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## Implementation of asthma clinical practice guidelines in primary care: A cross-sectional study based on the Knowledge-to-Action Cycle

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### ABSTRACT

**Objective:** Based on the Knowledge-to-Action Cycle, we assessed the self-reported implementation and perception of asthma clinical practice guideline (CPG) recommendations in primary care physicians (PCPs), along with the barriers and facilitators to CPG use in primary care. **Methods:** We conducted a cross-sectional study. Using the extended *Asthma Physicians' Practice Assessment Questionnaire*<sup>®</sup>, PCPs self-reported the following: their knowledge of 15 key asthma CPG recommendations, the perceived usefulness of each of these recommendations, their motivation to apply these recommendations, and their agreement with the content of these recommendations. Participants also reported the barriers and facilitators to CPG use in primary care. **Results:** Out of the 46 potential participants, 43 physicians completed the questionnaire (response rate: 93%). Results underlined care gaps regarding the provision of asthma education and written action plans, inhaler technique demonstrations, and assessment of patients' concerns. Results showed that the majority of physicians knew the key asthma CPG recommendations, but their motivation to implement them and the perceived usefulness of these recommendations varied from one proposal to another. Main barriers to the implementation of these recommendations were related to time and resources. PCPs stressed the importance of teamwork for enhancing the use of asthma CPGs in primary care. **Conclusions:** Our results suggest that the implementation of asthma CPGs remains suboptimal in primary care. Interventions addressing the identified barriers and providing facilitators to asthma CPG implementation, such as continuing education, could be implemented and evaluated to sustain asthma CPG use in primary care settings.

### ARTICLE HISTORY

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### KEYWORDS

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Knowledge-to-Action Cycle;  
practice guidelines;  
Translational medical  
research

## Introduction

Clinical practice guidelines (CPGs) for the prevention and management of asthma have been developed to update current knowledge of caregivers and to optimize care [1–3]. Perfectly guideline-concordant management of acute asthma was found to be associated with shorter hospital lengths of stay in patients hospitalized for asthma [4]. In adolescents and adults with asthma, achieving guideline-based asthma symptom control could result in a reduction of costs associated with resource use [5].

Although CPGs are widely available, asthma remains insufficiently controlled, and its care is often suboptimal [6–10]. Implementation of asthma CPGs also is suboptimal, particularly in primary care settings, suggesting the need to develop new strategies [11–14] and to identify the potential barriers and facilitators of the implementation of CPG recommendations [15].

The Canadian Institutes of Health Research (CIHR) has adopted the Knowledge-to-Action Cycle to promote knowledge translation in health care [16]. The framework distinguishes between two cycles: (1) knowledge creation and (2) action [16]. As part of the knowledge creation process, CPGs have been widely used as knowledge synthesis tools [17]. When trying to move from evidence to practice, several phases are required, including the identification of knowledge-to-action gaps and assessment of the barriers and facilitators to knowledge use [16].

Based on the Knowledge-to-Action Cycle and as a first step toward selecting and implementing interventions to sustain asthma CPGs use in primary care [16], we aimed to assess health care needs, as well as the determinants of knowledge translation within: the individual level, the health-care team level, and the organization and system levels.

## Methods

### Design, setting, and participants

We used a cross-sectional study design. The study population consisted of primary care physicians (PCPs) attending an organizational meeting, followed by an optional continuing medical education event on asthma CPGs. Participants were requested to fill in a questionnaire before attending the optional lecture.

All participants were family physicians from the province of Quebec, Canada, and were treating patients with asthma. In Quebec, Canada, most family physicians deliver care in medical clinics, family medicine groups, or local community service centers. They can also practice in hospitals, including emergency departments. Hospital and medical services are dispensed free of charge for all Quebecers, as part of the public Quebec health and social services system.

### Variables, data sources, and measurement

Using questionnaires, we assessed the sociodemographic and professional characteristics of PCPs, physicians' self-reported implementation and perception of the key asthma CPG recommendations, and the barriers and facilitators to CPG use in primary care.

