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To cite this article: A. Brad Hall, April Novotny, Donna M. Bhisitkul, James Melton, Tim Regan & Maureen Leckie (2017) Association of emergency department albuterol dispensing with pediatric asthma revisits and readmissions, Journal of Asthma, 54:5, 498-503, DOI: [10.1080/02770903.2016.1236942](https://doi.org/10.1080/02770903.2016.1236942)

To link to this article: <http://dx.doi.org/10.1080/02770903.2016.1236942>



Accepted author version posted online: 07 Oct 2016.
Published online: 07 Oct 2016.



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PEDIATRIC

Association of emergency department albuterol dispensing with pediatric asthma revisits and readmissions

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ABSTRACT

Introduction: Although pediatric asthma continues to be a highly studied disease, data to suggest clear strategies to decrease asthma related revisits or readmissions is lacking. The purpose of our study was to assess the effect of emergency department (ED) direct dispensing of beta-agonist metered dose inhalers on pediatric asthma ED revisit and readmission rates. **Methods:** We conducted a retrospective cohort study of pediatric patients discharged from the pediatric ED with a diagnosis of asthma. Our primary outcome measured the rate of asthma revisits to the ED or admissions to the hospital within 28 days. Logistic regression analysis was used to assess ED beta-agonist MDI dispensing and revisit and/or readmission as the outcome. **Results:** A total of 853 patients met eligibility for inclusion in the study, with 657 enrolled in the Baseline group and 196 enrolled in the ED-MDI group. The Baseline group experienced a revisit and readmission rate of 7.0% (46/657) versus 2.6% (5/196) in the ED-MDI group, ($p = 0.026$). ED direct dispensing of MDIs was found to be independently associated with a decreased risk of revisit or readmission (odds ratio 0.37; 95% confidence interval 0.14–0.95). **Conclusions:** In our study, ED direct dispensing of beta-agonist MDIs resulted in a reduction in 28-day revisit and readmission to the hospital. Further studies should be performed to evaluate the economic impact of reducing these revisits and readmissions against the costs of maintaining a dispensing program. Our findings may support modification of asthma programs to include dispensing MDIs from the emergency department.

ARTICLE HISTORY

Received 10 July 2016
Revised 14 August 2016
Accepted 10 September 2016

KEYWORDS

Asthma readmissions; beta-agonist; emergency medicine pharmacist; emergency service hospital; hospital readmissions metered dose inhalers; pediatrician; pediatrics; pharmacists

Introduction

Pediatric asthma remains a common and costly diagnosis in the United States, with 1 in every 11 children being diagnosed with asthma. Among children with asthma, 1 in 5 visited an emergency department (ED) for asthma-related care in 2009 [1]. With approximately 640,000 pediatric asthma ED visits in 2010, the ED represents a valuable point of contact to influence asthma patient care outcomes [2]. Although pediatric asthma continues to be a highly studied disease, data to suggest clear strategies to decrease asthma related revisits or readmissions is lacking.

A few studies have attempted to identify pediatric patient factors associated with asthma revisits or readmissions. From these studies, factors shown to be associated with an increased risk of relapse include age <2 years, history of asthma admission within past 12 months, steroid prescribed at discharge, poor access to follow up care, low asthma quality of life, and previous ED visit for asthma [3–7]. Unfortunately, some of these factors are not readily amenable to change, especially within the ED scope of

care. Use of preprinted order sheets and access to consultant pediatricians are the only known ED strategies which have been shown to be associated with a lower rate of relapse [8]. Although it provides valuable information, both of these strategies are already employed in many larger institutions. ED medical treatment and management has not been demonstrated to predict early asthma readmission [3]. It is unknown which, if any, factors related to ED management of the pediatric asthma patient may influence the rate of pediatric asthma relapse.

Compliance with the medication regimen has been shown to be critical in decreasing asthma exacerbations [9]. In some cases, access to medications may be a barrier to compliance [10]. In April of 2012, our institution began a program to discharge ED patients home with a beta-agonist metered dose inhaler (MDI) at no further cost to the patient. This benefit is optional to the physician, when they have utilized a MDI in the usual ED treatment of the patient. The purpose of our study was to assess the effect of ED direct dispensing of beta-agonist MDIs on pediatric asthma ED revisit and readmission rates.

