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Does participation in the community outreach for asthma care and healthy lifestyles (COACH) program alter subsequent use of hospital services for children discharged with asthma?

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ABSTRACT

Introduction: Transition from hospital to home is a challenging time for children with asthma and their caregivers because of the high risk for reutilization of acute hospital services. Detecting effective quality improvement initiatives to reduce utilization of urgent services in children discharged with asthma is an important clinical and public health question. This study was designed to identify the role of a multimodal, nurse-driven, inpatient initiated Community Outreach for Asthma Care and Healthy lifestyles (COACH) program on subsequent use of hospital services for pediatric patients with asthma.

Methods: We utilized comparative effectiveness design to identify the difference in recurrent emergency department (ED) visits and/or admissions within 12-months after discharge between patients with asthma who engaged in the COACH program (Intervention group) and those who did not (Comparison group). We used administrative databases of hospitals included in the Meridian Health system to identify the number of and time to asthma-related readmissions and ED re-attendances.

Results: We found no difference in the rate or number of recurrent hospital-based services used within 12 months, but found a reduction in ED re-visitation and/or readmission within 30 days for COACH program participants prior to and after adjustment for age, race/ethnicity, insurance status, and clinical presentation (Odd Ratio 0.44, 95% Confidence Interval 0.20, 0.93).

Conclusion: Participation in the COACH program decreases the likelihood for subsequent use of hospital services within a month of discharge for children with asthma. Enhanced post-discharge interactions with families may reduce long-term reuse of hospital-based services for COACH program participants.

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Introduction

Pediatric asthma is a common chronic condition that affects quality of life for children and caregivers, and increases the risk for development of serious pulmonary pathology in adulthood (1–4). From a public health perspective, asthma exacerbations that require utilization of urgent, hospital-based services are a significant burden on the health care system (5). The annual risk for asthma-related emergency department (ED) visitation and for hospitalization reported by the national surveillance of pediatric asthma is approximately 11% and 2%, respectively (6). The transition from hospital to home was recognized as a challenging time for pediatric patients with asthma due to a high risk for ED re-visitation and/or readmission (7–10). Substantial

numbers of children with asthma are at risk for ED revisits and readmissions within a year after hospitalization (7–9). Therefore, post-discharge utilization of urgent services has become a focus of both quality-of-care measures and implementation of quality improvement initiatives (11). Several studies attempted to identify effective strategies to reduce subsequent admissions and ED visits in pediatric patients hospitalized with asthma. Mostly, studies assessed the effectiveness of quality improvement strategies that were implemented during hospitalization, including compliance with the Joint Commission's Children's Asthma Care (CAC) measures and education of patients and their caregivers (12–15). Despite inconsistency in existing reports, meta-analysis showed no effect of inpatient-initiated,

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single educational or discharge planning interventions on subsequent healthcare utilization for children with asthma (16). Only a few studies evaluated effectiveness of multimodal quality improvement programs that incorporated post-discharge education and support strategies in addition to an inpatient intervention (15,17).

Community Outreach for Asthma Care and Healthy lifestyles (COACH) is a multimodal, nurse-led, quality improvement initiative that was implemented in 2014 at Jersey Shore University Medical Center (JSUMC), part of the Meridian Health system. We designed the study to find if participation in the COACH program reduced post-discharge utilization of acute hospital-based services in children with asthma. We expected at least a 35% relative reduction in reutilization of ED and/or inpatient services within one year among COACH program participants compared to patients hospitalized prior to implementation of the COACH program.

Methods

This is a retrospective study that utilizes comparative effectiveness design to identify recurrent ED visits and/or admissions for pediatric patients hospitalized with asthma within 30 days and 12 months after discharge from JSUMC. International Classification of Diseases, Ninth edition (ICD-9) codes were used to identify children hospitalized with asthma (493.00, 493.01, 493.02, 493.10, 493.11, 493.12, 493.20, 493.21, 493.22, 493.80, 493.81, 493.82, 493.90, 493.91 and 493.92) prior to and after implementation of the COACH program from October 1, 2012 to September 30, 2013 and from October 1, 2014 to September 30, 2015, respectively. We used a list of COACH program participants to identify patients engaged in the COACH intervention during the assigned study period. The Institutional Review Board (IRB) of Meridian Health approved this study.