### Assessment of health care needs

In regards to physicians' implementation and perception of asthma CPG recommendations, participants filled in an extended version of a previously validated questionnaire: the *Asthma Physicians' Practice Assessment Questionnaire*<sup>®</sup> (Asthma-PPAQ, see Appendix). The original PPAQ<sup>®</sup> included 14 items about the main recommendations of the Canadian CPG on asthma [18]. Items pertained to two domains: (1) diagnosis and assessment (items 1, 4, 5, 9–11), and (2) treatment and follow-up (items 2, 3, 6–8, 12–14) [18]. The questionnaire was shown to have good test-retest reliability and internal consistency [18]. In addition to these 14 original PPAQ items, participants were asked for what percent of their asthma patients they explained the benefits and risks of treatment.

### Barriers at the individual health care professional level

Using the extended Asthma-PPAQ<sup>®</sup>, PCPs reported, for each key action, their knowledge of the recommendation, its perceived usefulness, their motivation to apply the recommendation, and their agreement with its content.

### Barriers at the health-care team, organization, and system levels

Using the extended Asthma-PPAQ<sup>®</sup>, PCPs reported the barriers and facilitators to CPG use at the patient, provider, and institutional level.

### Study size

The 46 PCPs attending the continuing medical education activity were invited to fill in the extended Asthma-PPAQ<sup>®</sup>.

### Statistical methods

Simple descriptive statistical analyses were conducted using the SAS 9.3 Software (SAS Institute Inc., Cary, NC, USA). Participant characteristics were described using means and standard deviations, or frequency distributions. Frequency distributions were also used to describe PCPs' implementation of the key asthma CPG recommendations, as well as physicians' knowledge, perceived usefulness, motivation, and agreement with these recommendations.

## Results

### Participants

Out of the 46 PCPs attending the continuing medical education event on asthma, 43 filled in the extended Asthma-PPAQ<sup>®</sup>. Their sociodemographic and professional characteristics are presented in Table 1. PCPs were aged (mean  $\pm$  standard deviation)  $50 \pm 12$  years and

**Table 1.** Sociodemographic and professional characteristics of PCPs ( $N = 46$ ).

|                                                    |             |
|----------------------------------------------------|-------------|
| Age, years ( $n = 44$ )                            | $50 \pm 12$ |
| Gender                                             |             |
| Women                                              | 21 (46%)    |
| Men                                                | 25 (54%)    |
| Years in practice ( $n = 38$ )                     | $23 \pm 13$ |
| Practice type <sup>a</sup>                         |             |
| Medical clinic                                     |             |
| Solo                                               | 13 (28%)    |
| Group                                              | 12 (26%)    |
| Family medicine group                              | 11 (24%)    |
| Local community service center                     | 17 (37%)    |
| Hospital                                           | 6 (13%)     |
| Emergency department                               | 9 (20%)     |
| Other                                              | 13 (28%)    |
| Hours/week of professional activities ( $n = 44$ ) | $40 \pm 12$ |

*Note.* We present the sociodemographic and professional characteristics of the PCPs who participated in the continuing medical education event on asthma. Data are presented either as mean  $\pm$  standard deviation or  $n$  (%). Unless otherwise stated, herein  $n = 46$ .

PCP = Primary care physicians.

<sup>a</sup>Participants could select more than one answer.

**Table 2.** Percentage of patients in whom PCP reported CPG implementation ( $N = 43$ ).

| Extended asthma-PPAQ <sup>®</sup> items                                          | % of asthma patients |          |         |          |
|----------------------------------------------------------------------------------|----------------------|----------|---------|----------|
|                                                                                  | ≤25%                 | 26–50%   | 51–75%  | >75%     |
| 1. Confirm diagnosis by pulmonary function tests ( $n = 40$ )                    | 10 (23%)             | 14 (33%) | —       | 16 (37%) |
| 2. Provide written referral for asthma education                                 | 28 (65%)             | 6 (14%)  | 5 (12%) | 4 (9%)   |
| 3. Provide written action plan for exacerbation management                       | 24 (56%)             | 11 (26%) | 4 (9%)  | 4 (9%)   |
| 4. Assess inhaler technique (or refer to asthma educator) at each visit          | 26 (60%)             | 7 (16%)  | 1 (2%)  | 9 (21%)  |
| 5. Identify environmental triggers/inducers                                      | 9 (21%)              | 4 (9%)   | 7 (16%) | 23 (53%) |
| 6. Provide smoking cessation counseling or recommend cessation measures          | 2 (5%)               | 1 (2%)   | —       | 40 (93%) |
| 7. Prescribe an ICS as initial maintenance therapy                               | 6 (14%)              | 4 (9%)   | 1 (2%)  | 32 (74%) |
| 8. Prescribe ICS-LABA when asthma is not controlled by low-dose ICS alone        | 7 (16%)              | 4 (9%)   | 5 (12%) | 27 (63%) |
| 9. Check for treatment adherence at each visit                                   | 11 (26%)             | 7 (16%)  | 2 (5%)  | 23 (53%) |
| 10. Use the CTS control criteria or the GINA guidelines to assess asthma control | 18 (42%)             | 8 (19%)  | 4 (9%)  | 13 (30%) |
| 11. Address patients' concerns about disease/treatment                           | 16 (37%)             | 10 (23%) | 5 (12%) | 12 (28%) |
| 12. Refer to specialist because asthma is difficult to control                   | 28 (65%)             | 4 (9%)   | 2 (5%)  | 9 (21%)  |
| 13. Refer to specialist if diagnosis is uncertain                                | 26 (61%)             | 3 (7%)   | 1 (2%)  | 13 (30%) |
| 14. Schedule regular follow-up appointments                                      | 16 (37%)             | 9 (21%)  | 3 (7%)  | 15 (35%) |
| 15. Explain the benefits and risks of treatment to patients                      | 4 (9%)               | 8 (17%)  | 5 (12%) | 26 (61%) |

