

EDUCATION

The Asthma ePrompt: A Novel Electronic Solution for Chronic Disease Management

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Objective. This study tested the ability of an electronic prompt to promote an asthma assessment during primary care visits. **Methods.** We performed a prospective study of all eligible adult patients with previously diagnosed asthma in three geographically distinct ambulatory family medicine clinics within a 4-month period. The usual clinic visit process was performed at two geographically distinct control sites ($n = 75$ and $n = 55$ patients, respectively). The intervention group site ($n = 64$) had an electronic flag embedded in the Patient Check-in Locator field which prompted the distribution of a self-administered Asthma Management Questionnaire (AMQ) in the waiting room. The primary outcome measure was a documented asthma severity assessment. **Results.** The front desk distributed the AMQ successfully in 100% of possible opportunities and the AMQ was completed by 84% of patients. Providers in the intervention group were significantly more likely than providers in the two non-intervention groups to document asthma severity in the medical record during a non-asthma ambulatory clinic visit (63.3% vs. 18.7% vs. 3.6%; $p < .001$). **Conclusion.** The provision of standardized asthma information triggered by an electronic prompt at the time of check-in effectively initiates an asthma assessment during the primary care visits.

Keywords asthma, electronic prompt, point of service, quality improvement, standardized practice

INTRODUCTION

“Every system is perfectly designed to achieve the results it achieves” (1).

Paul Batalden, MD

Asthma affects millions of lives and continues to consume precious healthcare resources (2). Many studies have considered the challenges of overcoming barriers in chronic asthma management in primary care (3–10). One of the most significant challenges may be the failure to review asthma status regularly. Another is the missed opportunity to briefly address asthma management issues during office visits for non-asthma-related reasons. Other barriers to better patient outcomes in asthma include the persistent undertreatment with controller medications. The leading explanation cited for persistent undertreatment of asthma is the continued underestimation of disease severity by patients and by care providers (11, 12). Without making regular asthma assessments of severity or control, it is difficult to judge the therapeutic efficacy in controlling asthma (13, 14). Systems-based solutions for overcoming chronic disease management are needed for asthma and other diseases.

We postulate that a systems-based process to remind providers to assess asthma status could be successfully

integrated into routine primary care ambulatory practice. We identified attributes associated with successful chronic disease management programs. These include the use of multiple serial interventions (8), provider alerts (9), provider feedback to reduce practice variability (15), and decision support tools integrated into the clinical information system or into the electronic health record (EHR). A previous study improved asthma care just by providing pertinent asthma clinical information during a primary care pediatric visit (16). The use of dedicated study coordinators in this study to prepare the information in the lobby is a factor limiting its applicability to routine practice. We sought to circumvent this and other personnel-intensive steps with preexisting features already included in the EHR. There are published studies with mixed results evaluating provider reminders for pharmacy, preventative services, and chronic disease management (16, 17). Taking these into consideration, we added a reminder to administer an asthma questionnaire to the standardized rooming process already in place. We hypothesize that the availability of essential asthma-related patient information will allow the healthcare provider to quickly review the patient's asthma status. The actual prompt was to the front desk personnel as patients check in for their visit. We hypothesized that incorporating an electronic prompt in this fashion would result in an increased frequency of asthma severity assessments during a primary care visit regardless of whether asthma was the primary concern for the visit.

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METHODS

Study Design and Setting

This study was conducted at Mayo Clinic, Department of Family Medicine in Rochester, MN, from 16 April through 15 July 2007. This prospective study had an intervention arm (one site) and a control arm (two sites) and was approved by the Mayo Foundation IRB. The family medicine practice has full ownership of the initiative with subspecialty input as part of a healthcare team concept. An educational session on the use of the Asthma Control Test (ACT) (17), the asthma crib sheet (which had components from the 2006 Global Initiative for Asthma [GINA], the beta version of the 2007 National Asthma Education and Prevention Program [NAEPP] [the version sent for public comments prior to its release in the fall of 2007], and the Health Care Effectiveness Data and Information Set [HEDIS] criteria for persistent asthma), how to write an asthma action plan (18), and the Asthma Management Questionnaire (AMQ) was presented to the entire Department of Family Medicine prior to initiation of this study (therefore, all providers at all participating sites had the opportunity to participate in this educational session). The AMQ includes the ACT, healthcare utilization, and asthma triggers.

