {CI}, 0.377–2.110]), days to symptom resolution (group 1, 2.4; group 2, 2.5; OR, 0.974 [95% 95% CI, 0.838–1.132]), missed school days (group 1, 47%; group 2, 51%; OR, 1.114 [95% CI, 0.613–2.023]), or vomiting (group 1, 8.6%; group 2, 3.4%; OR, 2.424 [95% CI, 0.637–9.228]).

Conclusions: In this single-center, unblinded randomized trial of children and adolescents with mild to moderate acute exacerbations of asthma, there was no difference in the rate of return visits for continued or worsened symptoms between patients randomized to 1 or 2 doses of dexamethasone.

Key Words: asthma, dexamethasone, asthma exacerbation

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BACKGROUND

Asthma is a pulmonary condition affecting 9.1% of children, around 6.7 million in the United States, accounting for more than 500,000 emergency department (ED) visits in 2006 alone.[1] Current national guidelines recommend the administration of oral systemic corticosteroids for ED management of acute asthma in moderate or severe exacerbations.[2] Oral steroids are also standard therapy for patients with mild asthma who fail to respond promptly to a single albuterol treatment.[3–5]

Prednisone and dexamethasone are the 2 most common systemic steroids used for acute asthma exacerbations. Prednisone is currently recommended by the National Asthma Education and Prevention Program Expert Panel Report 3.[2] It requires a 5-day treatment course, with twice-daily dosing, and has been associated with vomiting as a significant adverse effect. Dexamethasone is a long-acting glucocorticoid, which is 5 to 6 times more potent than prednisone.[6] It has a half-life of 36 to 72 hours, thus requiring fewer doses to achieve similar results.[7] Furthermore, in contrast to the frequent emesis with prednisolone, dexamethasone is considered to have an antiemetic effect.[8]

Several published studies have compared dexamethasone with oral prednisone. Qureshi et al[9] and Greenberg et al[10] compared 2 days of oral dexamethasone 0.6 mg/kg (maximum 16 mg) to 5 days of prednisone in treating acute pediatric asthma and found that both had similar rates of relapse and persistence of symptoms after 10 days. Cronin et al[7] studies a single dose of dexamethasone 0.3 mg/kg (maximum of12 mg) versus prednisone 1 mg/kg/d for 3 days (maximum of 40 mg) and showed that dexamethasone is noninferior. A recent meta-analysis by Keeney et al[11] identified 6 studies comparing either 1 or 2 doses of oral or intramuscular dexamethasone to 5 days of prednisone. They concluded that there was no significant difference in rates of relapse in either treatment group, but that dexamethasone was associated with less vomiting. Dexamethasone was recommended over prednisone for acute asthma exacerbations.

As a general rule, single-dose treatment regimens in the ED are preferred to regimens requiring multiple dosing; in addition to being easier on families, single dosing ensures 100% compliance with treatment. For these reasons, single-dose dexamethasone for acute asthma exacerbations would seem to be the ideal treatment. However, although multiple studies have compared dexamethasone to prednisone, no study has ever directly compared single-dose dexamethasone with twice-daily dosing. If single dosing is to be recommended, we wanted to ensure that single-dose dexamethasone would give patients the same outcomes as twice-daily dosing.

OBJECTIVE

The purpose of this study was to compare the efficacy of a single dose of dexamethasone to 2 doses of dexamethasone in treating mild to moderate asthma exacerbations in pediatric patients. We hypothesized that there would not be a difference in the rate of return visits to the ED, urgent care, or primary care physician for continued asthma symptoms.

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M.M., M.P., H.T., H.Q., and B.H.W. conceived the study and designed the trial. H.Q. supervised the conduct of the trial, recruitment, and data collection and quality control. B.H.W. provided statistical advice on study design and analyzed the data. M.M. and H.T. drafted the manuscript, and all authors contributed substantially to its revision. M.M. takes responsibility for the article as a whole.