Note. For each key action, we present the number (percentage) of PCPs who reported the implementation the recommendation in either ≤25%, 26–50%, 51–75%, or >75% of their asthma patients.

Data are presented as  $n$  (%) unless otherwise stated, herein  $n = 43$ .

Original PPAQ<sup>®</sup> items were derived from Boulet et al. [18].

CPG = Clinical practice guidelines; CTS = Canadian Thoracic Society; GINA = Global Initiative for Asthma; ICS = Inhaled corticosteroids; LABA = Long-acting  $\beta_2$ -agonists; PCP = Primary care physicians; PPAQ = Physicians' Practice Assessment Questionnaire<sup>®</sup>.

had practiced family medicine for  $23 \pm 13$  years. About 40% of the participants were working in local community service centers.

### Health care needs: PCPs' implementation of the key asthma CPG recommendations in primary care

As reported in Table 2, a significant proportion of PCPs did not fully implement many key asthma CPG recommendations into their care. In fact, about 60% of the participants indicated that they neither provided a written referral for asthma education (65%) nor a written action plan for exacerbation management (56%) in at least three out of four asthma patients. About 60% of the PCPs reported that they referred between zero and one out of

four asthma patients to a specialist, if asthma remained uncontrolled (65%) or if asthma diagnosis was uncertain (61%). About 60% of the participating PCPs assessed asthma control (61%) and patient concerns about the disease and treatment (60%) in half or less of asthma patients, and 58% of physicians reported scheduling regular follow-up appointments in the same proportion of patients.

### Barriers within the individual level: PCPs' perception of the key asthma CPG recommendations

Table 3 presents the PCPs' perception of the 15 key asthma CPG recommendations. Although many recommendations were known by more than 80% of the participating PCPs, these key actions were considered of

**Table 3.** PCPs' perception of asthma CPG recommendations ( $N = 43$ ).

| Extended asthma-PPAQ <sup>®</sup> items              | Knowledge | Usefulness | Motivation | Agreement |
|------------------------------------------------------|-----------|------------|------------|-----------|
| 1. Confirm diagnosis                                 | 40 (93%)  | 29 (67%)   | 40 (93%)   | 39 (91%)  |
| 2. Refer to asthma educator                          | 40 (93%)  | 40 (93%)   | 41 (96%)   | 42 (95%)  |
| 3. Provide written action plan                       | 40 (93%)  | 38 (88%)   | 40 (93%)   | 39 (91%)  |
| 4. Assess device technique                           | 34 (79%)  | 35 (81%)   | 33 (77%)   | 36 (83%)  |
| 5. Identify environmental triggers/inducers          | 38 (88%)  | 36 (84%)   | 38 (88%)   | 41 (95%)  |
| 6. Provide smoking cessation counseling              | 42 (98%)  | 42 (98%)   | 42 (98%)   | 43 (100%) |
| 7. ICS as initial maintenance therapy                | 37 (86%)  | 36 (84%)   | 35 (81%)   | 35 (82%)  |
| 8. Combined ICS-LABA if uncontrolled asthma with ICS | 39 (91%)  | 35 (82%)   | 40 (93%)   | 39 (91%)  |
| 9. Assess treatment adherence                        | 33 (77%)  | 37 (86%)   | 37 (86%)   | 39 (91%)  |
| 10. Assess control                                   | 27 (63%)  | 25 (58%)   | 28 (65%)   | 30 (70%)  |
| 11. Address patients' concerns                       | 22 (51%)  | 24 (55%)   | 28 (65%)   | 30 (70%)  |
| 12. Referral to specialist (uncontrolled asthma)     | 31 (72%)  | 30 (70%)   | 35 (82%)   | 37 (86%)  |
| 13. Referral to specialist (asthma diagnosis)        | 23 (53%)  | 24 (56%)   | 28 (65%)   | 27 (63%)  |
| 14. Schedule regular follow-up appointments          | 28 (65%)  | 29 (67%)   | 31 (72%)   | 33 (77%)  |
| 15. Explain benefits/risks of treatment              | 28 (65%)  | 33 (77%)   | 34 (79%)   | 36 (84%)  |