Subject selection

The electronic health record (EHR) was reviewed to identify study subjects who met inclusion criteria: age six months to 18 years, primary diagnosis of asthma exacerbation and lack of chronic lung disease other than asthma, congenital malformation or neurodevelopmental disability. Data collection was standardized to verify each case with asthma and to collect demographic and clinical variables, including age, gender, race/ethnicity, insurance status, admission month,

comorbid conditions, family history of atopic disorders, asthma-related admissions, medications, as well as laboratory and radiologic data. In addition, we analyzed quality measures (classification of asthma severity, assessment of asthma control, and prescription of controller medications) documented in the EHR prior to discharge. We used the administrative databases of JSUMC and of the community hospitals ($n=4$) included in the Meridian Health system to identify the number of and time to asthma-related readmissions and ED re-attendances over the 12 months after discharge for studied patients.

Outcome measures

This study's primary outcome is the rate of asthma-related ED re-visitations and/or readmissions within 12 months, including 30 days after discharge for pediatric patients hospitalized with asthma. The first admission during the assigned study periods (October 1, 2012 to Sept 30, 2013 and October 1, 2014 to September 30, 2015) was used as a baseline for detection of time (days) to subsequent ED re-visits and/or readmissions. Secondary outcome data are other demographic and clinical variables, in addition to participation in the COACH program, that are associated with post-discharge utilization of hospital-based services for studied patients.

COACH program description

COACH is a nurse-led quality improvement initiative that performs asthma-related evaluation and education prior to and post-discharge in order to reinforce asthma self-management, such as use of controller medication and avoidance of asthma triggers. The program is managed by a certified pediatric nurse practitioner, who is a certified asthma educator. A 45 min face-to-face inpatient session between the COACH nurse, patient and family was used to assess psychosocial barriers, proper use of delivery devices for asthma treatment as well as utilization of controller and rescue medications. After discharge, families were contacted via phone by the COACH nurse within 24 to 48 h, at one week, and at 3–5 weeks and home visitations were conducted, based on parental request. Follow-up calls made at 3–5 weeks were used to identify patients in need of visitation with the primary care pediatrician (PCP) and an additional phone call at 12 weeks post-discharge. The COACH nurse used the Test for Respiratory and Asthma Control in Kids (TRACKTM) for patients under 5 years old,

Childhood Asthma Control Test (C-ACT) for patients between 5 and 11 years old, and ACTTM for patients 12 years and older (18–20). A TRACK score of less than 80 and an ACT or C-ACT score of 19 or less were used to identify the need for visitation with the PCP and an additional phone call at 12 weeks in children younger than and older than 5 years, respectively (18–20). The program nurse was responsible for documentation of the number of attempted and completed phone calls as well as home visitations for each enrolled patient. The design of the COACH program was to supplement management and not to interfere with the usual care of children hospitalized with asthma, which includes asthma education, development of an asthma action plan and request for follow-up with the PCP within 48 h of discharge. The medical staff (attending physicians, pediatric residents, and nurses) were completely aware of the COACH program's implementation in the study setting.

Sample size calculation

We calculated sample size to answer the study's main research question, does participation in the COACH program have an association with reduction of ED re-visitations and/or readmissions for children hospitalized with asthma within 12 months of discharge? An approximately 50% (8,9) risk for reutilization within 12 months for children discharged with asthma was used to calculate a sample to identify reduction in post-discharge use of hospital facilities by at least 35% in response to participation in the COACH program. We identified that 340 patients would be sufficient to detect a 35% reduction in the post-discharge outcome between study groups with a power of 80% and an alpha of 0.05.

Data presentation and statistical analysis

We compared study outcomes (ED re-visitation without admission, readmission, and combination of ED re-visitation and/or readmission) between children who participated in the COACH program (Intervention group) and those who did not (Comparison group). Univariate analysis was conducted to compare demographic and clinical characteristics of patients included in the study groups using χ^2 for comparison of categorical and analysis of variance (ANOVA) for continuous data. In addition to the patient's group status, characteristics that showed a difference between study groups at a level of $P < 0.05$ were selected for inclusion in multivariate regression models. Adjustment for age was conducted irrespective to the lack of significant difference between

