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Benefits of an asthma education program provided at primary care sites on asthma outcomes

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Summary
Background: Although it is a key-recommendation of all recent asthma guidelines, self-management education is still insufficiently offered in primary care settings.
Aims of the study: To demonstrate the benefits of an educational program offered at the site of primary care (Family Medicine Clinics- FMC) by trained asthma educators on patient outcomes and healthcare use.
Methods: This was a one-year pre-post intervention study. Patients with a diagnosis of mild to moderate asthma were enrolled from six FMC. After an initial encounter by the educator, an assessment of educational needs and a spirometry were done, followed by 3 follow-up visits at 4–6 weeks, 4–6 months and one year. Expiratory flows, asthma control criteria, knowledge about asthma, adherence to medication and healthcare and medication use were assessed at each visit.
Results: Data from 124 asthma patients (41M/83F), aged 55 ± 18 years, were analyzed. After initiating the intervention, there was a progressive increase in asthma knowledge and an improvement in medication adherence. The number of unscheduled visits for respiratory problems went from 137 to 33 ($P < 0.0001$), the number of antibiotic treatments from 112 to 33 ($P = 0.0002$) and the number of oral corticosteroids treatments from 26 to 8 (NS). Marked improvements were observed in regard to inhaler technique and provision of a written action plan.

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Conclusion: This study shows that an educational intervention applied at the site of primary care can result in significant improvements in patient asthma outcomes and reduce unscheduled visits and inappropriate use of medications such as antibiotics.

Introduction

Despite significant progress in our understanding of what could be the optimal management of asthma, this common disease is still frequently uncontrolled, resulting in a significant morbidity and acute healthcare use [1,2]. Insufficient understanding of the disease and its treatment by the patient is one of the main reasons proposed to explain this insufficient control of asthma [3,4]. Self-management asthma education is among key-recommendations of all recent guidelines on asthma management but it is still too infrequently provided [5,6].

In order to improve this situation, training programs for asthma educators and education networks have been developed in the last decades [7,8]. In the province of Quebec, the Quebec Asthma and Chronic Obstructive Pulmonary Disease (COPD) Network (QACN) has helped develop more than 100 asthma and COPD Education Centers and regularly trains the educators offering free educational interventions in these institutions [7,9]. Unfortunately, despite the availability of this service, referral for asthma education is still infrequent [8,10]. Among factors explaining such low rate of referral by primary care physicians are the non-integration of structured education into care, insufficient time or resources, and unwillingness of patients to attend [10,11]. Furthermore, many patients have not been informed about these educational services or have difficulties with the usually exclusive daytime availability of educators.

In a previous study, we reported that offering access to spirometry was not increasing the rate of referral to asthma education centers although an "automatic" referral program at the Emergency Department (ED) resulted in a marked increase in such referral [10]. However, a significant proportion of patients were not interested to take part to the educational program. Otherwise, spirometry is not often available or used in primary care, resulting, combined to a poor assessment of asthma control criteria, in inappropriate assessment of asthma severity/control and improper assessment of treatment needs [12—14]. In this regard, when the results of a spirometry are available, physicians often change the treatment offered [13].

To address this barrier to referral for asthma education, the QACN has developed an initiative to offer the services of an experienced asthma educator at the point of care of primary care clinics. The goal of this study was to determine if availability of educational services in Family Medicine Clinics could improve asthma outcomes and healthcare use for asthma.

Methods

Participants

Patients were recruited from six Family Medicine Clinics (FMC/Groupes de médecine familiale) from the Quebec City metropolitan area between January 2013 and August 2013. Patients could be referred to the educator by the physicians practicing at these clinics if: 1) they were using an inhaler for what was considered to be asthma, 2) they had evidences of poor asthma control, or 3) if the physician wanted to better assess patient asthma severity/medication needs. Patients had to be 18 years and older. In order to be included in the analyses, patients had to complete all four visits. A consent form was signed by each patient to proceed with data collection and analysis of the educational program results. Before further analyses, all data were anonymized.