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METHODS

We performed a single-site, prospective, parallel-group, unblinded randomized clinical trial that enrolled a convenience sample of patients aged 2 to 20 years with previously diagnosed asthma presenting to a single ED with a mild to moderate exacerbation of asthma. The hospital's institutional review board approved the study, and informed consent was obtained from eligible patients' legal guardians or adult patients (18–20 years age). In addition, patients 7 to 17 years of age provided written ascent.

Study Setting and Participants

Children aged 2 to 20 years with a known history of asthma who presented to the ED at Women and Children's Hospital of Buffalo/Oishei Children's Hospital between April 2015 and March 2018 with an acute exacerbation of mild or moderate asthma were eligible for the study. Asthma severity was defined by Pediatric Asthma Scores[2,12] (PAS). Mild asthma is defined as PAS of 5 to 7; moderate asthma, PAS of 8 to 11; and severe asthma, PAS of 12 or more. History of asthma is defined by physician diagnosis of at least 1 prior episode of wheezing, which responded to beta agonists. Patients were excluded from the study if they had signs of severe asthma exacerbation (PAS of 12 or more), had used oral steroids in the last 2 weeks, had chronic lung disease (eg, cystic fibrosis), had been given parenteral steroids, or vomited 2 doses of oral steroids in ED.

Research assistants screened asthma patients through the electronic medical record between the hours of 8 AM and 11 PM, 7 days a week. Patients were approached sequentially based on registration time. If a patient seemed to meet the study criteria, his/her ED treating physician was approached by the research assistant for identifying patient's eligibility. If a patient was fully eligible, the legal guardian and/or patient was approached for consent.

Study Protocol

Block randomization was used to generate a list to be used for subject assignment with a 1:1 ratio of allocation to the single-dose group and the 2-dose group. Demographic information such as age, sex, race, duration of asthma symptoms, number of previous hospitalizations, and current medication was collected. Pertinent examination findings such as patient's vital signs, pulse oximetry, and PAS were also collected along with medications given in the ED.

Group 1 was given 0.6 mg/kg (maximum of16 mg) of dexamethasone orally in the ED. Group 2 was given the same dose in the ED, and then a prescription for a second dose was sent to their pharmacy to be filled and administered at home 24 hours later. We worked with a nearby 24-hour pharmacy to ensure medication availability; however, pharmacy preference was left up to the family. Both groups received asthma treatment following a standardized asthma care path.

All patients were contacted by phone by a research assistant on the sixth day after the ED visit. Research assistants were not completely blinded during the study. They were initially blinded to the study group at the start of the phone interviews; however, during the course of the interview, they did ask if the prescription for the second dose of dexamethasone was filled and if the medication was given to the patient. Information collected during the phone interview included additional visits to medical providers (ED, primary care, or urgent care) for continued asthma symptoms; information was collected on the reason for visit, whether symptoms continued or worsened, and if additional treatment was needed (scheduled visits and unrelated visits were excluded). School days missed due to asthma exacerbation; length of time symptoms persisted; compliance with the recommended steroid regimen; and any vomiting, adverse effects, or medication administration problems caused by the steroids were also collected.

Analytic Plan

Descriptive characteristics were computed for all patients combined and separately by dexamethasone group assignment. Categorical variables were reported as proportions in percentage, and continuous-level variables as means and SDs. Separate independent *t* tests were used to assess differences by group for postdischarge outcomes of interest including days for symptoms to resolve. Separate binary logistic regression adjusting for age, sex, and severity of exacerbation was conducted to assess group differences in postdischarge outcomes including patients who had a return visit for unresolved asthma symptoms (ED, primary care, or urgent care), days to symptom resolution, any missed school days between discharge and follow-up, rates of vomiting, and adverse effects (changes in appetite, insomnia, mood swings); odds ratios (ORs) with 95% confidence intervals (CIs) were reported. Similar analyses were conducted to compare events and adverse effects between groups 1 and 2 by asthma severity, using an intention-to-treat approach. Based on our clinical experience, we based our a priori sample size calculation on an estimated noninferiority limit of 11% and a rate of 12% return for asthma for each group. With a power of 80% and α of 0.05, a minimum sample size of 216 (108 subjects per group) was determined. All statistical tests were 2-tailed, and analyses conducted with SYSTAT 13 (SYSAT Software, 2004).

