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Steroid Variability in Pediatric Inpatient Asthmatics: Survey on Provider Preferences of Dexamethasone versus Prednisone

Jillian Cotter MD¹, Amy Tyler MD, MSCS¹, Jennifer Reese MD¹, Sonja Ziniel PhD¹, Monica Federico MD^{1,2}, William Anderson MD¹, Oren Kupfer MD^{1,2}, Stanley Szeffler MD^{1,2}, Gwendolyn Kerby MD^{1,2}, Heather Hoch MD, MSCS^{1,2}

Affiliations: ¹Department of Pediatrics, Children's Hospital Colorado, Aurora, CO ²Breathing Institute, Children's Hospital Colorado, Aurora, CO

Address correspondence to: Jillian Cotter, Department of Pediatrics, Section of Hospital Medicine, Children's Hospital Colorado, 13123 E 16th Ave, Box B302, Aurora, CO 80045, [jillian.cotter@childrenscolorado.org], 720-777-5241

Running Head: Provider preference of inpatient steroid treatment

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Abstract

Objective: Our hospital's pediatric Emergency Department (ED) began using dexamethasone for treating asthma exacerbations after ED studies showed non-inferiority of dexamethasone compared to prednisone. However, providers have not reached consensus on optimal inpatient steroid regimen. This study evaluates provider preference for inpatient steroid treatment.

Methods: A survey was distributed to providers who care for inpatient pediatric asthmatics. Respondents answered questions about steroid choice and timing. Data was summarized as percentages; bivariate comparisons were analyzed with Pearson's chi-squared test.

Results: Ninety-two providers completed the survey(60% response rate). When patients received dexamethasone in the ED, subsequent inpatient management was variable: 44% continued dexamethasone, 14% switched to prednisone, 2% said no additional steroids, and 40% said it depended on the scenario. Hospitalists were more likely to continue dexamethasone than pulmonologists(61% and 15% respectively; $p<0.001$). Factors that influenced providers to switch to prednisone in the inpatient setting included severity of exacerbation(73%) and asthma history(47%). Fifty-one percent felt uncomfortable using dexamethasone because of "minimal data to support [its] use inpatient". In case-based questions, 28% selected dexamethasone dosing intervals outside the recommended range. Thirteen percent reported experiencing errors in clinical practice.

Conclusions: Use of dexamethasone in the ED for asthma exacerbations has led to uncertainty in inpatient steroid prescribing practices. Providers often revert to prednisone, especially in severe asthma exacerbations, possibly due to experience with prednisone and limited research on dexamethasone in the inpatient setting. Further research comparing the effectiveness of

dexamethasone to prednisone in inpatient asthmatic children with various severities of illness is needed.

Introduction

Asthma is the most common chronic disease of childhood and a very common reason for hospitalization among children. Systemic corticosteroids, specifically prednisone, have been the standard of care in asthma exacerbations for decades(1-3). However, dexamethasone, a systemic corticosteroid commonly used in viral croup, is becoming a popular alternative to prednisone in the asthma population. Studies have shown that dexamethasone is more palatable(4) and given the shortened treatment course, can improve medication compliance compared to prednisone(5). One survey-based study found that families prefer a one- or two-day course of steroids compared to five days, suggesting that dexamethasone is an attractive alternative to prednisone(6). Furthermore, recent studies in the emergency department (ED) setting found that dexamethasone was not inferior to prednisone when evaluating asthma relapse rate and admission rate, and was more cost-effective than prednisone(5, 7-14).

Given this evidence, in the summer of 2015 at a large urban academic children's hospital, the ED started primarily using dexamethasone instead of prednisone for the treatment of patients presenting with an asthma exacerbation. These changes were facilitated by modifications to our institutional guidelines, specifically the asthma clinical care pathway, and ED triage procedures to include a standing order for dexamethasone. After the ED policy change at our institution, steroid prescribing practices for patients hospitalized with asthma exacerbations were more variable(15). Despite much discussion, consensus has not been reached about which steroid to prescribe in the inpatient setting. Comparative effectiveness of prednisone and dexamethasone in

the inpatient setting has not been well studied, and national and international asthma guidelines do not elaborate on the use of dexamethasone versus prednisone in the inpatient setting(1-3). To our knowledge, there are no studies that describe the variability in inpatient prescribing preferences, or factors that influence providers to choose one steroid over the other.