About 1 patient out of 10 did not want to meet with the asthma educator and refused the educational intervention. These did not sign the consent form and were therefore not included in the recruitment flowchart (Fig. 1). From a total of 451 patients enrolled, ten patients were less than 18 years old and were not included in the analyses. From the remaining 441 adult patients, 262 did not complete all

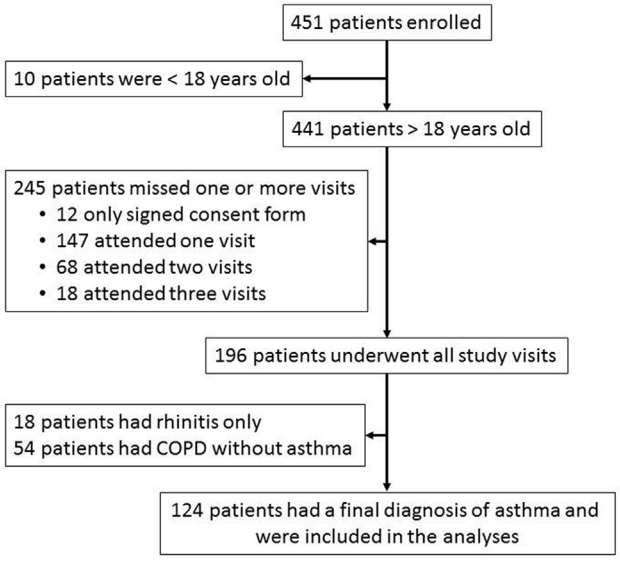

Figure 1 Flowchart of patients' recruitment.

visits; 12 patients signed the consent form but did not attend any study visit, 147 only benefited from the first educative intervention, 68 attended 2 visits and 18 completed 3 visits. Characteristics of drop-outs are shown in Table 1. Reasons for not attending subsequent visits included mainly the lack of time, lack of interest, and non-availability of transportation facilities. As the asthma diagnosis was confirmed at the final visit, from the 196 that completed the four visits, 72 had no final diagnosis of asthma (18 had only a rhinitis and 54 had COPD without asthma). Analysis therefore included data from the 124 remaining patients.

Definitions

Asthma

Patients were considered to have asthma if they fulfilled at least one of the following criteria: 1) Current asthma symptoms and a positive/borderline methacholine challenge test as shown by a $\geq$ 20% fall in forced expiratory volume in 1 s (FEV_1) after inhalation of a provocative dose of methacholine of less than 16 mg/mL (PC_{20}), 2) an FEV_1 increase of at least 12% and $\geq$200 mL after the use of a short-acting β2-agonist, 3) a respirologist's diagnosis of asthma after revision of the patient's medical report, or 4) any physician's diagnosis of asthma associated to the use of asthma medication taken for at least a six month period before entry in the study.

Table 1 Characteristics of subjects who dropped out from study (n = 245).

Characteristic	
Number of visits completed(0/1/2/3/4)[a]	12/147/68/18/0
Gender (F:M)[a]	137:108
Age (years)[b]	52 ± 20
Severity of asthma[a] (Mild/moderate/severe)	60/112/73
Knowledge (/52 questions)[b]	32 ± 8
Adherence (Good/partial/poor)[a]	88/59/98
Inhaler technique (Good/ requiring corrections)[a]	5/95
Acute care use in the previous year	
Unscheduled medical visits related to respiratory problems[c]	166
Emergency room visits (<24 h)[c]	14
Hospitalisations (>24 h)[c]	7
Treatment use in the previous year	
Antibiotics[c]	124
Prednisone[c]	12
SABA use/week (including Symbicort- SMART therapy)[b]	2.5 ± 10.8
Habits	
Absenteeism from work or school (days)[c]	89
Pulmonary function	
FEV_1 (L)[b]	2.4 ± 0.8
FEV_1 (% pred.)[a]	92 ± 18
FVC (L)[b]	3.0 ± 1.0
FVC (% pred.)[b]	96 ± 18
FEV_1/FVC[b]	79 ± 8
Asthma control (according to the 30s Asthma Control Test™)	
Participants with a good control[a]	98

SABA: Short-acting β_2-agonists, FEV_1: Forced expiratory volume in 1 s; FVC: Forced vital capacity.
[a] Results are presented as number of patients.
[b] Results are presented as means ± SD.
[c] Results are presented as number of events.

Asthma severity

Severity of asthma was assessed according to prescribed pharmacotherapy, as suggested by current guidelines [15]. Patients with mild asthma were using a short-acting β2-agonist (SABA) on demand and low doses ($\leq$250 mcg/day beclomethasone-HFA or equivalent) of inhaled corticosteroids (ICS). Patients with moderate asthma were using a SABA on demand and low to moderate doses (250-500 mcg/day beclomethasone-HFA or equivalent) of ICS, with or without additional therapy such as a long-acting β2-agonist (LABA) or a leukotriene receptor antagonist (LTRA). Patients were considered to have severe asthma if they were using high doses (>500 mcg/day beclomethasone-HFA or equivalent) of an ICS plus additional pharmacotherapy (LABA, LTRA, or prednisone) and a SABA.