RESULTS

A total of 318 children were initially enrolled in the study. Ten patients were excluded from the study; 5 patients were admitted to the pediatric intensive care unit during the hospital stay, 1 patient was found to have received dexamethasone within 2 weeks of study enrollment, 1 patient had multiple episodes of emesis in the ED, 2 were previously enrolled in the study, and 1 patient required intravenous steroids in the ED. Of the remaining 308 patients enrolled in the study, 154 were randomized to receive a single dose of dexamethasone and 154 were randomized to receive 2 doses of dexamethasone. Twenty-four patients were further excluded from the study because they were given additional doses of steroids once admitted to the hospital, and 52 were lost to phone follow-up. Ninety-four of the 116 patients randomized to group 2 successfully took the second dose of dexamethasone (81%). The 22 patients who failed to take the second dose of dexamethasone were analyzed with group 2 (Fig. 1, consort diagram). There was no difference in age ($P = 0.920$), sex ($P = 0.776$), or race ($P = 0.827$) within this subgroup.

Baseline demographic characteristics including sex and race were similar between the 2 groups. However, patients receiving 2 doses of dexamethasone were slightly older (6.8 vs 8.3 years, $P = 0.01$; Table 1).

Seventy-four of the 232 (32%) patients returned to a clinic or hospital for further evaluation or follow-up; 26 (11%) of these were due to worsening or continued and asthma symptoms. There was no difference between groups in return visits for continued asthma symptoms (group 1, 12.1%; group 2, 10.3%; OR, 0.892 [95% CI, 0.377–2.110]). Of the 26 patients with return visits due to asthma symptoms 15 were seen at the primary care doctor, 11 returned to the ED, and 1 of the 11 that returned to the ED was admitted to the hospital. No return visits were admitted to the pediatric intensive care unit. The patient who required admission was in the single-dose study group.

There were also no statistically significant differences between the 2 groups for any of the postdischarge outcomes, including days for symptom resolution, number of school days missed, adverse effects, and vomiting since discharge from the ED. Results were unchanged after adjusting for age (Table 2).