The objectives of this project were to 1) describe providers' steroid preferences between dexamethasone and prednisone in different case scenarios for inpatient asthmatics, 2) evaluate patient and provider level factors that influence providers' steroid preference between these steroids, and 3) assess the self-reported frequency of medication dosing outside the recommended range. We hypothesized that there would be differences in steroid choices amongst providers, and that the severity of the clinical presentation and the provider's specialty would influence steroid choices. We also hypothesized that medication interval or dosing errors may occur due to switching back and forth between the two steroid types.

Methods

We obtained institutional quality improvement approval (#170813) to perform this study. An anonymous electronic survey was distributed to 152 providers who care for patients admitted with asthma exacerbations including residents, fellows, advanced practice providers and attending physicians in both the hospital and pulmonary medicine sections of a large urban quaternary care academic children's hospital. We included all pulmonologists and hospitalists because patients admitted with asthma can be placed on either team depending on whether or not they were followed by pulmonary as an outpatient. We also included all residents because they often rotate on the pulmonary and hospitalist teams taking care of asthma patients. Allergy and Immunology providers were not surveyed because at our institution, these providers see

outpatient asthmatics but do not have an inpatient service so their patients are often placed on the hospitalist teams. There was no sampling selection as all pulmonary and hospital medicine attendings, advanced practice providers, and fellows along with pediatric residents were included.

Study data were collected and managed using REDCap electronic data capture tools and database management(16). The survey was created by a multidisciplinary group of pulmonary, allergy and hospital medicine providers and residents, along with a survey methodologist and pharmacist. This team was chosen to represent the spectrum of providers who care for asthmatic children, and purposefully included a mix of senior and junior faculty members along with attendings, advanced practice providers, fellows and residents. The survey methodologist worked in conjunction with the clinicians to develop a survey with targeted, non-leading questions and an appropriate spectrum of answer choices. Drafts of the survey were tested through think-aloud cognitive interviewing on five individuals with various levels of training from different sections. The survey was also piloted in its electronic REDCap form in an attempt to identify potential problems. The drafts were revised based on these results and comments prior to distribution in June 2016, approximately one year after the change in ED protocol. Three email reminders were sent, and the survey remained open for a total of five weeks.

The focus of the survey was on provider prescribing practices with respect to steroids for inpatient asthma. Respondents answered two questions about their general approach to inpatient steroid prescribing after patients received either prednisone or dexamethasone in the ED; options included to continue the steroid given in the ED, switch to the other steroid type, no additional steroids or “it depends on the clinical scenario”. An additional question examined factor(s) that influence providers’ decision to switch from dexamethasone to prednisone in the inpatient setting

including patient factors (such as younger and older age, history of severe asthma, severity of current exacerbation, concern for worsening illness, on continuous albuterol, clinical improvement, possibility that they will need prolonged course/taper of steroids, and concurrent bacterial pneumonia), medication factors (such as tolerability and cost) and provider factors (such as discomfort with medication based on lack of experience and minimal data to support its use). Respondents answered “yes” or “no” as to whether each was a factor influencing their decision to switch to prednisone in patients who receive dexamethasone in the ED.

The survey used eight case-based questions about the same 7-year-old male with a history of asthma who presented with an asthma exacerbation, received a steroid in the ED, and was admitted thereafter. The question asked what steroid the respondent would choose to give in the inpatient setting. In each scenario, the patient presented with a different asthma exacerbation severity (mild, moderate and improving, moderate and not improving, and severe) and for each severity level, the patient received either dexamethasone or prednisone in the ED (for a total of 8 case-based questions). In the mild case, the patient had a history of mild intermittent asthma and was admitted on albuterol every two hours with signs of improvement. In the moderate cases, the patient had a history of moderate persistent asthma and was admitted on continuous albuterol, either improving or not improving. The severe case involved a patient who was clinically worsening. For all cases, respondents selected a steroid to give in the inpatient setting (dexamethasone 0.5mg/kg with maximum 16mg, prednisone/prednisolone 1mg/kg BID, no additional steroids, other steroid regimen or IV steroids), and if they selected dexamethasone, providers had to choose a dosing interval for when to give the second dose of the steroid (12 hours, 24 hours, 24-36 hours, 36 hours or >36 hours after the steroid dose they received given in the ED). The final survey question asked whether providers have witnessed asthma related

steroid dosing errors in clinical practice. A steroid dosing error was defined as a dosing interval that does not fall within the recommended range based on the steroid's half-life.