Study design

This was a one-year pre-post intervention study including 4 visits. During a visit at the clinic (scheduled or unscheduled), general practitioners offered patients to meet the asthma educator and receive an educational intervention. If they agreed, the initial visit was scheduled in the following days. After an initial 1-h encounter by the educator, an assessment of educational needs and a spirometry were done, followed by 3 follow-up visits at 4–6 weeks, 4–6 months and one year after the initial visit. Assessment of expiratory flows via spirometry, asthma control criteria, asthma knowledge, adherence to medication, healthcare and medication use was performed at each visit. A project coordinating committee supervised the project; it included representatives from the QACN, FMCs, patients groups, health ministry and private partners.

Educational intervention

The educational intervention aiming at improving self-control of patients was based on the QACN learning program for educators and included the following topics: asthma control, smoking habits, environmental control, use of an action plan, patient knowledge and understanding of the disease (pathophysiology, medication, exacerbations), adherence to medication, inhalator technique, and spirometry [9]. The two educators had received training on asthma education about 5 and 15 years ago respectively and had attended the yearly updates of the QACN. Educators not only provided key-information adapted to the patient but aimed at improving his/her skills and behavior in regard to medication use, inhaler technique, asthma monitoring and use of an action plan. It was based on the established QACN program [16], based on the PRECEDE model [17].

Subjects characteristics, habits, healthcare use and medication use

Demographic data were recorded and a questionnaire regarding smoking status, atopy (as assessed by skin prick tests with animal danders, tree pollens, ragweed pollens, grasses pollens, housedust mites and feathers), co-morbid conditions, environment and medication use was completed. Absenteeism from work or school, self-reported unscheduled visits related to asthma problems, ED visits and hospital admissions were also recorded. Absenteeism was recorded as the number of days missed in the previous year for baseline visit and as the number of days missed since the last visit for the other time points and reported as the number of days missed per patient per month. The same data collection method was applied for unscheduled visits, ED visits, hospitalisations, number of antibiotic treatments and number of prednisone treatments but these were reported as a number of events or treatment per patient per month.

Treatment adherence

Treatment adherence was assessed by the educator, according to a questionnaire and pharmacologic profile. Not taking maintenance medication once/week or less was defined as good adherence, whereas missing doses 2–3 days/week was defined as partial adherence and not taking medication $\geq$4 days/week was defined as poor adherence.

Asthma knowledge

A recently developed asthma knowledge questionnaire, approved by the QACN's scientific committee, was used to assess patients' knowledge about their disease. The questionnaire included 52 questions in five domains: (1) nature of the disease, (2) triggering factors (3) asthma assessment, (4) asthma treatment and (5) general aspects of asthma management. All questions had trichotomous response options (true/false/do not know). The total score was the number of items in the total instrument (or domain of the instrument for sub-scores) that were correctly scored (1 for a correct response, 0 for a wrong response or "do not know").

Asthma control

The 30-Second Asthma Test™, based on the Canadian Asthma Consensus Guidelines, was used to assess asthma control [18]. Briefly, this is a five-item questionnaire on the presence or absence of nocturnal symptoms, daytime symptoms (coughing, chest tightness and wheezing), the use of rescue medications, symptom interference with daily activities and absenteeism from work or school. A score of 1 means a positive response (presence of symptoms) while a score of 0 is considered a negative response (absence of symptoms) for a possible maximum score of five. Adequate asthma control is defined as a score $<$2 and out of control is defined as a $\geq$ 2 score.

Inhaler technique

Inhaler technique was assessed at each visit by the asthma educator using a checklist of steps reviewed by the QACN scientific committee and based on current guidelines [5], specific for each device. Each patient demonstrated inhaler technique with placebo devices of each type of inhaler they were using. They were asked to use their inhalers as they normally did at home. If they were already using an inhaler, technique was defined as good if no error was made during the demonstration and was defined as requiring corrections if one or more errors were made.

Spirometry

Baseline FEV_1 and forced vital capacity (FVC) were measured according to the ATS criteria [19]. FEV_1 was defined as the best of 3 reproducible values and the predicted values were obtained from the European Respiratory Society [20] for patients between 18 and 65 years old and

Table 2 Baseline characteristics of included patients (n = 124).