Note. For each key action, we present the number (percentage) of PCPs who reported knowledge of the recommendation, who found it very useful, who were motivated to implement it, and who agreed with it.

Data are presented as  $n$  (%). For some items, there were missing data.

Original PPAQ<sup>®</sup> items were derived from Boulet et al. [18].

CPG = Clinical practice guidelines; ICS = Inhaled corticosteroids; LABA = Long-acting  $\beta_2$ -agonists; PCP = Primary care physicians; PPAQ = Physicians' Practice Assessment Questionnaire<sup>®</sup>.

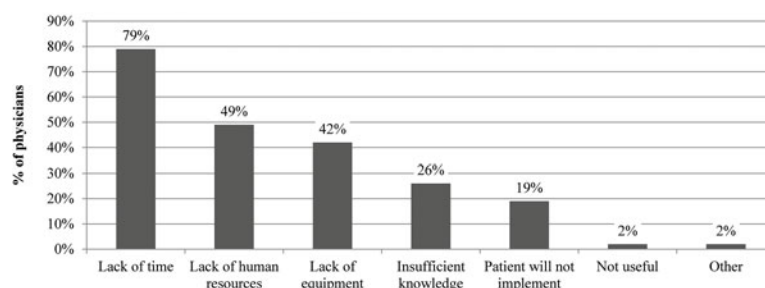


**Figure 1.** Barriers to the implementation of key asthma CPG recommendations ( $N = 43$ ). We present the percentage of PCPs who identified each of these elements as a barrier to the implementation of key asthma CPG recommendations. CPG = Clinical practice guidelines; PCP = Primary care physicians.

variable usefulness. About 50% of the participating physicians reported that they did not know or remember that they should address patients' concerns about asthma and treatment (47%). About 35% of physicians indicated that they did not know or remember that they should use the Canadian Thoracic Society (CTS) or the Global Initiative for Asthma (GINA) criteria to assess asthma control (35%). A similar percentage of participants did not know the recommendation to explain the benefits and risks of treatment (33%). Less than 60% of the participating PCPs found the assessment of patients' concerns (55%) and asthma control using the CTS or GINA criteria (58%) very useful. Similarly, 56% of the participants considered that referring patients to a specialist, when their asthma diagnosis was uncertain, was very useful. Only 65% of physicians were motivated to implement these last three recommendations, and 70% or less agreed with them.

#### **Barriers and facilitators to the implementation of key asthma CPG recommendations within the health-care team, organization, and system levels**

As shown in Figure 1, the most frequent obstacles when PCPs implement the key asthma CPG recommendations were the lack of time (79%) and resources, either human (49%) or material (42%). To help PCPs implement these recommendations, the assistance of other health-care professionals was in high demand (77%), followed

by facilitated referrals to specialists and asthma educators (63%). About half of the physicians (47%) suggested easier access to respiratory physiology test equipment (Figure 2).

## **Discussion**

### **Main findings**

In this study, we assessed PCPs' self-reported implementation of 15 key CPG recommendations for the prevention and management of asthma, as well as the PCPs' perception of these recommendations. Our analysis highlighted health care needs, provided some insights into the barriers and facilitators to the implementation of these key asthma CPG recommendations. It suggested that the implementation of these key recommendations could be improved by providing PCPs with increased access to human (e.g. asthma educators) and material resources. Our results helped us to make five observations.