Descriptive analyses of survey responses were summarized as percentages, and bivariate comparisons were analyzed with Pearson's chi-squared or Fisher's exact tests. Comparisons of survey responses were made between pulmonologist and hospital medicine providers, across various degrees of experience (trainee, attending <5 years, 5-10, 10-20, >20 years of experience) and levels of training (attending, fellow, advanced practice provider and resident). Besides the change in ED protocol, there were no other ongoing interventions at our hospital regarding steroid treatment in asthma exacerbations.

Results

The survey was sent to 152 providers and 92 responded (60% response rate). Respondents included residents, advanced practice providers, fellows and attending physicians in the pulmonary and hospital medicine sections (Table 1). The average years of attending experience of pulmonary respondents was more than that of hospital medicine respondents; 56% of pulmonary respondents had more than 10 years of experience compared to only 23% of hospitalists ($p=0.04$).

If a patient received prednisone in the ED, 79% of respondents ($n=72$) indicated that they would continue prednisone as the next dose in the inpatient setting. However, if a patient received dexamethasone in the ED there was more variability in the inpatient management: 44% ($n=40$) would continue dexamethasone, 14% ($n=13$) would switch to prednisone, and 40% ($n=36$) said "it depends on the clinical scenario" (Figure 1). If a patient received dexamethasone in the ED, more hospitalists (61%, $n=22$) than pulmonologists (15%, $n=3$) agreed with

continuing dexamethasone in the inpatient setting ($p<0.001$). Neither level of training ($p=0.83$) nor years of experience ($p=0.43$) affected responses.

Nearly half of respondents identified the following as factors that influenced their decision to switch to prednisone in the inpatient setting after patients received dexamethasone in the ED: the need for prolonged course of steroids, severity of current exacerbation, concern for worsening illness, need for continuous albuterol, history of severe asthma, and “minimal data to support the use of dexamethasone in the inpatient setting” (Table 2). More than two-thirds of respondents did not believe the following were influential factors: patient clinical improvement, concurrent bacterial pneumonia, patient age, medication tolerability, medication cost, and provider discomfort with dexamethasone due to lack of experience using it. These trends were also reflected in the responses to case scenarios.

In the four case scenarios where the patient received prednisone in the ED, most providers (72-88%) chose to continue prednisone and this trend did not change despite the severity of the presentation. In the four case scenarios where the patient received dexamethasone in the ED, as the severity of the current presentation and past asthma history increased, providers were more apt to switch to prednisone than continue dexamethasone; in the mild case scenario the majority continued dexamethasone, but in the severe case scenario, few continued dexamethasone, over half switched to prednisone, and nearly a third switched to intravenous steroids (Figure 2).

In the mild case scenario, more hospitalists (88%, $n=29$) continued dexamethasone while most pulmonologists were split between continuing dexamethasone (42%, $n=8$) and switching to prednisone (42%, $n=8$) ($p<0.001$). However, in the moderate but worsening and severe case scenarios, hospitalists and pulmonologists did not differ in their steroid choices ($p=0.07$ and 0.43 respectively). Neither level of training nor years of experience affected responses in these case-

based questions ($p>0.05$).

The survey evaluated for medication dosing errors, specifically focusing on the timing of dexamethasone dosing either after an initial dose of dexamethasone or when switching steroid types after an initial dose of prednisone in the ED. Excluding respondents who selected prednisone for all eight case scenarios ($n=24$), and focusing only on those who selected dexamethasone in at least one case scenario ($n=68$), we identified that 28% of respondents ($n=19$), in at least one case, selected to schedule a dose of dexamethasone with a dosing interval (time between initial steroid dose in the ED and when respondents selected to give next dexamethasone) that was outside the recommended range. The frequency of this error was the same across levels of experience, training and specialties ($p=0.14$, 0.26 and 0.17 respectively). Furthermore, 13% of providers ($n=12$) reported having seen a steroid dosing error in clinical practice.