Gender (F:M)[a]	83:41
Age (years)[a]	55 ± 18
Body mass index (BMI; kg/m^2)[a]	29 ± 8
Diagnosis entry criteria (1/2/3/4)[b]	30/11/28/55
Allergy (Y/N)[c]	65/14
Severity of asthma (Mild/Moderate/Severe)[a]	33/72/19
Smoking status (Non-Smoker/ Smoker/Ex-Smoker)[a]	60/20/44
FEV_1 (L)[a]	2.3 ± 0.8
FEV_1 (% pred.)[a]	90 ± 17
FVC (L)[a]	3.0 ± 1.0
FVC (% pred.)[a]	96 ± 18
FEV_1/FVC[a]	77.3 ± 8.4
Comorbidities[d]	
Chronic obstructive pulmonary disease (COPD)	6 (4)
Obstructive sleep apnea (OSA)	1 (1)
Sinusitis	48 (39)
Diabetes	11 (9)
Cardiovascular disease	24 (19)
Rhinitis	42 (34)
Gastroesophageal reflux disease (GERD)	52 (42)
Medication[d]	
Short-acting β_2-agonist (SABA)	74 (60)
Long-acting β_2-agonist (LABA)	4 (3)
Inhaled corticosteroid (ICS)	67 (5)
ICS/LABA combined	67 (5)
Short-acting anti-cholinergic (SAAC)	1 (1)
Long-acting anti-cholinergic (LAAC)	7 (6)
Anti-leucotriene	15 (12)
Prednisone	4 (1)
Anti-IgE	0
Nasal corticosteroids	80 (65)

F: Female, M: Male, Y: Yes, N: No, FEV_1: Forced expiratory volume in 1 s; FVC: Forced vital capacity.

[a] Results are presented as means ± SD or numbers.

[b] 1: current asthma symptoms and a provocative dose of methacholine inducing a 20% fall in FEV1 $<$16 mg/mL), 2: an FEV1 increase $\geq$12% and $\geq$200 mL after the use of a short-acting β2-agonist, 3: a respirologist's diagnosis of asthma, 4: any physician's diagnosis of asthma.

[c] Confirmed by allergy skin-prick tests.

[d] Results are presented as number of patients (%).

from Knudson [21] for patients >65 years old. Airway obstruction was defined as a FEV_1 <80% of predicted values and a FEV_1/FVC ratio < 0.7.

Statistical analyses

Adherence measures were compared between baseline visit and one-year follow-up visit using the Bowker's test of symmetry, while the evolution over the 4 time scales were compared using a mixed multinomial model with subject's id as a random factor. Following a significant effect of time, posthoc contrasts were constructed to compare the compliance distribution among pairs of time. The average number of unplanned medical visits, number of hospital emergency visits, number of hospitalisations, number of antibiotic treatments, number of cortisone treatments, number of BACA utilisations, and number of days of absence from work or school were compared across time using a GEE Poisson model.

When appropriate, the duration of each time scale was taken as an offset variable in order to compare the rate of events, instead of comparing raw values. Means values were compared using the posthoc LSD protected multiple comparisons technique. The decision to abandon or not their domestic animal between baseline visit and one-year follow-up visit was analyzed using the Bowker's test of symmetry in a two-dimensional contingency table framework. The McNemar's test was used to compare the technic evaluation at baseline and one-year follow-up, while the evolution of this technic through time of measurements was compared using a mixed logit model with subject's id as a random factor. Variation of mean values of FEV_1, FVC, and FEV_1/FVC from baseline to one-year follow-up was tested using the paired Student t-test. The global knowledge scores were compared over time using a classical mixed model.

The control of asthma and the occurrence of each symptom were compared across time using a mixed logit model. However, the number of symptoms were compared across time using a GEE Poisson model. Relationships between variables were investigated using Pearson's correlation coefficient. Significance level was set at the $\alpha = 0.05$ level. The data were analyzed using SAS v9.4 TS1M2 software program.

Results

Subjects' characteristics

Data from 124 asthmatic patients (83F/41M), aged 55 ± 18 years were included in the analyses. Subjects' characteristics are presented in Table 2. Most subjects had mild to moderate

Table 3 Changes in asthma outcomes after 1-year follow-up (n = 124).