Physicians practice primarily in a single designated location and do not see patients in other locations. The intervention site is located in the downtown campus; the control sites are freestanding facilities within 5 miles of the downtown campus in Rochester. All three sites have the same EHR (LastWord Client, Centricity® Enterprise, GE Healthcare) and office visit flow process. For baseline, we had conducted an extensive chart review of a sample of one primary care site (not one of the sites that participated in this study) and found that only 15 of 89 patients (16.8%) had asthma severity categorization in the prior 18 months. Extending the time period definition to “anytime in the medical record” resulted in an additional seven patients with any severity categorization at anytime from 1999 to 2007.

Participants

All adult patients (>18 years old) with asthma attended by staff physicians within the study period were eligible. Patients seen only by residents and nurse providers were excluded. Review of asthma care during a non-asthma visit was limited to the designated primary care provider on record. As per request of participating physicians, patients with appointment visits less than 30 minutes were excluded.

Intervention

For this initiative, an asthma disease registry was created which included only patients with a physician diagnosis of asthma in the EHR. The disease registry automatically pulled and queried the scheduling calendar of all participating physicians in all three study sites 1, 2, and 3 days prior to the office visit to identify eligible patients.

The reception desk personnel routinely refer to the comment section of the “Patient Check-in Locator” in the EHR for visit-specific instructions. The standardized rooming procedure consists of the following: update medication list; record vital signs; and inquire about the chief complaint, preventive care, and immunization status. The provider sees the patient after the licensed practical nurse (LPN) completes the standardized rooming procedure. For the intervention group, the asthma prompt or “AMQ” was inserted into the comment section of the Patient Check-in Locator in the EHR. This instructs the reception desk to distribute the AMQ. The patient presents the completed AMQ to the LPN. The ACT is scored while tobacco use and personal best peak flow rate are documented in the EHR. The provider reviews the AMQ and documents severity assessment in the Mayo Asthma Plan.

Data Collection

The medical record was abstracted 3 days in advance to prepare for the visit and again within 24 hours after the appointment to collect outcome measures at both intervention and control sites. We recorded the number of patients who refused to fill in the AMQ. Demographic information of all eligible subjects was extracted. A significant number of the patients in the family medicine practice are employees and dependents of the Mayo Clinic and medical service and pharmacy claims are available for these patients. To compare the case mix between the control and intervention sites, we categorized patients based on the prior 12 months according to the HEDIS definition of persistent asthma, the GINA Medication Intensity, and the Kaiser Permanente Medication Intensity Scale. The pharmacy data included the National Drug Code number, information on dispensing, size of dispensing, number of canisters, and days of supply.

We tracked the successful distribution of the AMQ by the reception desk personnel to eligible patients. We monitored the frequency of tobacco use and personal best peak flow rate documentation by the LPN. For the providers, we documented the frequency of asthma severity assessment documentation within 24 hours of the visit. Independent variables included sex, age, race, location of care, body mass index, comorbidities, medication use, and asthma patient volume per provider (during the study period). We analyzed each participating physician’s asthma patient volume during the study period to determine whether any observed difference in severity assessment was due to familiarity with the initiative. Two members of the study team extracted the data within 24 hours of the visit. A structured data abstraction tool (a form with specific fields) was used.

Statistical Analysis

The null hypothesis was that the proportion of patients receiving a severity assessment would be the same across the three sites. The intervention was planned as a 3-month trial at one site with two sites as concurrent controls. No sample size calculations were performed a priori; however, the existing sample sizes were large enough to detect at

TABLE 1.—Demographics.