Methods

Design and setting

We conducted a retrospective cohort study of pediatric patients seen and discharged from the pediatric ED with a diagnosis of asthma during the time periods of August 1, 2011 to January 31, 2012 and May 1, 2012 to July 31, 2013. Treatment was provided at a community tertiary care hospital with a single site ED hosting an annual census of >200,000 visits per year. The ED houses a dedicated 20-bed pediatric emergency department with an annual census of approximately 45,000 visits per year. The Institutional Review Board of Lakeland Regional Health approved this study.

Measures and data collection

Patients eligible for inclusion in the cohort included those 0 to 17 years old with an index ED visit and subsequent discharge home for asthma between August 1, 2011 to January 31, 2012 and May 1, 2012 to July 31, 2013. An ED visit for asthma was defined as a primary discharge diagnosis of International Classification of Disease, 9th revision (ICD-9) codes 493.xx. For the time period of May 1, 2012 to July 31, 2013, patients meeting the asthma discharge diagnosis criteria were cross-referenced with ED MDI dispensing records to identify asthma patients who were discharged home with a beta-agonist MDI. All eligible patients were included in the study. For patients that were included, electronic medical records were queried for demographic, clinical, and revisit and readmission information.

Collected demographic and clinical information included sex, age, insurance type (defined as either government, private, or unknown/ none), history of asthma related admission within 1 year of index ED visit (defined as ICD-9 codes 493.xx), beta-agonist prescription at discharge, steroid prescription at discharge, and antibiotic prescription at discharge. Data was abstracted by trained doctorate of pharmacy students. Data collectors were oriented to both the electronic medical record system and the standardized data collection tool. Abstractors were not aware of the intervention being evaluated or the study's objectives. Inter-rater agreement testing was performed by a similarly trained individual not associated with the trial using an enriched 10% sample of patients. Due to the low frequency of revisit and readmission observations, the sample evaluated for inter-rater agreement was enriched by inclusion of a higher proportion of patients initially identified to have a revisit or readmission.

Our primary outcome measured the rate of revisits to the ED or admissions to the hospital within 28 days of the index ED visit with a repeat primary diagnosis of asthma (ICD-9 codes 493.xx). Two groups were created to compare these rates. The first group, defined as the Baseline group, was assessed for rate of 28-day revisit and readmission prior to implementation of the ED dispensing program. Index ED visits for the Baseline group were identified during the time period of August 1, 2011 to January 31, 2012.

Patients in the Baseline group were treated in the ED for asthma and, when indicated, were discharged with a prescription for a beta-agonist MDI. When the ED physician documented presence of a pre-existing active prescription for a beta-agonist, a new prescription was not considered indicated and the patient was recorded as having a beta-agonist prescription. The second group, defined as the ED-MDI group, was also assessed for the 28-day rate of revisit and readmission. The patients in the ED-MDI group were all dispensed a beta-agonist MDI directly from the ED at the conclusion of their visit. Index ED visits for the ED-MDI group were identified during the time period of May 1, 2012 to July 31, 2013. ED 28-day revisits were not considered for further evaluation as an index admission and thus not evaluated for a subsequent revisit or readmission. If a patient presented to the ED 29 days or more after the index ED visit, they were considered a new index ED visit and further evaluated for revisit or readmission.

Statistical analysis

All patients in the study were included in the data analysis. Demographic data was compared utilizing chi-squared analysis for categorical data and *t*-tests for continuous data. Revisit and readmission rates of the two groups, Baseline and ED-MDI, were compared using counts, percentages, and chi-squared analysis. Logistic regression analysis was used to assess the independent association between ED direct beta-agonist MDI dispensing and revisit and/or readmission as the outcome.

Additionally, a multivariate analysis using logistic regression was performed for potential confounders that were chosen based on being previously associated with the risk for revisit or readmission. These additional factors were age <2 years old, history of an asthma admission within previous year, and presence of government-type insurance in the logistic regression analysis [3]. A Hosmer and Lemeshow test was performed to test the goodness of fit and an area under the receiver operating curve was performed to examine predictive power of the logistic regression analysis.

Table 1. Demographic information.