	Baseline	1-year Follow-up	*P*
Knowledge (/52 questions)[a]	35 ± 8	45 ± 5	<0.0001
Adherence (Good/partial/poor)[b]	31/25/44	87/26/4	<0.0001
Patients with an asthma action plan[b]	0	55	<0.0001
Inhaler technique (Good/requiring corrections)[b]	1/101	76/41	<0.0001
Acute care use			
Unscheduled medical visits related to respiratory problems[c]	137	33	<0.0001
Emergency room visits (<24 h)[c]	11	10	NS
Hospitalisations (>24 h)[c]	5	4	NS
Treatment use			
Antibiotics[c]	112	33	0.0002
Prednisone[c]	26	8	NS
SABA use/week (including Symbicort- SMART therapy)[c]	2.4 ± 6.6	1.2 ± 3.6	NS
Habits			
Absenteeism from work or school (days)[c]	47	35	NS
Animal at home[b]	28	26	NS
Smoking[b]	20	17	NS
Pulmonary function			
FEV_1 (L)[a]	2.3 ± 0.8	2.4 ± 0.8	NS
FEV_1 (% pred.)[a]	90 ± 17	92 ± 18	0.02
FVC (L)[a]	3.0 ± 1.0	3.0 ± 1.0	NS
FVC (% pred.)[a]	96 ± 18	96 ± 18	NS
FEV_1/FVC[a]	77 ± 8	79 ± 8	0.01
Asthma control (according to the 30s Asthma Control Test™)			
Participants with a good control[d]	52 (48)	90 (78)	<0.0001

SABA: Short-acting β_2-agonists, FEV_1: Forced expiratory volume in 1 s; FVC: Forced vital capacity.
[a] Results are presented as means ± SD.
[b] Results are presented as number of patients.
[c] Results are presented as number of events.
[d] Results are presented as number of patients (%).

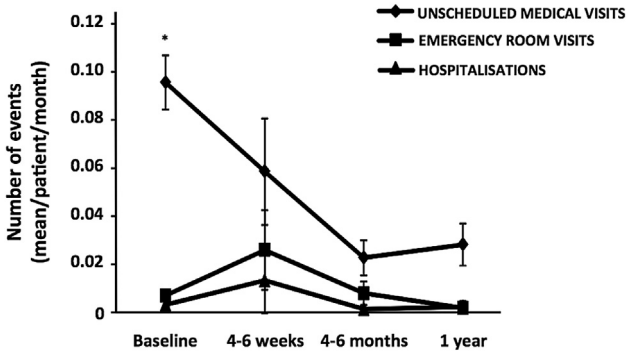

Figure 2 Patients' self-reported healthcare use as defined by the number of unscheduled medical visits related to asthma, number of emergency department visits related to asthma and number of hospitalisations related to asthma. Values are mean number of events/patient/month, bars indicate SD.*$P < 0.0001$ vs 4–6 months and one-year follow-up.

asthma, with normal pulmonary function tests and used ICS alone or in association with a LABA. Atopy was confirmed by skin prick tests in 79 patients and most of them (82%) had a positive reaction.

Changes in outcomes

Healthcare use

Global changes after a one-year follow-up are presented in Table 3. Overall, healthcare use was improved, particularly unscheduled medical visits related to asthma problems,

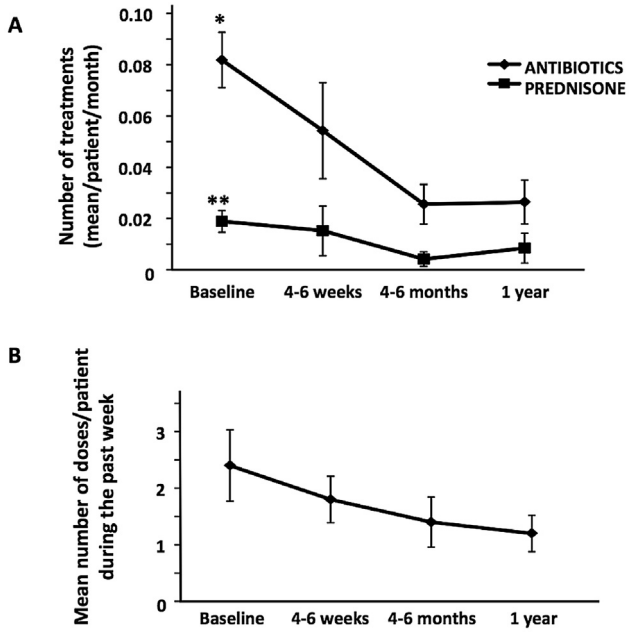

Figure 3 A) Number of treatments of antibiotics and prednisone at baseline and at the different time points. Values are means/patient/month, bars indicate SD. *$P = 0.0002$ vs 4–6 months and one-year follow-up, **$P = 0.004$ vs 4–6 months. B) Number of doses of short-acting β2-agonist per patient in the previous week at baseline and at the different time points. Values are means, bars indicate SD.