Variable	Category	Intervention (n = 64)	Northeast (control) (n = 75)	Northwest (control) (n = 55)	p-Value
Sex	Male	23 (35.9)	14 (18.7)	10 (18.2)	.03
	Female	41 (64.1)	61 (81.3)	45 (81.8)	
Age, mean (SD)		41.6 (16.9)	46.8 (20.1)	45.9 (16.7)	.22
	18–24	17 (26.6)	12 (16.0)	7 (12.7)	.07
	25–34	3 (4.69)	11 (14.7)	4 (7.27)	
	35–44	13 (20.3)	8 (10.7)	13 (23.6)	
	45–54	12 (18.8)	10 (13.3)	14 (25.5)	
	55–64	10 (15.6)	14 (18.7)	6 (10.9)	
	65+	9 (14.1)	20 (26.7)	11 (20.0)	
Race	Caucasian	52 (81.3)	68 (90.7)	48 (87.3)	.61
	Non-Caucasian	2 (3.1)	1 (1.33)	1 (1.82)	
	Unknown	10 (15.6)	6 (8.00)	6 (10.9)	
Smoking status	Never	40 (62.5)	52 (69.3)	40 (72.7)	.52
	Former	11 (17.2)	14 (18.7)	7 (12.7)	
	Current	13 (20.3)	9 (12.0)	8 (14.6)	
Body mass index(BMI)	BMI—mean (SD)	31.3 (11.1)	29.8 (8.11)	27.9 (6.89)	.15
Comorbidities	Rhinosinusitis	35 (54.7)	50 (66.7)	43 (78.2)	.03
	Obstructive sleep apnea	14 (21.9)	11 (14.7)	8 (14.6)	.45
	Gastroesophageal reflux disease (GERD)	20 (31.3)	30 (40.0)	18 (32.7)	.51
Spirometry in the last 5 years		21 (32.8)	36 (48.0)	26 (47.3)	.14
FEV ₁ (L)	Mean (SD)	3.03 (0.9)	2.59 (0.68)	2.94 (0.98)	.12
FEV ₁ (% predicted)	Mean (SD)	0.93 (0.2)	0.84 (0.17)	0.93 (0.17)	.09
ACT score	Mean (SD)	21.6 (3.8)			

Notes: FEV₁, forced expiratory volume in 1 second.

P-value < 0.05 are shown in bold.

least a 24% improvement in severity assessment with an alpha of 0.05 and 80% power of detection using a two-sided test. All continuous variables were presented as mean $\pm$ SD and compared between groups with analysis of variance tests. Categorical variables were expressed as actual numbers as well as percentages and analyzed by chi-square as appropriate. All statistical tests were two sided and significance was accepted at $p \leq .05$. The independent effect of location of care on severity categorization was estimated using multiple logistic regression analysis. Statistical analysis was performed using SAS® Statistical software version 8.1 (SAS Institute Inc., Cary, NC, USA) and S-PLUS version 7.0.6 for Unix (Insightful Corporation, Seattle, WA, USA).

RESULTS

There were 64 patients in the intervention arm and 75 and 55 patients at the two control sites. Four patients refused the AMQ (two felt that their asthma was no longer a problem and two declined). Fourteen percent of visits were excluded because they were <30-minute visits. Control sites had more women (81% and 82% vs. 64%, $p = .03$) and more patients complicated by rhinosinusitis (67% and 78% vs. 55%, $p = .03$) (see Table 1 for demographics summary). There were 21 participating providers in the intervention arm and 32 at the control sites. To compare the subjects across the study, patients were stratified according to severity based on HEDIS criteria, medication needs by GINA, and by the Kaiser Permanente Medication Intensity score. Medical service and pharmacy data were available for 122 out of 194 subjects. There were

also more patients with HEDIS-persistent asthma not on controller medications at control sites (20% and 24% vs. 8%, $p = .05$). There were no differences in the use of controller medication (inhaled corticosteroids, leukotriene receptor antagonists), oral corticosteroid, or beta-agonist use.

The front desk distributed the AMQ successfully in 100% of possible opportunities. The AMQ was completed in 84% of possible opportunities. Table 2 summarizes the performance of the electronic prompt in improving peak flow rate documentation and physician assessment of asthma severity. There were no significant differences in

TABLE 2.—Results of the electronic prompt (n = 194).