	Baseline Group	Dispensing Group	<i>p</i> value
Total Patients, <i>n</i>	657	196	
Male, <i>n</i> (%)	392 (59.7%)	118 (60.2%)	0.89
Mean age, <i>n</i> (SD)	6 (3.9)	8.1 (4.0)	<0.0001
Age <2, <i>n</i> (%)	80 (12.2%)	7 (3.6%)	0.0002
Age 2–5, <i>n</i> (%)	275 (41.9%)	51 (26.0%)	0.0001
Age 6–9, <i>n</i> (%)	171 (26.0%)	60 (30.6%)	0.2396
Age 10–13, <i>n</i> (%)	96 (14.6%)	56 (28.6%)	0.0001
Age 14–17, <i>n</i> (%)	35 (5.3%)	22 (11.2%)	0.0062
Insurance Type, <i>n</i> (%)			
Public/ Government Supported	562 (85.5%)	152 (77.5%)	0.0079
Private	56 (8.5%)	17 (8.7%)	0.095
Unknown/ none	39 (6.0%)	27 (13.8%)	0.00031
History of asthma admission within 1 year, <i>n</i> (%)	237 (36.1%)	48 (24.5%)	0.0023
Prescription for albuterol at discharge, <i>n</i> (%)	654 (99.5%)	196 (100%)	0.343
Prescription for steroid at discharge, <i>n</i> (%)	610 (92.8%)	138 (70.4%)	<0.0001
Antibiotic prescribed at discharge, <i>n</i> (%)	249 (37.9%)	55 (28.1%)	0.0112

All *p* values presented are two-tailed with $p < 0.05$ considered statistically significant. To assess the inter-rater agreement and validity of chart abstraction, percent agreement and Cohen's kappa coefficient were calculated for the outcome of 28-day revisit or readmission. A kappa coefficient of $k > 0.80$ was considered acceptable and almost perfect agreement [11]. All statistical analyses were performed using MedCalc statistical software version 13.0.0.0 (Ostend, Belgium).

Results

A total of 853 patients met eligibility for inclusion in the study, with 657 enrolled in the Baseline group and 196 enrolled in the ED-MDI group. Table 1 describes the demographic and clinical data collected for each group. Patients were 59.7% and 60.2% male and had a mean age of 6 ($SD = 3.9$) and 8.1 years ($SD = 4.0$) in the Baseline and ED-MDI groups, respectively. Overall, patients tended to be younger in the Baseline group when compared to the ED-MDI group. Patients in both the Baseline and ED-MDI groups predominately held government supported insurance at 85.5% and 77.5%, respectively. There were a significant percentage, 36.1% of the Baseline group and 24.5% of the ED-MDI group, with a history of an asthma admission in the prior year. The rate of albuterol prescribing in the Baseline group was high at 99.5%, with 3 of 657 patients not having documentation of active albuterol prescriptions. Of note, none of these three patients experienced an ED revisit or readmission. Additionally, more patients in the Baseline group were prescribed steroids and antibiotics when compared with the ED-MDI group.

Table 2. Dispensing program results.

	Baseline Group	ED – MDI Group	<i>p</i> value
28-day ED Revisit/ Readmission Rate	46 (7.0%)	5 (2.6%)	0.026
Days from index ED visit to revisit or readmission			
0–7 days (<i>n</i>)	18	1	n/a
8–14 days (<i>n</i>)	5	0	n/a
15–28 days (<i>n</i>)	23	4	n/a

Rate of revisit and readmission

The Baseline and ED-MDI groups were compared for their 28-day rate of revisit and readmission (Table 2). The Baseline group experienced a revisit and readmission rate of 7.0% (46/657) versus 2.6% (5/196) in the ED-MDI group, a 62.9% relative decrease ($p = 0.026$). The inter-rater level of agreement for presence of 28-day revisit or readmission met the goal of almost perfect agreement, with a percentage agreement of 98% and a kappa coefficient of 0.954. ED revisits and readmissions were categorized as 0–7 days, 8–14 days, or 15–28 days to assess the distribution pattern. A bimodal distribution was observed for ED revisits and readmissions, with most occurring either within the first 7 days or 15–28 days after the index ED visit and relatively few at 8–14 days (Table 2 and Figure 1).

Multivariate analysis

To assess the independent association between our intervention and other potential patient confounding factors previously associated the rate of revisit and readmission, a multivariate analysis using logistic regression was performed (Table 3). The presence of an ED revisit or readmission within 28 days was the dependent variable. Dichotomized independent variables included patients age < 2 years, presence of government type insurance, history of hospital admission for asthma within 1 year, and ED dispense of beta-agonist MDI.