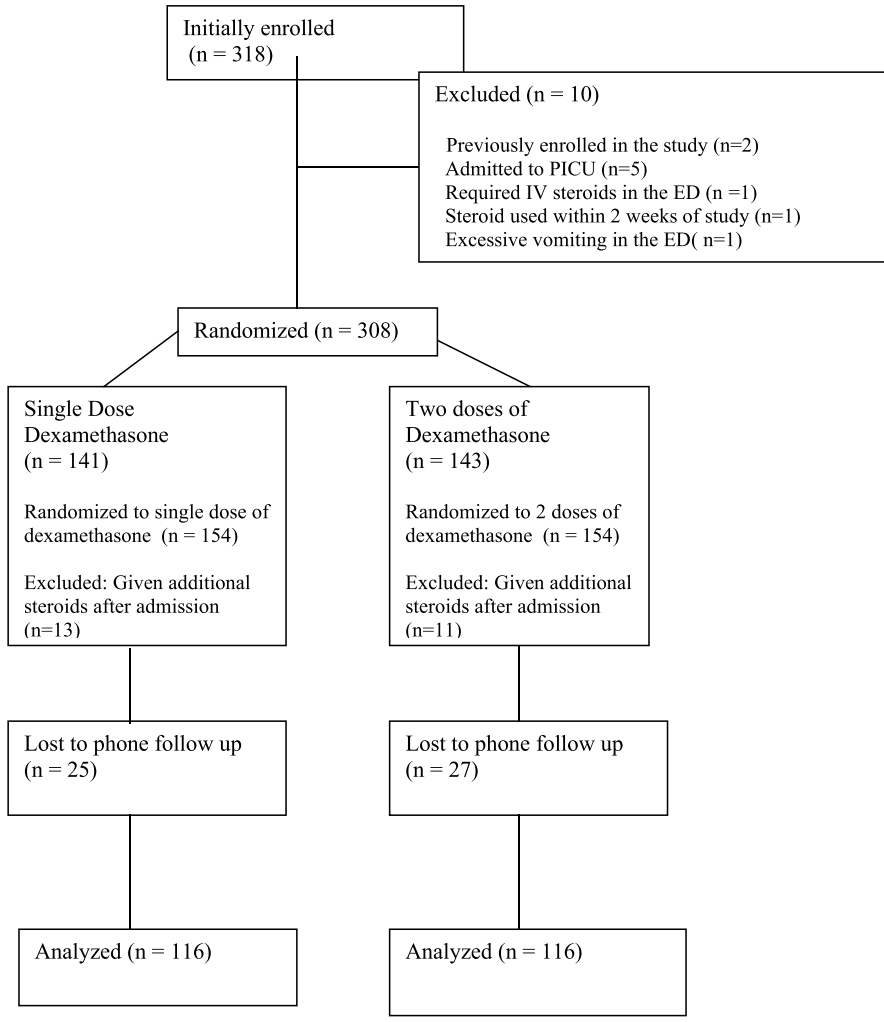

FIGURE 1. CONSORT diagram.

Of the 232 patients enrolled in the study, 148 were categorized with a mild asthma exacerbation (based on PAS score) and 65 were categorized as a moderate asthma exacerbation (19 patients had no PAS score calculated and were not analyzed). Overall, patients with mild asthma exacerbations had a 13.5% (20 patients) rate of return visits for continued asthma symptoms and had an average of 2.7 days to symptom resolution. We found no difference between patients with mild asthma exacerbations enrolled in group 1 or 2 in regard to return visits, days to symptoms resolution, patients who missed school, or adverse effects. Overall, patients with moderate asthma had a 7.7% (5 patients) rate of return visits for continued symptoms and had an average of 2.5 days to symptoms resolution. We found no difference between patients with moderate asthma exacerbations enrolled in group 1 or 2 in regard to return visits, days to symptom resolution, patients who missed school, or adverse effects. Results were unchanged after adjusting for age, sex, and severity of exacerbation (Table 3).

DISCUSSION

Multiple previous studies have demonstrated dexamethasone to be equivalent to prednisone/prednisolone for the treatment of acute asthma exacerbations. However, these studies did not use consistent dexamethasone treatment regimens; some of the studies used a single dose of dexamethasone, and some of them gave a second dose the following day. Although both dosing regimens were shown to be equivalent to longer courses of prednisone, single-dose dexamethasone has never been directly compared with 2 daily doses. With the obvious logistical benefits of a single-dose treatment regimen in mind, we compared giving a single dose of dexamethasone in the ED to giving a dose in the ED and a second dose 24 hours later. Our goal was to show noninferiority with a single dose of dexamethasone treatment regimen. With regard to symptom resolution, return visits, or missed school, we found no significant difference between patients given a single dose of dexamethasone and patients who were given 2 doses.

We broke our results down further and used PAS scores to separate patients into mild exacerbations and moderate exacerbations. In both groups, we found that single-dose dexamethasone was noninferior to 2 daily doses. This shows that our data were not skewed by a preponderance of patients with mild exacerbations and suggests that there may be a role for future studies to investigate single-dose dexamethasone in even sicker patients.

The effectiveness of a single dose of dexamethasone has important implications, especially in the ED setting. First and foremost, single-dose treatment ensures 100% compliance. In addition, single-dose treatment will likely be more cost-effective for families, as there is no extra prescription to be filled. Lastly, the