### **Regarding health care needs**

First, in this study, we observed persistence of the same care deficiencies that were previously reported. These care gaps were mostly related to the low referral to asthma educators [18–21] and specialists, if asthma remained uncontrolled [18]. Other care gaps included the low

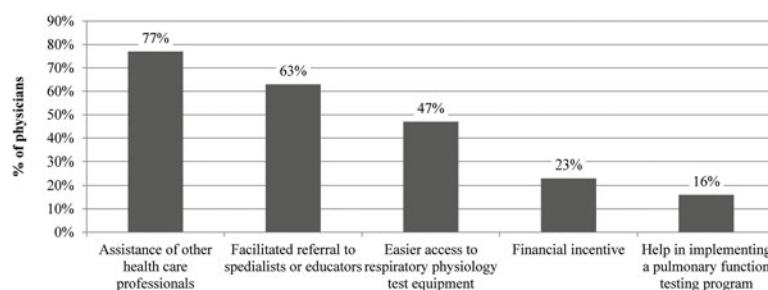


**Figure 2.** Facilitators of the implementation of key asthma CPG recommendations ( $N = 43$ ). We present the percentage of PCPs who identified each of these elements as a facilitator of the implementation of key asthma CPG recommendations. CPG = Clinical practice guidelines; PCP = Primary care physicians.

frequency of asthma action plan deliveries [18,20,22] and inhaler technique assessments [18,19]. Moreover, very few PCPs reported scheduling regular follow-up appointments, underlining an important discontinuity of care, as previously reported [18].

Second, our results indicated that the majority of PCPs knew the key asthma CPG recommendations, which contrasted with previous studies suggesting that physicians' level of asthma CPG knowledge was suboptimal [8,23,24]. We believe that this discrepancy could be explained by the instruments used to measure PCPs' knowledge of the CPG recommendations. In the present study, PCPs self-reported their understanding of the recommendations, whereas studies by Doerschug et al. [8], Pinnock et al. [23], and Lagerlov et al. [24] questioned health care professionals and calculated knowledge scores. Although it was encouraging that the majority of PCPs reported knowing the key asthma CPG recommendations, knowledge-to-action gaps could have been greater.

#### **Regarding barriers to CPG implementation within the individual and health care professional level**

Third, our data suggested that physicians found that the usefulness of the 15 key asthma recommendations was quite variable, with a lower percentage of physicians who considered the recommendations to assess asthma control and to address patients' concerns about the disease and

its treatment as very useful. These two recommendations were also less known or remembered than the others. Similarly, previous studies have shown that lack of knowledge could predict CPG adherence [25,26] and act as a barrier to CPG implementation, along with relevance to primary care and doubt about the evidence supporting the recommendations [20]. We also observed that a lower percentage of PCPs considered the recommendation to refer to a specialist, if the diagnosis was uncertain, as very useful. This observation is important to note, since it has been shown that about one-third of patients who have been diagnosed with asthma by a physician do not have evidence of asthma [27].

#### **Regarding the selection and implementation of interventions to enhance asthma CPG use in primary care**

Fourth, even though the barriers to CPG implementation could differ according to the type of practice, most PCPs seemed to be facing the same difficulties, regardless of the type of clinical setting. In accordance with the findings of Wiener-Ogilvie et al. [20], who assessed CPG implementation in 15 practices in the National Health Service Borders region in Scotland, PCPs reported that teamwork could help overcome the main identified barriers to asthma CPG implementation, specifically the lack of time and resources. Accordingly, results from two Cochrane

systematic reviews indicated that interprofessional collaboration could improve health-care processes—including adherence to CPG—and patient outcomes [28,29]. Based on the CIHR knowledge translation framework, Licskai et al. [30] developed a multi-level regional guideline-based interdisciplinary asthma program. As part of their program development, they identified professional training and creation of an asthma management program as solutions to improve the implementation of CPGs [30]. They trained health care professionals as asthma educators and placed them as guideline content experts of the interdisciplinary team [30]. Results from their pre/post comparisons indicated that their multi-level regional guideline-based interdisciplinary asthma program could facilitate the implementation of CPGs and improve health outcomes in community primary care practices [30].

Our study suggests that asthma education is still not integrated into care for many PCPs. In our practice, the Quebec Asthma and chronic obstructive pulmonary disease (COPD) Network (QACN) has trained more than 20,000 asthma and COPD educators, mainly nurses and respiratory therapists, to assist physicians in providing respiratory care in accordance with the Canadian CPGs [31]. Self-management interventions delivered by QACN trained asthma educators have been shown to enhance the provision of written action plans, improve medication adherence, and decrease the number of unscheduled visits for respiratory problems in patients with asthma followed in family practice clinics [32]. Unfortunately, these services are still underused [21].