	Intervention group (%)	Northeast (control) (%)	Northwest (control) (%)	p-Value
n	64	75	55	
AMQ successfully distributed (%)	64 (100%)	NA	NA	
Patient refused to complete AMQ	4 (6%)	NA	NA	
AMQ successfully completed	54/60 (84%)	NA	NA	
Tobacco use documented	64 (100%)	74 (99%)	55 (100%)	1.00
Peak flow rate documented	42/60 (70%)	0 (0%)	0 (0%)	<.001
Severity documented in record 3 days prior to visit	13/60 (22%)	20 (27%)	6 (11%)	.14
Medical doctor severity categorization present within 24 hours	38/60 (63%)	14 (19%)	2 (4%)	<.001

Note: p-Value based on chi-square test with two degrees of freedom.

TABLE 3.—Independent variables associated with severity categorization.

Variable	Category	Severity categorized	Severity not categorized	<i>p</i> -Value
<i>n</i>		54	140	
Sex	Male	20 (37.0)	27 (19.3)	.01
	Female	34 (63.0)	113 (80.7)	
Age (mean ± SD)		40.9 (18.1)	46.3 (18.1)	.07
Age group	18–24	15 (27.8)	21 (15.0)	.30
	25–34	3 (5.56)	15 (10.7)	
	35–44	10 (18.5)	24 (17.1)	
	45–54	7 (13.0)	29 (20.7)	
	55–65	9 (16.7)	21 (15.0)	
	65+	10 (18.5)	30 (21.4)	
Race	Caucasian	46 (85.2)	122 (87.1)	.90
	Non-Caucasian	1 (1.85)	3 (2.14)	
	Unknown	7 (13.0)	15 (10.7)	
Smoking status	Never	37 (68.5)	94 (67.1)	.70
	Former	7 (13.0)	25 (17.9)	
	Current	10 (18.5)	20 (14.3)	
Comorbidities	BMI—mean (SD)	30.1 (11.5)	29.7 (7.80)	.58
	Rhinosinusitis	34 (63.0)	94 (67.1)	
	OSA	9 (16.7)	24 (17.1)	
	GERD	16 (29.6)	52 (37.1)	
Spirometry in the last 5 Years		15 (27.8)	68 (48.6)	.009
FEV ₁ (L)		2.77 (0.9)	2.82 (0.9)	.83
FEV ₁ (% predicted)		0.85 (0.2)	0.90 (0.2)	.37
ACT score		21.6 (3.4)	21.5 (4.4)	.91
Persistent asthma by HEDIS criteria		<i>n</i> = 40	<i>n</i> = 82	
Four or more asthma meds		14 (35.0)	36 (43.9)	.58
1 + ED asthma visit		1 (2.50)	5 (6.10)	.66
1 + inpatient asthma care		0 (0)	5 (6.10)	.17
4 + OPD asthma visit + 2 meds		2 (5.00)	5 (6.10)	1.00
On controller medications		16 (40.0)	43 (52.4)	.20
Persistent asthma by HEDIS criteria		14 (35.0)	38 (46.3)	.23

Note: FEV₁, forced expiratory volume in 1 second; OSA, obstructive sleep apnea; OPD, outpatient department.

asthma severity documentation between sites prior to the visit. The intervention site had 63% severity categorization in the EHR within 24 hours post-visit compared with 19% and 4% in the control sites ($p < .001$).

By univariate analysis, male gender ($p = .01$) and lack of spirometry ($p = .01$) in the last 5 years were positively associated with severity assessment (see Table 3 for summary). The association between severity assessment and persistent asthma by HEDIS criteria was not statistically significant and was not included in the multivariate analysis. Multiple logistic regression analysis showed no association of gender, age, physician's asthma patient volume, or spirometry with severity categorization (Table 4). After adjusting for all of these variables, only indicators for the location of care (intervention site vs. control sites) were significantly associated with severity categorization (adjusted odds ratios: 4.8 [compared to Northeast control site] and 31.3 [compared to Northwest control site], 95% confidence interval: 2.1–11.3 and 6.8–144.0, $p < .0001$).