TABLE 1. Comparison of Characteristics Between Dosing Groups

Characteristics	Overall	Group 1 (n = 116)	Group 2 (n = 116)
Age*, mean (SD), y	7.5 (4.2)	6.8 (3.9)	8.2 (4.4)
Sex, n (% female)	92 (39.8)	48 (41.4)	44 (38.3)
Race, n (%)			
White	61 (26.4)	28 (24.3)	33 (26.4)
Black	113 (48.9)	61 (53.0)	52 (48.9)
Asian	10 (4.3)	5 (4.3)	5 (4.3)
American Indian	3 (1.3)	1 (0.9)	2 (1.3)
Other	44 (19.0)	20 (17.4)	24 (19.0)
Anyone smoke in home, n (% yes)	63 (27.3)	32 (30.8)	31 (29.5)
Days of symptoms, mean (SD)	3.3 (8.7)	3.6 (9.7)	3.1 (7.5)
On controller med at home, n (% yes)	104 (45.0)	50 (43.5)	54 (46.6)
No. previous hospital admissions, mean (SD)	1.3 (2.2)	1.4 (1.9)	1.2 (2.5)
PAS score before albuterol, mean (SD)	7.1 (1.6) n = 213	7.2 (1.8) n = 106	6.9 (1.5) n = 107

Overall, there was a difference between the ages of patients, with group 2 being older. There was no between-group differences in sex, race, smokers at home, controller medications, number or symptom days, or previous admissions in life for asthma.

*Between-group difference for age of $P < 0.05$.

added convenience that comes with single-dose treatment will lead to an overall improved experience for patients and their parents.

Of the patients initially randomized to group 2, 81% of patients took the prescribed second dose. The most common reason for missing the second dose was the taste of the dexamethasone prohibited the child from taking the medication at home. Other reasons included the following: the family was unable to pick up at the pharmacy and the pharmacy was unable to get the medication. Regardless of the reason, 81% compliance is an unacceptably low rate, emphasizing the need for a protocol that guarantees compliance. We do recognize that our reported prescription compliance rate was higher than generally observed.[7] Before initiation of the study, we worked with a nearby 24-hour pharmacy with a drive-through to ensure medication availability. Prescriptions were sent electronically to a pharmacy of the families preference; however, this pharmacy was encouraged for convenience. The fill rate was reported by the family and not confirmed with the pharmacy.

We found dexamethasone to be well tolerated, with minimal but equal adverse effects in both treatment groups (Table 2). The most common adverse effect we found was vomiting (6.2% of overall patients). The adverse effects our patients experienced were comparable to the adverse effect profiles of dexamethasone in previous studies, and although not specifically evaluated by our study, our data seem to emphasize previous data showing that dexamethasone is better tolerated than prednisone.

Our study had some limitations. First, although our study was randomized, it was not blinded. We did not have funding, so we were unable to dispense study/placebo medications. Not blinding could have created a placebo effect, where patients overreport positive outcomes. However, if the placebo effect were occurring, it would likely bias results away from the null hypothesis, with patients taking 2 doses overreporting positive effects. Our results do not suggest this, and we do not think that this had any effect on the outcome of our results. Lack of blinding could have also led to a reporting bias.

Second, there were several patients who were lost to follow-up, and the outcome of these patients is unknown. Rates of loss to follow-up were due to a multiple factors including invalid phone numbers and unanswered phone calls and did not differ between the 2 groups; therefore, this did not affect our results. Third, phone follow-up was self-reported by the patient and/or family, so some of the information provided is potentially subjective; but both groups were given the same telephone survey, so this would be very unlikely to have any effect on our results. Prescription fill rates and additional visits were obtained by phone follow-up and unable to be validated by a pharmacy or primary pediatricians, which could have also led to reporting bias. Fourth, there was a difference in the ages of the 2 groups, with the average age being 1.5 years apart. We were able to analyze results after adjusting for age, and our results were unchanged. Fifth, there was a group of patients who were excluded from the study because after being admitted to the hospital, the steroid treatment was changed to prednisone by the admitting physician. This happened in both treatment arms, so it likely had no effect on our data but could possibly