study groups because previous data revealed an age associated variation in re-hospitalization for children with asthma (9). All categorical data included in regression models were identified as binary variables (coded 1/0). The models were designed to identify an association of participation in the COACH program with a reduction of ED re-visitation and/or readmission within 12 months and 30 days of discharge, independent of other important factors that contribute to reuse of acute-care resources by patients with asthma. Controlled models were also designed to identify the role of completed post-discharge interactions (phone calls and/or home visits) on the number of ED visits and/or hospitalizations within 30 days and 12 months of discharge for COACH program participants. In addition, survival analysis was performed to compare the trend for asthma-related ED re-visitations and/or readmissions within 12 months of hospital discharge. Statistical data are presented as proportion (%), mean, odds ratio (OR), and regression coefficient (β), including 95% Confidence interval (95%CI). All statistical tests were 2-sided with the significance level set at a p values of < 0.05 . STATISTICA 13.2 (StatSoft, Tulsa, OK, USA) was used to analyze the study results.

Results

A flow diagram depicts the group-based distribution of study participants (Figure 1). Among 214 pediatric patients admitted with asthma during implementation of the COACH program, 166 were engaged in COACH interventions. Lack of patient participation ($n = 48$) during the study period has been associated with the work schedule of the COACH program's personnel. Of COACH participants, 14 patients were excluded. Prior to implementation of the COACH program, 194 patients were hospitalized with asthma during the assigned period and among those 12 were excluded. Asthma-related ED re-visitations and/or readmissions within 12 months after discharge were collected on all eligible patients in the Intervention and Comparison groups.

Narrative of COACH program

All COACH program participants completed a 45 min face-to-face educational session prior to discharge. The COACH program nurse attempted to call 84.7% (95%CI 79.2, 90.6) of the participants' families within 24–48 h, 76.7% (95%CI 70.3, 83.7) at the end of the first week, and 70.7% (95%CI 63.8, 78.3) at 3–5 weeks. At 12 weeks, 14% (95%CI 8.3, 19.3) of patients were contacted by the nurse because of results of age-