At this point, it must be recognized that providing PCPs with the assistance of trained educators may require considerable funding and resources. In a realist review on CPG use, Kastner et al. (2015) suggested that solutions that require a significant investment of time and resources should be limited to foster guideline implementability, unless data were available regarding resource requirement and cost-effectiveness [33]. Yong and Shafie (2014) underwent a systematic review of economic evaluations of asthma education and self-management programs [34]. Based on a narrative analysis of 49 studies comparing such programs to usual care, their results suggested that asthma education and self-management programs, delivered by an integrated team of medical and allied health professionals, were effective and cost-reducing [34].

Fifth, our results showed that more than half of the PCPs did not address patients' concerns about disease and treatment, although asthma patients have previously expressed their willingness for greater involvement in decision making and improved access to information about asthma [19]. In this context, interventions or tools to facilitate discussion between health care providers and patients might be helpful to foster the implementation of

this key recommendation [11]. For instance, decision aids have been shown to have a positive impact on patient-practitioner communication [35], because they provide evidence-based information about the disease and its treatment options, guide and support patients in making value-based decisions [35–37], and could be used to implement shared decision making into care [35,38]. To facilitate discussions between PCPs and patients about the use of asthma maintenance medication, clinicians and patients could use a decision aid. Our team recently developed one for inhaled corticosteroids use, alone or in combination with long-acting  $\beta_2$ -agonists. This decision aid explains the positive and negative features of inhaled controller treatments, and guides patients to compare and weigh these benefits and risks [39]. However, to foster decision aid use in clinical setting and to overcome the barrier related to the perceived lack of time for shared decision making [40], health-care professional training might be useful [41].

### **Strengths and limitations of this study**

Our study carries important messages, due to the fact that we measured several aspects of CPG implementation, specifically PCPs' self-reported implementation of 15 key asthma CPG recommendations, physicians' perception of these recommendations, along with the barriers and facilitators to the implementation of these recommendations. Nevertheless, the present study has some limitations. First, we recruited a limited sample of physicians, although they were representative of the whole PCP population and reported quite uniform gaps in the implementation of CPGs on asthma. Second, the questionnaire was based on the Canadian asthma CPGs, and although national and international asthma guidelines may slightly differ regarding recommendations [42], those assessed by the extended Asthma-PPAQ<sup>®</sup> were common. Third, since our study participants were aware that they were questioned about key asthma CPG recommendations, the self-reported percent of implementation could have been overestimated, due to a socially desirable response bias. Fourth, our study assessed PCPs' perceptions of only some barriers and facilitators to the implementation of key asthma CPG recommendations, but nevertheless provides insight into what could facilitate the use of CPGs in primary care.

### **Generalizability**

Despite the fact that the study was conducted in Quebec, Canada, we are confident that our results, which identified current care gaps and stressed teamwork as an important

means to foster CPG adoption by PCPs, could be generalized, in the same way that it was reported in Scotland [20], and elsewhere [18,19,21]. While some barriers and facilitators to the implementation of key asthma CPG recommendations have been identified in this present study, researchers and health organizations, based on the Knowledge-to-Action Cycle [16], could work together in the future to develop and evaluate knowledge translation interventions that include continuing professional development.

## Conclusions

PCPs' implementation of key asthma CPG recommendations remains suboptimal in primary care, although many recommendations are now well known. Barriers to the implementation of these recommendations should be addressed. Not only should efforts be made to make these recommendations known to PCPs, but resources that facilitate their implementation—especially assistance of trained allied health professionals—should be provided.

## Contributions

L.P.B. designed the study. M.E.G. and L.P.B. were involved in data analysis and interpretation. M.E.G. drafted the manuscript, and L.P.B. revised it for important intellectual content. M.E.G. and L.P.B. approved the final version before submission.