DISCUSSION

Our study evaluated the effectiveness of a process aimed at increasing the frequency of asthma assessment in routine family medicine ambulatory practice. The strengths of this study include the use of two control sites and assessment of documentation prior to the visit and within 24 hours after

TABLE 4.—Multiple logistic regression analysis for severity categorization.

Variable	Odds ratio	95% confidence interval	<i>p</i> -Value
Gender			
Female	1.00		.18
Male	1.796	0.76–4.26	
Age group			
18–24	1.187	0.35–4.03	.78
25–34	0.729	0.14–3.93	.71
35–44	0.745	0.21–2.70	.65
45–54	0.572	0.16–2.07	.39
55–64	0.840	0.22–3.25	.80
>64	1.00		
Location			
Intervention site	8.379	3.81–18.43	<.0001
Usual care site	1.00		
Physician's volume			
1 asthma visit	2.339	0.50–10.87	.28
2 asthma visits	1.242	0.47–3.26	.66
>2 asthma visits	1.00		
FEV (% predicted)			
Missing	2.219	0.90–5.50	.09
<60	4.186	0.059–29.95	.15
60–80	0.443	0.04–5.23	.52
>80	1.00		

Note: FEV, forced expiratory volume in 1 second.

the office visit. Additionally, there were standardized office procedures between the control and intervention groups: same front desk and rooming procedures at all

three sites, same type of practice, and the same electronic medical record with the only difference being the geographic site of the clinic. Compared to other studies involving physician alerts (computerized and non-computerized) (17, 19), the size of the difference we observed in asthma assessment between intervention and control groups was large (63.3% vs. 12.3% for control sites combined). This may be due to the nature and approach of the provider prompt. While most other prompting studies involve a direct message or reminder to the provider to perform an action (vaccinate, measure blood pressure, order laboratory, etc.), we made essential asthma information conveniently available to the provider at the time of the visit, leading to a review of the patient's asthma status as evidenced by assessment and documentation of asthma severity. In the future, it will be important to evaluate whether this process will increase the assessment of asthma control, medication compliance, and exacerbations, ultimately leading to better asthma outcomes.

This study offers several lessons: (1) an electronic prompt to the support staff has a high level of compliance; (2) adult patients were receptive to an asthma-specific questionnaire even for a non-asthma visit (only four patients declined to participate); and (3) clinical information could be gathered for periodic assessment of disease status without a disease-specific office visit. This latter consideration should improve the response rate in contrast to integrated care models that remind patients to schedule asthma visits (20).

The applicability of this intervention in other healthcare settings will require further study in order to address some key limitations of this study: (1) expanding the initiative to appointments <30 minutes as is typical for most primary care visits; (2) inclusion of resident trainees and other allied healthcare providers; (3) additional analysis of the resources required to develop the registry and insert the electronic prompt for other disease states; (4) the long-term impact of using electronic prompts for multiple preventive services and chronic diseases at the risk of reminder fatigue (21–23); and (5) assessment of the impact of increased asthma status review on patient-centered asthma outcomes such as asthma control, quality of life, and reduction in emergency department visits and hospitalizations.

There are several weaknesses in our study. For practical reasons, the study sites could not be easily randomized and we were only able to assess three sites that served a large number of healthcare employees and dependents. Another possible weakness of this study was that it was performed before the release of the NAEPP guidelines in 2007. We used severity categorization since this was one of the outcomes recommended by the earlier version of the NAEPP. In the new NAEPP guidelines, asthma severity categorization is still used but has more relevance when initiating therapy in newly diagnosed or treatment-naïve patients. Subsequent adjustments in controller therapy are now based on the level of asthma control (1, 24). In anticipation, we had incorporated the ACT in the AMQ but did not use it as an outcome. Whether the asthma assessment is termed severity or control, we feel that an

electronic prompt for a defined information set is an important first step to ensure that consistent and relevant asthma assessment is performed. In our study, it facilitated a review by the primary care provider of the patient's asthma status even when asthma may not be the primary purpose of the visit.

CONCLUSION/KEY FINDING

Introduction of an electronic prompt increased the frequency of asthma assessment during asthma and non-asthma-related office visits.

DECLARATION OF INTEREST

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

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