Discussion

This study identified provider and patient factors that influenced inpatient providers to choose between dexamethasone and prednisone when managing acute asthma exacerbations. The results of this evaluation demonstrate differences in prescribing practices once dexamethasone was given in the ED. Furthermore, it appears this variability could impact clinical care due to dosing variability and duration of steroid administration. These results support the need for research comparing the effectiveness of dexamethasone and prednisone in children hospitalized with an asthma exacerbation.

Many providers chose to continue prednisone in the inpatient setting if it was first given in the ED. However, if a patient received dexamethasone in the ED, inpatient steroid prescription

practices varied. In a database study by Parikh et al.(17), only 3% of asthma patients received dexamethasone and 97% prednisone, but this data was collected from 2007-2012, so we suspect that increased popularity of dexamethasone for ED asthma exacerbations has led to different prescribing practices than what is demonstrated in the prior study. To our knowledge variability in dexamethasone and prednisone prescribing practices for pediatric asthma exacerbations in the inpatient setting has not been studied. Furthermore, variability in the recommended dose and duration of systemic steroids across studies and commonly used asthma guidelines may lead to variability in practice(3, 7, 8, 18).

We identified several patient and provider level factors that influenced the choice of steroids, specifically switching from dexamethasone to prednisone, and these factors should be examined in future research. Influential patient factors included: patients' baseline asthma severity, the severity of exacerbation symptoms, need for prolonged steroid course, and clinical concern for worsening illness following admission. Conversely, patient factors such as age and concurrent infection were not influential. Provider level factors influencing choice of steroid included a perception of insufficient data to support dexamethasone in the inpatient setting and less often, a lack of experience with using dexamethasone. Many barriers must be overcome when changes to guidelines or new medications are introduced – lack of awareness, familiarity, agreement and outcome expectancy all play into provider medical decision making (19). Future comparative effectiveness research on dexamethasone and prednisone in inpatient asthmatics needs to be conducted on patients with a range of mild-to-severe asthma histories and clinical presentations.

The concern for insufficient data to support dexamethasone in the inpatient setting is valid. While several studies have shown non-inferiority of dexamethasone to prednisone in the ED setting with respect to relapse and admission rates(5, 7-9, 20), only one observational study

compared the two in the inpatient setting(17). This multicenter retrospective cohort study used propensity score matching to show that length of stay and hospital cost were lower in those who received dexamethasone compared to prednisone, with no difference in transfer to the intensive care unit or readmission rates. This study is limited because it is observational and thus cannot infer causality. In addition, the number of doses of steroid given was not reported, and patients that received both dexamethasone and prednisone were excluded. Furthermore, this study excluded patients with high illness severity, which supports providers concerns for using dexamethasone in patients with severe asthma presentations. No randomized controlled trials have been conducted to compare the two medications in the inpatient setting. Future research on dexamethasone should focus on important inpatient outcomes including length of stay, transfers to the intensive care unit, and readmissions, especially in the severe asthmatic population, for which providers appear to be more concerned about its use. If dexamethasone can be truly found to be non-inferior to prednisone in the inpatient setting with regards to these important outcomes, then providers may be more apt to adopt it.

In both the general and case-based questions, fewer pulmonologists compared to hospitalists agreed with using dexamethasone instead of prednisone in the inpatient setting. The exact reason for this difference is unknown. Pulmonologists in this institution often care for inpatients with more severe asthma (patients who have had previous severe exacerbations and those who have been in the intensive care unit), and ones who need prolonged courses of steroids, so this may be related to the above-mentioned patient-level factors for preferring prednisone. Additionally, pulmonologists may be more familiar with prednisone as it is used in a variety of other pulmonary disorders.