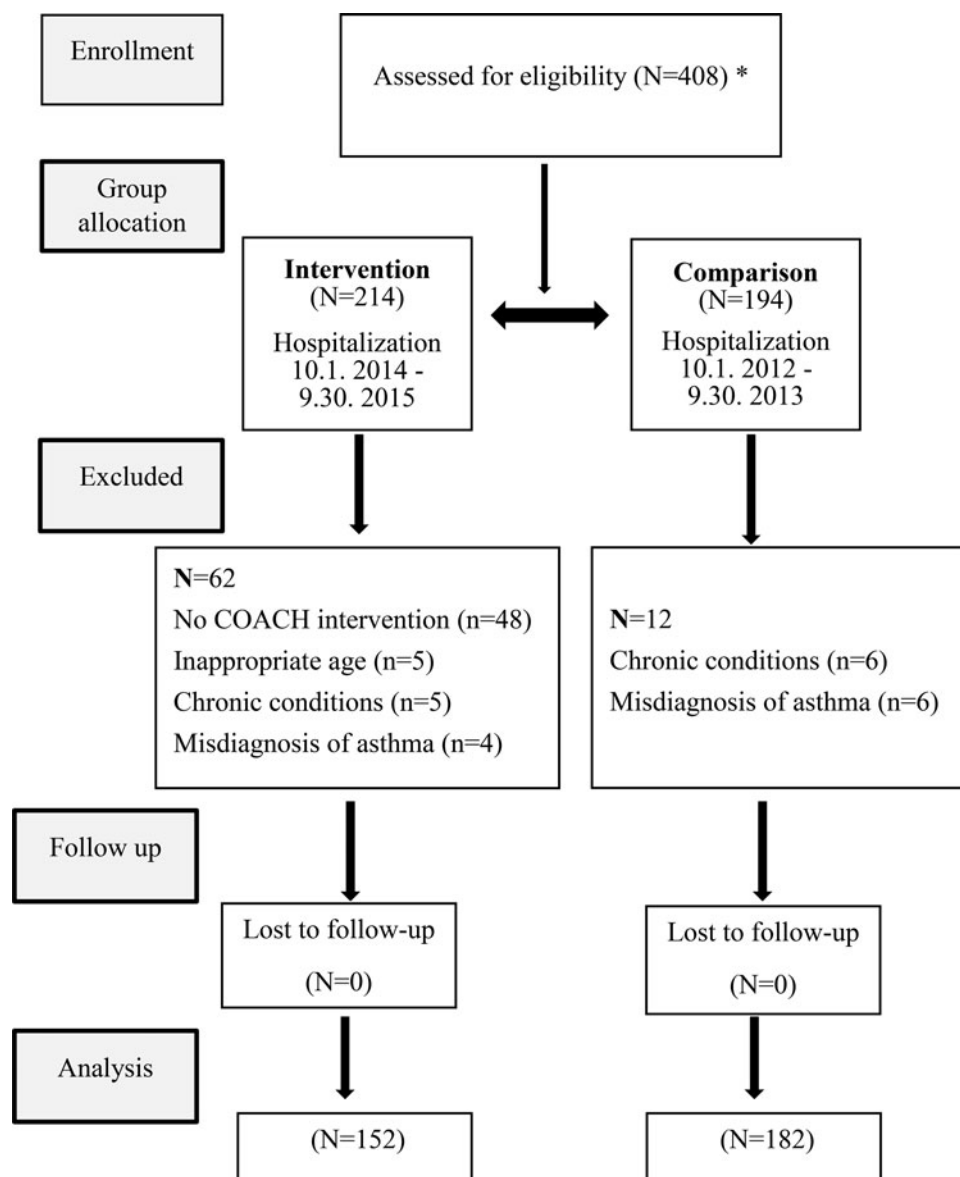


Figure 1. Flow diagram of nonrandom allocation and follow-up for pediatric patients discharged with asthma.

* ICD-9 codes for asthma were used to identify pediatric patients hospitalized with asthma prior to (October 1, 2012 to September 30, 2013) and after implementation of the COACH program (October 1, 2014 to September 30, 2015)

appropriate asthma control tests and 5.9% (95%CI 3.2, 10.9) completed home visits. As shown in [Figure 2](#), no calls were completed for 34.9% (95%CI 27.3, 42.4) of patients engaged in the COACH program during the 12 week period after discharge. Most completed phone calls were made during the first month after discharge ([Figure 2](#)), which reflects the strategies used for implementation of the COACH program.

Comparison of patients' characteristics

Public insurance, prior asthma-related hospitalization, need for O₂ supplementation and admission to the pediatric intensive care unit (PICU) were recorded

more frequently in the Intervention group compared to the Comparison group ([Tables 1](#) and [2](#)). Comparable numbers of children in the Intervention group (65.1%, 95%CI 57.6, 72.7) and the Comparison group (59.3%, 95%CI 52.2, 66.5) had a history of at least one additional atopic condition ($P=0.25$), including allergic rhinitis, eczema, and food allergy.

Quality measures

Prior to discharge, asthma severity was classified according to National Heart, Lung and Blood Institute guidelines ([21](#)) in 77.5% (95%CI 70.3, 83.7) of patients in the Intervention group and 35.9% (95%CI 28.8,

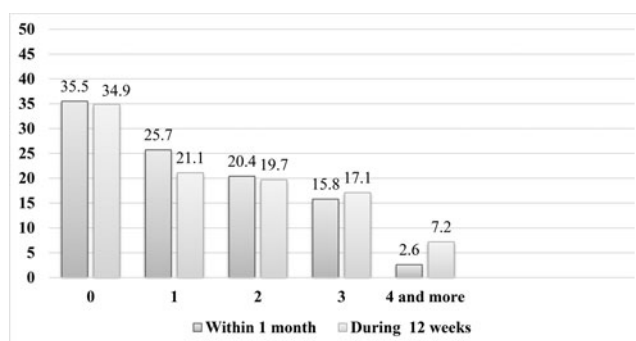


Figure 2. Post-discharge interactions completed by the COACH program nurse with participants (%).

Table 1. Comparison of demographics and asthma-related history for hospitalized patients.