TABLE 2. Reported Events and Adverse Effects, Overall and by Dosing Group

Outcome	Overall	Group 1	Group 2	OR (95% CI)
Return visit for asthma, n (%)	26 (11.2)	14 (12.1)	12 (10.3)	0.892 (0.377–2.110)
Days to symptom resolution, mean (SD)	2.4 (3.4)	2.4 (3.5)	2.5 (3.4)	0.974 (0.838–1.132)
Patients who missed any school, n (%)	98 (47.6)	47 (48.0)	51 (47.2)	1.114 (0.613–2.023)
Vomiting since discharge, n (%)	14 (6.0)	10 (8.6)	4 (3.4)	2.424 (0.637–9.228)
Adverse effects, n (%)				
None	154 (66.4)	71 (61.2)	83 (71.6)	0.787 (0.351–1.767)
Decreased appetite	11 (4.7)	4 (3.4)	7 (6.0)	0.451 (0.098–2.077)
Difficulty sleeping	9 (3.9)	9 (7.8)	0	—
Mood swings/agitation	10 (4.3)	7 (6.0)	3 (2.6)	1.098 (0.228–5.293)
Headache	4 (1.7)	3 (2.6)	1 (0.9)	—
Other	9 (3.9)	5 (4.3)	4 (3.4)	0.579 (0.122–2747)
Multiple	35 (15.1)	17 (14.7)	18 (15.5)	Side effects, reference

Between-group analyses were conducted with binary logistic regression adjusting for age, sex, and severity of exacerbation and showed no statistically significant difference. Return visits for asthma was defined as an additional visit to primary care provider, urgent care, or the ED for continued or worsening asthma symptoms. This information was collected on phone follow-up.

TABLE 3. Comparison of Events and Adverse Effects Between Groups 1 and 2 by Asthma Severity

	Mild Asthma			Moderate Asthma		
Outcome	**Group 1 (1 Dose; n = 66)**	**Group 2 (2 Doses; n = 82)**	**OR (95% CI)**	**Group 1 (1 Dose; n = 40)**	**Group 2 (2 Doses; n = 25)**	**OR (95% CI)**
Return visit for asthma, n (%)	10 (15.2)	10 (12.2)	1.29 (0.499–3.347)	3 (7.5)	2 (8.0)	0.720 (0.104–4.977)
Days to symptom resolution, mean (SD)	2.5 (1.7) n = 62	2.8 (1.9) n = 73	0.914 (0.754–1.108)	2.4 (2.4) n = 38	2.6 (2.1) n = 24	0.944 (0.749–1.191)
Patients who missed any school, n (%)	30 (54.5) n = 55	34 (44.7) n = 76	1.483 (0.733–3.001)	13 (37.1) n = 35	11 (47.8) n = 23	0.606 (0.204–1.802)
Vomiting since discharge, n (%)	7 (12.7) n = 55	3 (3.9) n = 76	2.696 (0.649–11.197)	3 (7.5)	1 (4.0)	1.770 (0.167–18.772)
Adverse effects, n (%)			$P = 0.364$			$P = 0.786$
None	42 (63.6)	60 (73.2)		24 (60.0)	18 (72.0)	
Decreased appetite	2 (3.0)	5 (6.1)		1 (2.5)	1 (4.0)	
Difficulty sleeping	4 (6.0)	0 (0.0)		3 (7.5)	0 (0.0)	
Mood swings/agitation	4 (6.1)	1 (1.2)		3 (7.5)	2 (8.0)	
Headache	1 (1.5)	0 (0.0)		2 (5.0)	0 (0.0)	
Multiple	11 (16.7)	14 (17.1)		4 (10.0)	2 (8.0)	
Other	2 (3.0)	2 (2.4)		3 (7.5)	2 (8.0)	

The first column shows all patients with mild asthma and compares group 1 with group 2 (18 patients had no PAS score calculated and were not analyzed in this table). Between-group analyses were conducted using simple logistic regression adjusting for age and sex. There was no significant difference for any of the events or adverse effects between groups. The second column shows all patients with moderate asthma and compares group 1 with group 2, with between-group analyses for categorical variables conducted with simple logistic regression adjusting for age and sex. There was no significant difference for any of the events or adverse effects between groups.

have resulted in the exclusion of a segment of sicker patients from our analysis. Sixth, we did not collect information about insurance status. This could potentially play a role, and we were unable to control for it because we did not collect this information at the time of the study.