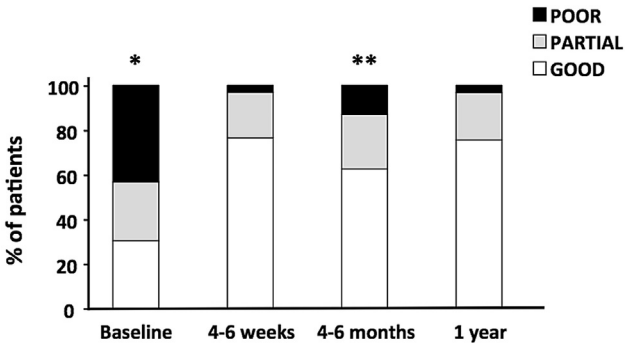

Figure 4 Distribution of patients among the treatment adherence categories between the different study time points. Good adherence was defined as not taking medication once/week or less, partial adherence was defined as missing doses 2–3 days/week and poor adherence was defined as not taking medication $\geq$ 4 days/week. *$P < 0.0001$ vs all other time points, **$P < 0.03$ vs 4–6 weeks and one-year follow-up.

which were markedly reduced. In addition, when looking at the number of events per month per patient, at the 4–6 month visit, there was a significant decrease in this parameter (Fig. 2). No impact was observed for emergency department visits or hospitalizations for asthma although these were already low before the intervention (Fig. 2).

Medication use

Regarding medication use, antibiotic treatments related to respiratory problems decreased by more than 50 percent after one-year follow-up. On initial visit, 58 patients had received influenza vaccine and 8, pneumococcal vaccine. Such decrease was already observed at the 4–6 month visit (Fig. 3a). Total number of oral corticosteroid treatment (prednisone) did not vary significantly from baseline visit to one-year follow-up visit, but a significant decrease was observed at the 4–6 month visit (Fig. 3a). Regarding SABA use, although not statistically significant, the mean number of occasions where SABA was used in the previous week went from 2.4 times/week at baseline to 1.2 times/week after one-year follow-up (Fig. 3b).

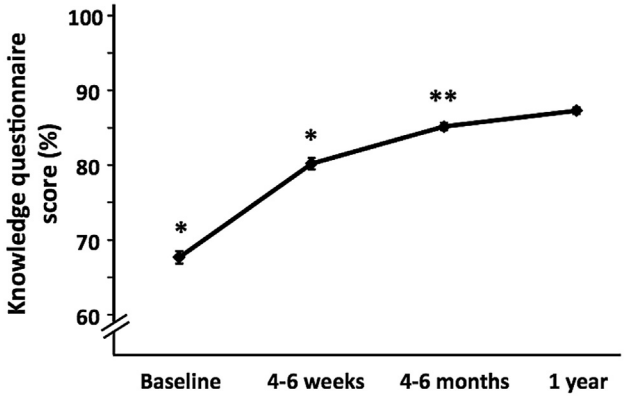

Figure 5 Percent scores to the asthma knowledge questionnaire at baseline and at the following time points. Values are means, bars indicate SD. *$P < 0.0001$ vs other time points, **$P = 0.0002$ vs one-year follow-up.

Treatment adherence

Fig. 4 shows the variation in treatment adherence between each time point. There was a significant increase in adherence to treatment from baseline to all other time points. At the 4–6 month visit, a significant decrease in the proportion of patients with good adherence was observed compared to 4–6 week follow-up, but this proportion significantly increased at one-year follow-up.

Asthma knowledge

The asthma knowledge questionnaire global scores increased significantly between baseline assessment and all other time points as well as between follow-up time-points (Fig. 5). There was however no correlation between knowledge improvement and the other asthma outcomes.

Asthma control

According to the 30 Second Asthma Test™ [18], at initial visit, 48% of patients were defined as having controlled asthma (Fig. 6). This proportion significantly increased to 78% at the 4–6 week follow-up visit and remained high through the 4–6 month and one-year follow-up visits. At baseline, the mean number of symptoms was significantly higher than at the three follow-up visits (1.5 ± 1.4 at baseline vs 0.8 ± 1.1 at all three follow-up visits, $P < 0.0001$). The most prevalent symptom at entry in the study was nighttime awakenings due to symptoms, reported by 48% of patients.

Inhaler technique

At the start of the study, only one patient showed good inhaler technique whereas at one-year follow-up, 76 patients showed good inhaler technique ($P < 0.0001$). Conversely, the technique required correction in 101 patients at baseline and only in 41 patients after one-year follow-up ($P < 0.0001$).