Characteristics	Study Groups		P value
	Intervention (n = 152)	Comparison (n = 182)	
Age in years, mean (95%CI)	5.5 (4.8, 6.2) n = 152	5.5 (4.6, 5.9) n = 182	0.64
Male gender	57.2% (87/152)	61.5% (112/182)	0.42
Race/ethnicity			
White	50.0% (76/152)	60.8% (110/181)	0.14
Black	27.0% (41/152)	24.9% (45/181)	
Hispanic	15.1% (23/152)	9.9% (18/181)	
Other	7.9% (12/152)	4.4% (8/181)	
Public or no insurance	69.7% (106/152)	58.8% (107/182)	<0.03
Season of admission			
Summer	18.4% (28/152)	13.7% (25/182)	0.31
Fall	31.6% (48/152)	31.3% (57/182)	
Winter	26.3% (40/152)	23.6% (43/182)	
Spring	23.7% (36/152)	31.3% (57/182)	
Smoking	40.6% (52/128)	40.8% (62/152)	0.97
Family history of atopy	58.0% (87/150)	69.4% (125/180)	<0.04
Known asthma trigger	64.7% (97/150)	70.2% (127/181)	0.28
At least one prior asthma admission	58.7% (88/150)	47.0% (85/181)	<0.04
Number of prior admissions			
0	41.6% (62/150)	53.0% (96/181)	0.11
1	16.8% (25/150)	14.9% (27/181)	
2 or more	41.6% (62/150)	32.0% (58/181)	
Prior asthma-related PICU admission	22.5% (31/138)	17.0% (30/177)	0.22
Use of controller medications	40.8% (62/152)	34.3% (62/181)	0.11

42.7) of those in the Comparison group ($P < 0.001$). Level of asthma control was documented in the health records in 15.2% (95%CI 9.4, 20.0) and 3.9% (95%CI 1.1, 6.6) respectively ($P < 0.001$). Controller medications (mainly inhaled corticosteroids) were prescribed at discharge for 90.8% (95%CI 86.2, 95.4), of patients in the Intervention and 78.0% (95%CI 72.0, 84.0) of patients in the Comparison group ($P < 0.002$).

Outcome measures

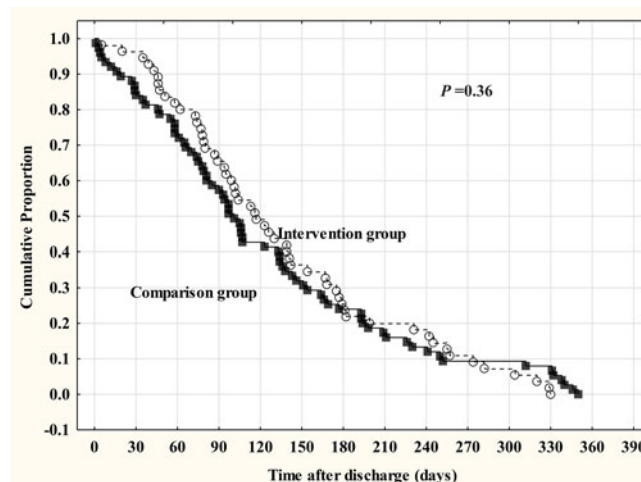
There was neither a difference in interval to first post-discharge ED visit nor to first admission between Intervention and Comparison groups: 141.4 days, 95%CI 117.3, 165.5 versus 151.9 days, 95%CI 123.8, 179.9 ($P = 0.57$) and 145.4 days, 95%CI 116.6, 174.3 versus 159.3 days, 95%CI 115.4, 203.3 ($P = 0.61$), respectively. Survival analysis showed no difference in

the cumulative proportion of repeat asthma-related ED visits and/or hospitalizations between study groups (Figure 3). Overall, at least one ED re-visitation and/or readmission within 12 months after discharge was recorded in 35.5% (95%CI 28.4%, 43.4%) of patients in the Intervention group and 41.8% (95%CI 34.8%, 49.0%) in the Comparison group ($P = 0.24$), including ED re-visitation [28.3% (95%CI 21.7%, 35.9%) versus 35.2% (95%CI 28.6%, 42.3%)] and readmission [16.5% (95%CI 11.4%, 23.2%) versus 17.0% (95%CI 12.3%, 23.2%)], $P = 0.35$ and 0.84, respectively. The association between participation in the COACH program and at least one ED re-visitation and/or readmission within 12 months after discharge did not change after adjustment for the patient's age, race/ethnicity, insurance status, history of prior asthma hospitalization, family history of atopy, requirement for PICU admission, and need for

Table 2. Group-based comparison of clinical characteristics for patients with asthma.