Finally, this survey identified the potential for errors in medication dosing. Almost a third of

respondents selected an incorrect dosing interval in our case scenarios. Providers may not be used to switching between steroid types, especially dexamethasone and prednisone which have different half-lives and dosing intervals. This may lead to medication errors that could cause patient harm. Several studies have shown that variability in care could contribute to medication errors, and standardization efforts such as computerized physician order sets, may increase uniformity and reduce medication errors(21, 22). Once an institution has decided which steroid(s) to use, creating order sets or updating existing order sets to reflect the recommended steroid courses could help reduce the risk of medical errors. After reviewing the results of this survey, relevant stakeholders were convened, and a systemic steroid clinical care guideline and computerized order set for inpatient steroid management were created in order to minimize variability in practice.

This study has several limitations. First, our results are limited by using provider self-report with inherent recall bias, response bias, and the fact that responses to the survey reflect provider preference and may not reflect true clinical decisions. Secondly, the small number of respondents in different groups (hospitalists versus pulmonologists), may limit our comparisons. Finally, this study was done at single site large academic free-standing children's hospital and our findings may not be applicable to all institutions.

Conclusions

In conclusion, after the change in the ED protocol, which now recommends dexamethasone in asthma exacerbations, we observed differences in provider preferences on the treatment of inpatient asthmatics with respect to steroids. Providers tended to report wanting to revert to prednisone, especially in more severe patients, due to experience with prednisone and lack of

sufficient research to support the effectiveness of dexamethasone in the inpatient setting. The variability in steroid prescribing practices and tendency to switch between prednisone and dexamethasone raises the potential for dosing irregularities, which could result in inadequate or excess steroid treatments. Randomized controlled trials are needed to determine the comparative effectiveness of dexamethasone and prednisone in the inpatient setting and must be conducted across a range of asthmatic children with various severities of presentation to determine the optimal treatment regimens for inpatient asthma exacerbations.

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Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1. Population Characteristics of Survey Responders (N=92)

Category	N (%)
Level of Training	
Attending	48 (52%)
Fellow	5 (5%)
Advanced Practice Provider	4 (4%)
Resident	35 (38%)
Department	
Hospitalist	36 (63%)
Pulmonologist	21 (37%)
Attending experience	
<5 years	15 (31%)
5-10 years	15 (31%)
10-20 years	11 (23%)
>20 years	7 (15%)

Table 2. Factors that Influenced Respondents to Switch to Prednisone in the Inpatient Setting after Patients Received Dexamethasone in the ED

	N	(%) ^a
Possibility that they will need prolonged course/taper of steroids	62	(78%)
Severity of current exacerbation	58	(73%)
Concern for worsening illness	57	(72%)
Minimal data to support the use of Dexamethasone in inpatients	40	(51%)
On continuous albuterol	37	(47%)
History severe asthma	36	(47%)
Tolerability of medication	22	(29%)
Uncomfortable using dexamethasone due to lack of experience	22	(29%)
Clinical improvement	20	(27%)
Concurrent bacterial pneumonia	9	(12%)
Younger age	6	(8%)
Cost of medication	5	(7%)
Older age	3	(4%)

^aPercent of respondents that selected “yes” when asked if this variable was a factor that influenced them to switch from dexamethasone to prednisone in the inpatient setting out of all respondents who answered “yes” or “no” for each variable (N varied from 73-80)