ED direct dispensing of beta-agonist MDIs was found to be independently associated with a 2.7-fold decreased risk of revisit or readmission (odds ratio 0.37; 95% confidence interval 0.14–0.95). Additionally, history of a hospital admission for asthma within 1 year of the index ED visit was associated with an increased risk of revisit or readmission with an odds ratio of 3.08 (95% confidence interval 1.7–5.6). Patient factors not found to be associated with revisit or readmission included age < 2 years old (95% confidence intervals 0.2–1.08) and presence of government type insurance (95% confidence 0.49 – 2.90). A Hosmer and Lemeshow test was performed to assess goodness of fit with chi-squared = 1.63, DF 5, and $p = 0.90$. The area under the receiving operating curve was

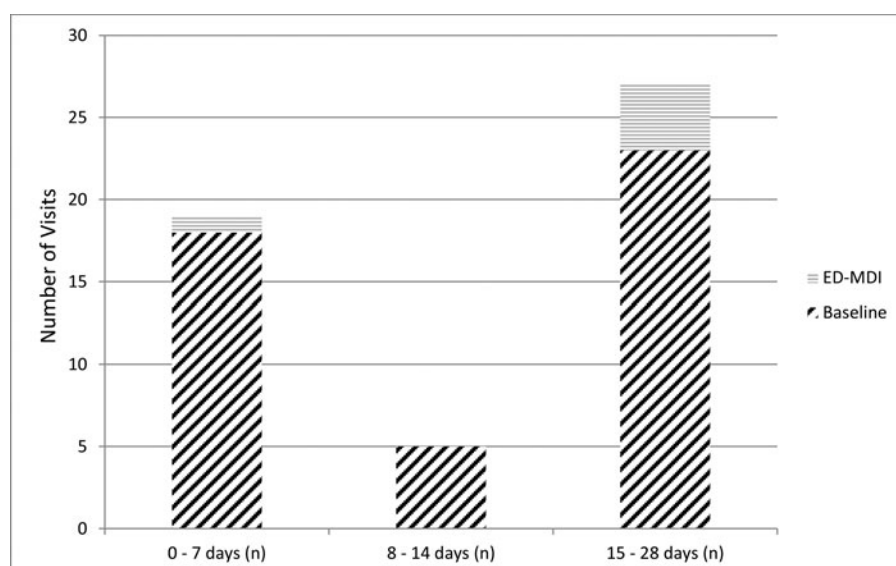


Figure 1. Distribution of observed ED revisits and readmissions.

0.71 with a standard error of 0.034 and 95% confidence interval of 0.683 to 0.744.

Discussion

Causes of pediatric asthma ED revisits and readmissions are multi-factorial. Identification of modifiable factors that may be targeted in the ED presents a substantial area of opportunity to improve patient care [12]. We found direct ED dispensing of medications to be one factor that decreases the likelihood of revisit and readmission of the pediatric asthma patient.

Low socioeconomic status and thus ability to afford prescribed asthma medication has been associated with non-adherence [13,14]. Eliminating the need to travel to a pharmacy to fill and purchase the prescription may reduce a potential barrier to compliance. Currently, the smallest albuterol MDI available is an institutional size 8-gram MDI with 60 actuations. A typical ED patient may only utilize 4 to 12 actuations during their visit and institutions are left a MDI with many remaining actuations. The patient's account is billed for the initial medication administration; however the balance of the cost of the MDI is the hospital's burden.

Table 3. Multivariate analysis of variables associated with ED Revisit or readmission.

Variable	Odds Ratio	95% Confidence Interval
MDI Dispensed in ED	0.37	(0.14–0.95)
Hospital admit for asthma within past 12 months	3.10	(1.72–5.62)
Age <2 years	0.15	(0.02–1.09)
Presence of government-type insurance	1.19	(0.49–2.90)

Note. Area under the receiver operative characteristic curve = 0.714.

Organizations must then make choices to either discard the remaining drug or re-use the MDI among many patients. Our program, developed by the ED pharmacist, nursing administrators and physicians, aimed to increase compliance with beta-agonist therapy by providing this remaining MDI to the patient at no further cost. This program incorporates all the required elements of lawful dispensing from an ED. A logbook and pre-printed labels were created to facilitate rapid, complete documentation and dispensing from the ED, eliminating the need to transport and process these prescriptions to and from the centralized hospital pharmacy. This process ensures timely discharge and reduces potential delays imparted by the dispensing process. Standardization and streamlining of this dispensing process also allows for potential replication in EDs where pharmacy services may be limited.