Characteristics	Study Groups		P value
	Intervention (n = 152)	Comparison (n = 182)	
Fever at admission	47.4% (72/152)	51.1% (93/182)	0.49
Bacterial infection	17.1% (26/152)	22.5% (41/182)	0.21
Upper respiratory infection	49.3% (75/152)	48.4% (88/182)	0.85
Wheezing			
None	15.9% (24/151)	14.3% (26/182)	0.06
Expiratory	51.0% (77/151)	63.2% (115/182)	
Biphasic	33.1% (50/151)	22.5% (41/182)	
Retractions	74.2% (112/151)	69.2% (126/182)	0.33
O ₂ saturation %, mean (95%CI)	94.0% (93.4, 94.6) n = 151	94.3 (93.7, 94.9) n = 181	0.29
Respiratory rate, mean (95%CI)	33.2 (31.4, 35.0) n = 151	34.8 (32.8, 36.8) n = 181	0.26
PICU admission	34.4% (52/151)	23.2% (42/181)	<0.02
PICU stay in hours, mean (95%CI)	83.1 (66.5, 99.7) n = 52	93.8 (73.8, 113.8) n = 42	0.41
Frequency of O ₂ supplementation	66.2% (100/151)	47.0% (85/181)	<0.001
Duration of O ₂ in hours, mean (95%CI)	47.4 (37.2, 57.6) n = 100	47.3 (34.9, 59.6) n = 85	0.98
WBC $\times 10^3$ per microliter, mean (95%CI)	13.1 (12.2, 14.0) n = 141	12.2 (11.5, 13.0) n = 165	0.13
PMN, % mean (95%CI)	70.8 (68.0, 73.6) n = 141	69.2 (66.1, 72.1) n = 165	0.43
Hb grams/deciliter, mean (95%CI)	12.5 (12.3, 12.7) n = 141	12.6 (12.4, 12.7) n = 165	0.65

WBC, white blood cells; PMN, polymorphonuclear neutrophils; Hb, hemoglobin.

**Figure 3.** Trend in time to ED revisit and/or hospitalization by study group (Kaplan-Meier).

oxygen supplementation (OR_{crude} 0.77, 95%CI 0.49, 1.20; OR_{adjusted} 0.88, 95%CI 0.70, 1.10).

Within 30 days of discharge, at least one ED re-visitation and/or readmission was recorded in 1.3% (95%CI 0.4%, 4.7%) and 6.6% (95%CI 3.8%, 11.2%) of patients in the Intervention and Comparison groups, respectively ($P < 0.02$). The association between participation in the COACH program and a reduction in 30 day reutilization decreased after adjustment for the demographic and clinical differences between study groups (OR_{crude} 0.20, 95%CI 0.04, 0.91; OR_{adjusted} 0.44, 95%CI 0.20, 0.93). Recurrent ED visits, admissions, and combined data on ED re-visitation and/or admissions

within 12 months was comparable (Figure 4). Data from linear regression models confirmed a lack of association between the number of recurrent ED visitations and/or admissions and participation in the COACH program ($\beta = 0.042$, 95%CI -0.066, 0.150), but did demonstrate a dependence on nonwhite race/ethnicity ($\beta = 0.204$, 95%CI 0.098, 0.310) and use of public insurance ($\beta = 0.233$, 95%CI 0.128, 0.338).

We performed subgroup analysis to identify the role of completed post-discharge interactions (phone calls and/or home visits) with patients engaged in the COACH program on ED re-visitations and/or readmissions within 12 months after controlling for age,

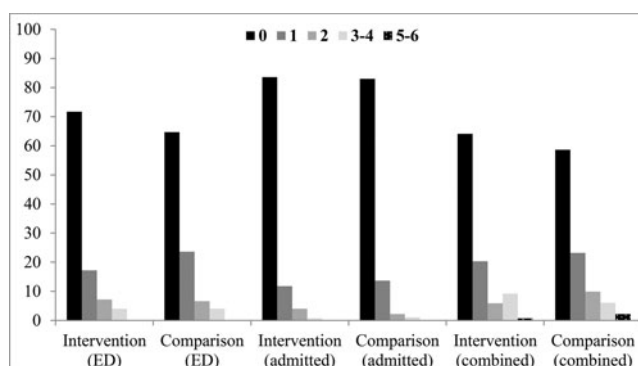


Figure 4. Frequency (%) of ED revisits, readmissions, and combined data on ED and/or hospitalizations after discharge for study participants

race/ethnicity, type of insurance, and history of previous hospitalization. Data from constructed regression models showed no association between the frequency of ED re-visitations and/or readmissions within 12 months after discharge and the number of completed post-discharge interactions ($\beta = 0.135$, 95%CI -0.024, 0.295). Because only a few patients reused hospital-based services within 30 days, no regression model was constructed to identify the role of number of completed post-discharge interactions on ED re-visitations and/or readmissions within one month.