## References

- Adkinson NFJ, Yunginger JW, Busse WW, Bochner BS, Holgate ST, Simons FER. Middleton's allergy: principles and practice. 6th ed. St. Louis: Mosby; c2003. Boulet LP. Chapter 70, Asthma guidelines and outcomes; p. 1283–1301.
- Bousquet J, Bieber T, Fokkens W, Humbert M, Kowalski ML, Niggemann B, et al. Consensus statements, evidence-based medicine and guidelines in allergic diseases. *Allergy* 2008;63:1–4.
- Bousquet J, Clark TJH, Hurd S, Khaltaev N, Lenfant C, O'Byrne P, et al. GINA guidelines on asthma and beyond. *Allergy* 2007;62:102–112.
- Hasegawa K, Brenner BE, Nowak RM, Trent SA, Herrera V, Gabriel S, et al. Association of guideline-concordant acute Asthma care in the emergency department with shorter hospital length of stay: a multicenter observational study. *Acad Emerg Med* 2016;23:616–622.
- Sadatsafavi M, Chen W, Tavakoli H, Rolf JD, Rousseau R, FitzGerald JM. Saving in medical costs by achieving guideline-based asthma symptom control: a population-based study. *Allergy* 2016;71:371–377.
- Chapman KR, Boulet LP, Rea RM, Franssen E. Sub-optimal asthma control: prevalence, detection and consequences in general practice. *Eur Respir J* 2008; 31:320–325.
- FitzGerald JM, Boulet LP, McIvor RA, Zimmerman S, Chapman KR. Asthma control in Canada remains suboptimal: the reality of asthma control (TRAC) study. *Can Respir J* 2006;13:253–259.
- Doerschug KC, Peterson MW, Dayton CS, Kline JN. Asthma guidelines: an assessment of physician understanding and practice. *Am J Respir Crit Care Med* 1999;159:1735–1741.
- Carlton BG, Lucas DO, Ellis EF, Conboy-Ellis K, Shoheiber O, Stempel DA. The status of asthma control and asthma prescribing practices in the United States: results of a large prospective asthma control survey of primary care practices. *J Asthma* 2005;42:529–535.
- Légorreta AP, Christian-Herman J, O'Connor RD, Hasan MM, Evans R, Leung K. Compliance with national asthma management guidelines and specialty care: a health maintenance organization experience. *Arch Intern Med* 1998;158:457–464.
- Boulet LP, Becker A, Bowie D, Hernandez P, McIvor A, Rouleau M, et al. Implementing practice guidelines: a workshop on guidelines dissemination and implementation with a focus on asthma and COPD. *Can Respir J* 2006;13(Suppl A):5–47.
- Cabana MD, Rand CS, Powe NR, Wu AW, Wilson MH, Abboud PA, et al. Why don't physicians follow clinical practice guidelines? A framework for improvement. *JAMA* 1999;282:1458–1465.
- Gagliardi AR, Brouwers MC, Palda VA, Lemieux-Charles L, Grimshaw JM. How can we improve guideline use? A conceptual framework of implementability. *Implement Sci* 2011;6:26.
- Yawn BP, Rank MA, Cabana MD, Wollan PC, Juhn YJ. Adherence to asthma guidelines in children, tweens, and adults in primary care settings: a practice-based network assessment. *Mayo Clin Proc* 2016;91:411–421.
- Gagliardi A, Alhabib S, and the members of the guidelines international network implementation working group. Trends in guideline implementation: a scoping systematic review. *Implement Sci* 2015;10:54.
- Graham ID, Logan J, Harrison MB, Straus SE, Tetroe J, Caswell W, et al. Lost in knowledge translation: time for a map? *J Contin Educ Health Prof* 2006;26:13–24.
- Brouwers M, Stacey D, O'Connor A. Knowledge creation: synthesis, tools and product. *Can Med Assoc J* 2010;182:E68–E72.
- Boulet LP, Devlin H, O'Donnell DE. The physicians' practice assessment questionnaire on asthma and COPD. *Respir Med* 2011;105:8–14.
- Boulet LP, Thivierge RL, Bellera C, Dorval E, Collet JP. Physicians' assessment of asthma control in low vs. high asthma-related morbidity regions. *J Asthma* 2004;41:813–824.
- Wiener-Ogilvie S, Pinnock H, Huby G, Sheikh A, Partridge MR, Gillies J. Do practices comply with key recommendations of the British Asthma Guideline? If not, why not? *Prim Care Respir J* 2007;16:369–377.
- Robichaud P, Laberge A, Allen MF, Boutin H, Rossi C, Lajoie P, et al. Evaluation of a program aimed at increasing referrals for asthma education of patients consulting at the emergency department for acute asthma. *Chest* 2004;126:1495–1501.