Finally, we had a prolonged enrollment period of 36 months. The biggest reason for this was that we have numerous practitioners at our institution, including residents, fellows, nurse practitioners, moonlighting attending physicians, and full-time physicians, and it took a long time to educate the entire team about the study; there were many patients who were disqualified because they were given prednisone immediately upon presentation, as had previously been our protocol. We had some research staffing issues that contributed to this problem as well, but this was a lesser factor. We feel that the prolonged enrollment period had no effect on our results. During this enrollment period, we did have seasonal fluctuations with enrollment rates higher in colder months (November–April). There were no changes to the asthma protocol during the study period.

Further research directions include evaluating dexamethasone administration in hospitalized patients or in patients who have higher PAS scores. This could possibly lead to eliminating frequent dosing of solumedrol, which is currently given every 6 hours in severe asthma exacerbations. Lower doses of dexamethasone could also be studied to evaluate if a lower dose is as effective, possibly decreasing adverse effects.

CONCLUSIONS

Several studies have shown dexamethasone to be equivalent to prednisone/prednisolone in the treatment of mild to moderate asthma exacerbations. These studies lack a consistent dexamethasone dosing regimen. In this unblinded, single-center, randomized trial, there was no significant difference in return visits for asthma symptoms between 1 and 2 doses of dexamethasone for mild to moderate acute exacerbations of asthma. With noninferiority, similar adverse effects, and guaranteed compliance, we believe that a single dose of dexamethasone should be considered in the care for mild to moderate asthma exacerbations treated in the ED.

REFERENCES

1. Akinbami LJ, Simon AE, Rossen LM. Changing trends in asthma prevalence among children. *Pediatrics*. 2016;137:1–7.
2. National Asthma Education and Prevention Program. Expert Panel Report 3 (EPR-3): guidelines for the diagnosis and management of asthma—summary report 2007. *J Allergy Clin Immunol*. 2007;120(suppl 5):S94–S138.
3. Chapman KR, Verbeek PR, White JG, et al. Effect of a short course of prednisone in the prevention of early relapse after the emergency room treatment of acute asthma. *N Engl J Med*. 1991;324: 788–794.
4. Rachelefsky G. Treating exacerbations of asthma in children: the role of systemic corticosteroids. *Pediatrics*. 2003;112:382–397.
5. Scarfone RJ, Fuchs SM, Nager AL, et al. Controlled trial of oral prednisone in the emergency department treatment of children with acute asthma. *Pediatrics*. 1993;92:513–518.
6. Zoorob RJ, Cender D. A different look at corticosteroids. *Am Fam Physician*. 1998;58:443–450.
7. Cronin J, Kennedy U, McCoy S, et al. Single dose oral dexamethasone versus multi-dose prednisolone in the treatment of acute exacerbations of asthma in children who attend the emergency department: study protocol for a randomized controlled trial. *Trials*. 2012;13:141.

8. Karaman M, Ilhan AE, Dereci G, et al. Determination of optimum dosage of intraoperative single dose dexamethasone in pediatric tonsillectomy and adenotonsillectomy. *Int J Pediatr Otorhinolaryngol*. 2009;73:1513–1515.
9. Qureshi F, Zaritsky A, Poirier MP. Comparative efficacy of oral dexamethasone versus oral prednisone in acute pediatric asthma. *J Pediatr*. 2001;139:20–26.
10. Greenberg RA, Kerby G, Roosevelt GE. A comparison of oral dexamethasone with oral prednisone in pediatric asthma exacerbations treated in the emergency department. *Clin Pediatr (Phila)*. 2008;47:817–823.
11. Keeney GE, Gray MP, Morrison AK, et al. Dexamethasone for acute asthma exacerbations in children: a meta-analysis. *Pediatrics*. 2014;133:493–499.
12. Kelly CS, Andersen CL, Pestian JP, et al. Improved outcomes for hospitalized asthmatic children using a clinical pathway. *Ann Allergy Asthma Immunol*. 2000;84:509–516.