Pulmonary function

Baseline FEV_1 and FVC were (mean ± SD) 90 ± 17% and 96 ± 18% of predicted values respectively. After one-year follow-up, a minor but significant increase in FEV_1 was observed (92 ± 18% of predicted value, $P = 0.02$) while FVC remained the same.

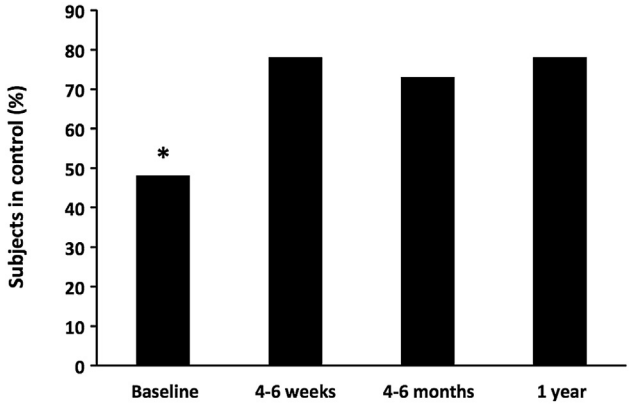

Figure 6 Prevalence of subjects with good asthma control at the different time points. Asthma control was assessed by the 30 s Asthma Test™. Good control was defined as a global score <2 and out of control was defined as a ≥ 2 score. *$P < 0.001$ vs all other time points.

Asthma action plan

Before the intervention, none of the patients had an asthma action plan on the management of asthma exacerbations. At the end of the study, more than half had a written action plan. The main reason for not providing one was that the physician did not want to offer one to the patient for various reasons.

Other outcomes

Number of days of work or school missed was similar between baseline and the other evaluation time points. At inclusion in the study, 20 patients were active smokers while it was 17 at the end of the study (NS). Similarly, 28 patients had an animal at home when they started the project and only two of them agreed to get rid of it by the end of the one-year follow-up (NS).

Discussion

It is mandatory to assess how to optimize the benefits of asthma education, a major component of asthma management. However, most studies on such programs have been conducted in specialized institutions. This study explored the effects of an educational intervention offered at the site of primary care to uncontrolled mild to moderate asthma patients. This intervention resulted in a marked improvement of asthma control, a progressive increase in knowledge of asthma, an improvement in inhaler technique and medication adherence, provision of a written asthma action plan and a reduction in the number of unscheduled visits for respiratory problems in addition to a statistically significant reduction in the number of antibiotic treatments, and although not statistically significant, four-fold reduction in the number of oral corticosteroids treatments. Other components of healthcare use such as ED visits or hospital admissions for asthma were not significantly reduced, although these events were initially not frequent in the study population of mild to moderate asthmatic patients.

We previously showed that asthma education could result in an improvement of asthma control and of subsequent ED visits in patients seen for acute asthma at the ED [22]. The bulk of evidence shows that education offered by trained asthma educators is an essential component to asthma management and provides an added value to physician's intervention [23]. We however observed an insufficient reference for asthma education and, in a previous study, we showed that a major barrier to attendance to education was the need for scheduling this session at another institution, at a time asthma was better controlled, losing therefore the incentive of wanting to get better when asthma is more troublesome [10]. Often, physicians are reluctant to send their patients to an asthma education center, for various reasons including the need to explain and motivate the patient for such intervention.

Feedback from physicians and participating asthma educators stressed that the proximity of the educator was a major facilitator for asthma education referral, the vast

majority of patients seen for asthma being therefore referred for such educational session. Also, better knowledge of the nature of the intervention inspired confidence to the physician, therefore facilitating his/her willingness to refer to the educator. Furthermore, participating physicians indicated that a perceived benefit from such referral was the possibility to confirm the diagnosis and identify co-morbid conditions. These comments led us to develop this model, in which educators are sent to primary care clinics to support educational interventions of family physicians.

In our study, although asthma education could have shown better results in markedly uncontrolled asthma or in moderate to severe disease, impressive potential benefits were observed even in these milder forms of asthma [3]. It suggests that educators' assessments and interventions could influence physicians' practice and that additional information on asthma control and barriers to proper management were useful to the physician to adapt therapy and avoid unnecessary prescriptions. It also helped to provide written action plans to many patients, a key-component of asthma management, but a remaining care gap despite current guidelines recommendations. Surprisingly, a frequent comment from physicians was that the patient did not require an action plan, suggesting that they either did not agree with this recommendation, considered that it was not necessary or that it was not timely to provide one. Such difficulties with provision of action plans have been frequently reported in the past [24—26].