Guttman et al. studied pediatric ED asthma patients and found the use of preprinted order sheets and access to a pediatrician for consultation were strategies significantly associated with a reduction in return visits. Their data showed a revisit rate of 4.4% in EDs that incorporated both strategies compared with 6.9% that used neither [8]. Walsh-Kelly et al. evaluated pediatric ED asthma patients and found an overall 7-day ED revisit rate of 4.1%. In their study, variables associated with ED revisits included chronic asthma severity classified as persistent, age younger than 2 years and lower asthma quality of life [3]. Interestingly, both studies identified factors generally recommended to improve asthma care which did not impact the rate of ED revisit [15].

These included use of preprinted discharge instructions, use of peak flow testing and teaching, use of trained personnel in asthma teaching, ability to dispense and

teach spacer use, use of controller medications, and prescription of steroid at discharge. A 2006 study by Reznik et al. of hospitalized children evaluated the factors associated with 30-day readmission. Similar to the Guttman and Walsh–Kelly studies, they found factors such as in-hospital management and environmental triggers were not associated with the rate of readmission; however, a previous 12-month hospital admission was a predictor of early readmission [4].

Data obtained in our study suggest ED direct dispensing of a beta-agonist MDI may significantly reduce the revisit and readmission rate among pediatric asthma patients. Our intervention resulted in a 62.9% reduction in the rate of 28-day revisit or readmission, from a baseline of 7.0% to 2.6% after implementation of the dispensing program. Further analysis showed ED direct dispensing of MDIs to be independently associated with a 2.7-fold decreased risk of revisit or readmission. Given the decrease in revisit and readmission rates, we estimate 23 MDIs must be dispensed to prevent one revisit or readmission for asthma. This could represent an important finding for the body of pediatric asthma literature as few modifiable factors have been shown to decrease the likelihood of revisit and readmission.

Our study has a number of potential limitations to understand. First, our study was done retrospectively over a 2-year period and relied on the accuracy of the documentation in the medical record. The 2-year time frame may introduce other factors that could have influenced the rate of ED revisit and readmission such as demographic changes, out-of-hospital practice changes or admission criteria changes. Aside from the dispensing program, no significant asthma practice changes were implemented in our institution during this time; however, we are unable to verify the same for out-of-hospital pediatric practices.

A focused effort to reduce antibiotic use was started during the study period and may have influenced the rate of antibiotic prescribing upon discharge. Additionally, although our study was done at a high volume ED, it is a single practice site, which may limit generalizability to institutions dissimilar to our own. Our study also is limited in the ability to assess compliance with the medication regimen. We infer that direct dispensing increased compliance; however this cannot be assured. Many patients may also be diagnosed with asthma as a secondary diagnosis to a primary illness such as acute bronchitis. Patients with secondary diagnoses of asthma were not a target of our evaluation, however, are often dispensed a beta-agonist MDI through the program.

This may strengthen the conclusion of our primary outcome in strictly defined asthma patients; however, the greater impact of the dispensing program in all diagnoses remains unknown. Finally, a history of admission for

asthma within the previous year is associated with an increased risk of readmission [4]. This conclusion was also confirmed in our logistic regression analysis with an odds ratio of 3.08 (95% confidence interval 1.7–5.6). This is important to note as more patients in the Baseline group had a history of admission for asthma within 1 year compared to the ED-MDI group at 36.1% versus 24.5%, respectively. Although we identified an independent association between MDI dispensing and revisit and readmissions, the difference in these populations may have influenced the overall rates observed.

Conclusion

The large number of pediatric asthma patients seeking care in emergency departments represents an opportunity to improve pediatric asthma care; however, few ED strategies have shown to decrease rates of revisit or readmission. In our study, dispensing a beta-agonist MDI to pediatric asthma patients directly from the ED resulted in a reduction in 28-day revisit and readmission to the hospital. This intervention seems to take aim at the complex issue of access and compliance. Further studies are needed to evaluate the economic impact of reducing these revisits and readmissions balanced against the institutional cost of a MDI dispensing program. Our findings may support modification of asthma programs to include dispensing MDIs from the emergency department.

Acknowledgments

The authors of this article would like to thank Theresa Horne, MBA, MSN for her support and assistance with the dispensing program and Kayla Montgomery, PharmD, BCPS for her assistance in coordinating data collection.

Declaration of interest

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

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