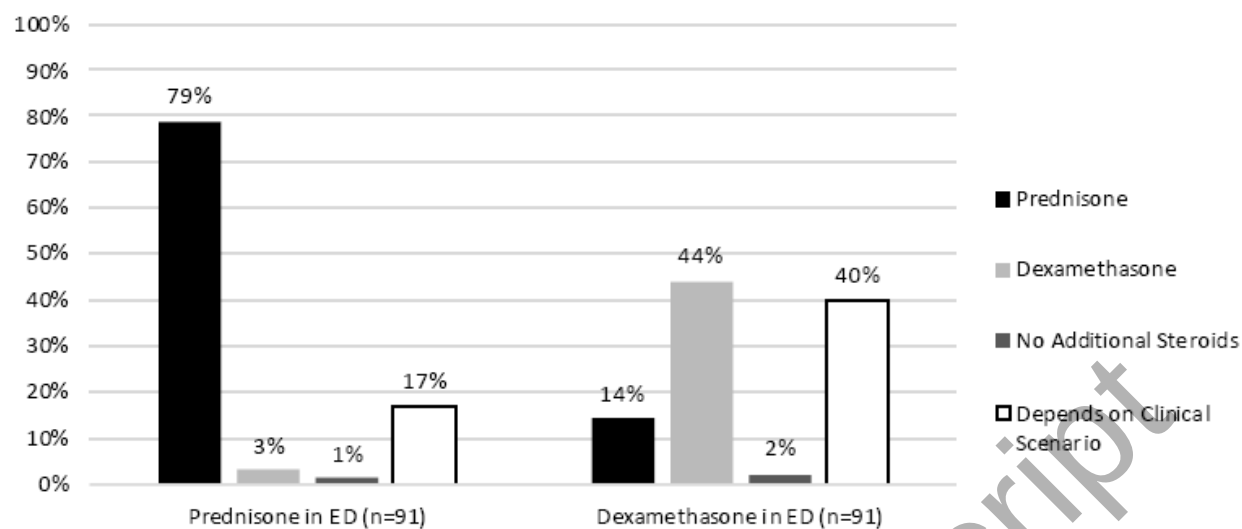


Figure 1. Steroid Choice in the Inpatient Setting After Patients Receive Dexamethasone or Prednisone in the ED

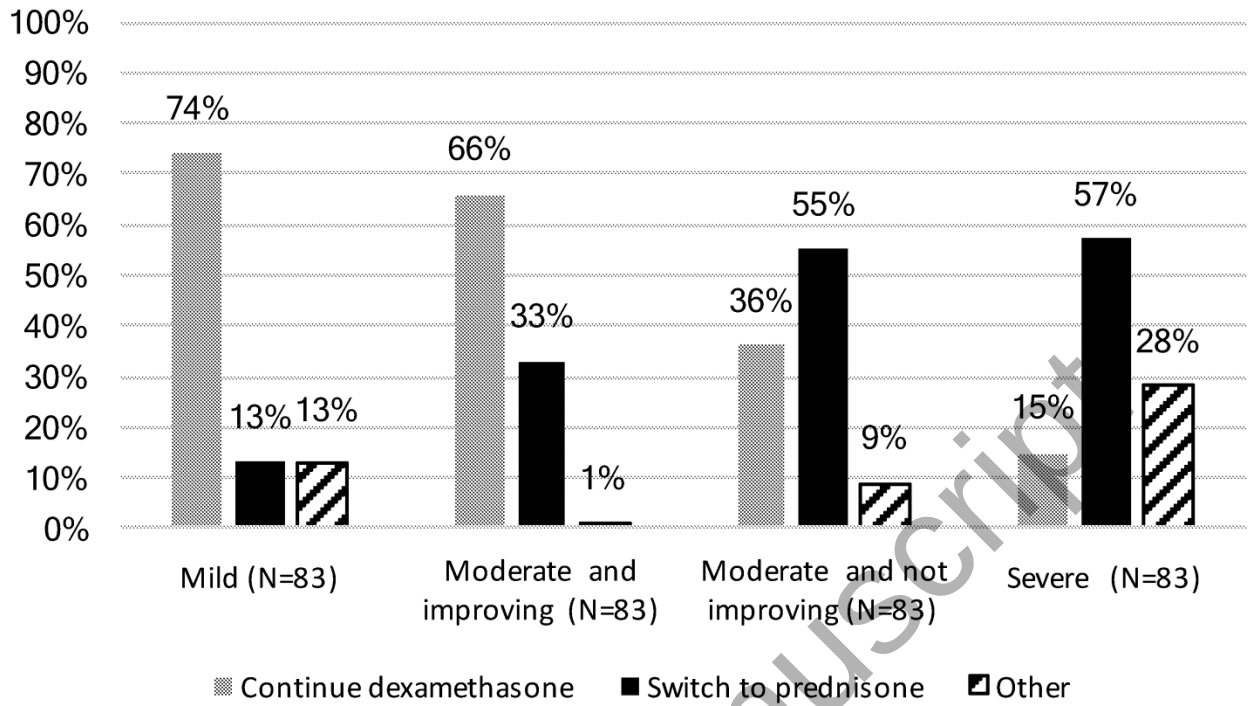


Figure 2. Case-Scenarios: After a Patient Received Dexamethasone in the ED, Steroid Choice in the Inpatient Setting is Based on the Severity of the Asthma Presentation