Discussion

The present study showed no difference in the prevalence of subsequent use of hospital-based resources within 12 months of discharge for pediatric patients with asthma who were engaged in the COACH program compared to those who were hospitalized prior to implementation. Furthermore, the rate of ED re-visitations and/or hospital admissions for COACH program participants was not related to the number of completed post-discharge interactions. However, the risk for ED re-visitation and/or readmission within 30 days was reduced by approximately 50% among COACH program participants, which could be associated with better pre-discharge planning, more frequent prescription of controller medications and/or the shorter interval from the delivery of educational sessions. This identified accomplishment should be recognized as important because 30 day reutilization of hospital-based services for children discharged with asthma is a quality indicator even though prevalence of early (≤ 30 days) reuse of hospital services is relatively low (7,13,22,23). One early controlled trial that utilized nurse-led, multifaceted pre and post-discharge interventions for pediatric patients identified significant reduction in readmission during inconsistent follow up periods ranging from two to 14 months (17).

The strategic plan used in this trial (17) included interventions additional to those implemented by the COACH program, such as three training sessions delivered prior to discharge and visitation at a nurse-run asthma clinic within 2–3 weeks after discharge in addition to phone calls and home visits. A pediatric randomized controlled trial conducted in England (15), that utilized a nurse-led discharge package and self-management plan, showed significantly lower readmission and ED re-attendance rates within six months of discharge in the intervention group (15% and 8%) compared to controls (37% and 38%). Additionally, randomized controlled trials that used nurse-led interventions to target high risk populations led to reduced healthcare utilization for adult patients with asthma (24,25).

Our study also showed a strong association of 30 day and 12 month reutilization for pediatric patients discharged with asthma with nonwhite race/ethnicity and public insurance coverage, which is comparable to other reports (9,26). Although meta-analysis did not confirm a predictive role for social determinants in repeat utilization of hospital-based services for children with asthma (27), participation in a multifaceted community-based program was highly effective in lessening post-discharge admissions and ED use in low-income children with asthma (28). The Centers for Disease Control and Prevention (CDC) recognized the importance of community-based initiatives to reduce reutilization of hospital services for disadvantaged groups of pediatric patients with asthma (29).

Study limitations

Lack of experimental design is a limitation of our study, but comparative effectiveness methodology has been recognized as an important tool for evaluating the efficacy of clinical practice, particularly for

studying the management of asthma in pediatric patients (30–32). Moreover, we standardized data extraction tools to maximize the quality of collected data and regression models were used to control for potential confounders in order to enhance the internal validity of the present report. Additionally, we recognize several areas of possible biases, including attention bias that could be related to a lack of complete blinding during review and statistical analysis of data collected from health records and administrative databases. Selection bias could also be considered due to an unequal opportunity for engagement by the COACH program based on work scheduling, although all patients hospitalized with asthma were eligible to receive services with no restriction and according to our data, a large majority were engaged during the study period. One of the other limitations is lack of documentation of level of asthma control in the EHR for the vast majority of studied patients. We believe that despite its short-term variability (33,34), the level of asthma control detected prior to discharge could be associated with post-discharge utilization of emergency-based services. Lack of information from pediatric primary care providers on post-discharge management is another limitation because potential differences in treatment could not be controlled. The chance for study participants to reuse hospital-based services outside of the Meridian Health system could also be a subject for discussion. However, it is unlikely that patients discharged from our hospital would present to other healthcare facilities.

Conclusion

Participation of children hospitalized with asthma in the Community Outreach for Asthma Care and Healthy lifestyles program has been associated with reduction of reuse of hospital-based services within one month of discharge, but not throughout the subsequent year. We suggest that reduction of long-term reuse of hospital-based services for COACH program participants may be achieved with enhanced post-discharge engagement of families, including increased frequency of phone and/or in person communication and home visitation.

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asthma, as well as our patients whose medical records were utilized to complete this study.

Declaration of interest

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