Another reason for the positive results of this study could be that patients agreeing to attend the educational program may be more motivated to improve their asthma control. The regular visits to the educator, at what time asthma control could be reassessed and treatment adjusted, may have also helped. This is supported by the observation of a progressive benefit for repeated interventions, although it seemed to plateau at six months. Furthermore, despite the limitations of the method used to assess adherence to therapy, this outcome showed significant improvements during the study period, a factor that could have helped improve asthma control. It is possible also that less adherent patients withdrew from the study before its completion. The fact that a knowledge questionnaire was administered to participants could be considered another type of educational intervention but this could be used indeed, not only to guide educational interventions but to help patients reflect on these concepts.

Although patients did not have frequent Emergency Department visits or hospital admissions before entry in the study, precluding observation of significant changes in these parameters, it clearly showed a marked reduction of unscheduled visits, probably reflecting frequent exacerbations or unstable asthma, not properly self-managed by the patient. The percentage of patients with uncontrolled asthma is in keeping with our previous Canadian surveys but we showed that such prevalence could be markedly improved with the educational intervention, going from 48% to 78% in our group [2]. The improvement observed in asthma outcomes, however, may be explained by the use of asthma action plans and by a better understanding of the management of asthma, as suggested by a better score on patient's knowledge questionnaire. There was no correlation between improvement in knowledge and asthma outcomes, suggesting that knowledge alone may not translate into behavior changes although these patients already had a relatively good knowledge of asthma initially. We may nevertheless consider that adequate knowledge is required to promote behavior changes, as the patient should know why recommendations should be implemented and how.

Pulmonary function did not change significantly as it was already good at the start of the study. It confirms the discordance often observed between punctual tests and the global asthma control. Recent guidelines stress the need to adjust treatment not only according to current control but also to risk factors, such as exacerbations. Our study shows that despite minimal changes in lung function, we observed a marked reduction of unscheduled visits to the physician. This study also confirms that although assessment of asthma control and medication use can be improved by the added educational intervention, it remains difficult to address the frequent problem of smoking and domestic animal exposure in sensitized patients [27]. Furthermore, the decrease in number of oral corticosteroid treatments at the 4—6 month visit but not at the end of the study could be due to the fact that this visit was done during the summer time, a period during which we usually observe less exacerbations.

The strengths of such study are first that it is a "real-life" intervention performed in a primary care setting, in a vast variety of patients not seen by specialists or educators. It shows the added benefits of such intervention in this population, particularly in regard to proper use of drugs, with improved adherence and reduced usage of antibiotics. In this regard, it suggests that primary care physicians often interpret episodes of loss of control of asthma as resulting from bacterial infections, therefore prescribing unnecessary antibiotics while an increase in asthma therapy would be the appropriate intervention.

The main weaknesses of the study are also related to the "real-life setting" nature of this study. First, diagnosis of asthma was often physician's made (44% of patients), and not every patient had proof of reversibility of airway obstruction, as a weaning period with re-testing was not done. It is therefore possible that some non-asthmatic patients were included. If these patients had no asthma, we would think that this would reduce the magnitude of the benefits observed. Nevertheless, we still observed a quite significant improvement in asthma control as well as a reduction in healthcare use. Moreover, analysis of the educational effect according to the entry criteria showed no difference between patients whose diagnosis was made by a physician and those whose diagnosis was based on more objective parameters (data not shown).

Analysis of the past medical history and one-year data recording also allowed rejecting the diagnosis in a substantial number of individuals (therefore not included in the analysis). Furthermore, this was not a randomized clinical trial with a control group without intervention, but a "real-life" study. Lack of resources and the difficulties to motivate Primary Care Centers to participate without added intervention would have been major barriers here. Despite this fact, this pre-post evaluation brought useful information on the benefits of such addition to the

physician's assessment and intervention. Among these, in addition to a better assessment of asthma control and acquisition of improved self-management skills, the follow-up allowed rejecting a diagnosis of asthma in some patients, alternative diagnoses being mostly COPD or rhinitis, often for this last, related to an associated cough considered to be probably due to asthma initially. Finally, as only patients who attended the whole program were included in the analysis, results can have been influenced by the fact that the most motivated patients completed the study.

In conclusion, this study showed the significant benefits of access to asthma education at the point of care in Family Medicine Clinics, even in non-severe asthma patients. Expansion of such program can result in improvements in asthma control, more appropriate treatment prescription and use, and reduced healthcare costs. The QACN aims at developing such initiatives across the province of Quebec in the next years, in collaboration with the ministry of health and health network institutions.

Conflict of interest statement

No conflict of interest.

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