22. Wisnivesky JP, Lorenzo J, Lyn-Cook R, Newman T, Aponte A, Kiefer E, et al. Barriers to adherence to asthma management guidelines among inner-city primary care providers. *Ann Allergy Asthma Immunol* 2008;101:264–270.
23. Pinnock H, Holmes S, Levy ML, McArthur R, Small I. Knowledge of asthma guidelines: results of a UK general practice airways group (GPIAG) web-based ‘Test your Knowledge’ quiz. *Prim Care Respir J* 2010;19:180–184.
24. Lagerlov P, Veninga CC, Muskova M, Hummers-Pradier E, Stalsby Lundborg C, Andrew M, et al. Asthma management in five European countries: doctors’ knowledge, attitudes and prescribing behaviour. *Eur Respir J* 2000;15:25–29.
25. Almutawa FN, Al-Mutairy G, Al-Arada N, Kamel MI. Perception of primary care physicians about guidelines of bronchial asthma. *Alexandria Med J*. 2014;50:17–24.
26. Lugtenberg M, Zegers-van Schaick JM, Westert GP, Burgers JS. Why don’t physicians adhere to guideline recommendations in practice? An analysis of barriers among Dutch general practitioners. *Implement Sci* 2009;4:54.
27. Aaron SD, Vandemheen KL, Boulet LP, McIvor RA, Fitzgerald JM, Hernandez P, et al. Overdiagnosis of asthma in obese and nonobese adults. *CMAJ* 2008;179:1121–1131.
28. Zwarenstein M, Goldman J, Reeves S. Interprofessional collaboration: effects of practice-based interventions on professional practice and healthcare outcomes. *Cochrane Database Syst Rev* 2009;CD000072.
29. Reeves S, Perrier L, Goldman J, Freeth D, Zwarenstein M. Interprofessional education: effects on professional practice and healthcare outcomes (update). *Cochrane Database Syst Rev* 2013;CD002213.
30. Licskai C, Sands T, Ong M, Paolatto L, Nicoletti I. Using a knowledge translation framework to implement asthma clinical practice guidelines in primary care. *Int J Qual Health Care* 2012;24:538–546.
31. Boulet LP, Côté P, Bourbeau J. [The Quebec Asthma and COPD Network (QACN): a model of integration of the therapeutic education into care]. *Ther Patient Educ* 2014;6:10301.
32. Boulet LP, Boulay ME, Gauthier G, Battisti L, Chabot V, Beauchesne MF, et al. Benefits of an asthma education program provided at primary care sites on asthma outcomes. *Respir Med* 2015;109:991–1000.
33. Kastner M, Bhattacharyya O, Hayden L, Makarski J, Estey E, Durocher L, et al. Guideline uptake is influenced by six implementability domains for creating and communicating guidelines: a realist review. *J Clin Epidemiol* 2015;68:498–509.
34. Yong YV, Shafie AA. Economic evaluation of enhanced asthma management: a systematic review. *Pharm Pract (Granada)* 2014;12:493.
35. Stacey D, Legare F, Col NF, Bennett CL, Barry MJ, Eden KB, et al. Decision aids for people facing health treatment or screening decisions. *Cochrane Database Syst Rev* 2014;CD001431.
36. Elwyn G, O’Connor A, Stacey D, Volk R, Edwards A, Coulter A, et al. Developing a quality criteria framework for patient decision aids: online international Delphi consensus process. *Br Med J* 2006;333:417.
37. Joseph-Williams N, Newcombe R, Politi M, Durand MA, Sivell S, Stacey D, et al. Toward minimum standards for certifying patient decision aids: a modified Delphi consensus process. *Med Decis Making* 2013;34:699–710.
38. Legare F, Stacey D, Turcotte S, Cossi MJ, Kryworuchko J, Graham ID, et al. Interventions for improving the adoption of shared decision making by healthcare professionals. *Cochrane Database Syst Rev* 2014;CD006732.
39. Gagne ME, Legare F, Moisan J, Boulet LP. Development of a patient decision aid on inhaled corticosteroids use for adults with asthma. *J Asthma* 2016;53:964–974.
40. Legare F, Ratte S, Gravel K, Graham ID. Barriers and facilitators to implementing shared decision-making in clinical practice: update of a systematic review of health professionals’ perceptions. *Patient Educ Couns* 2008;73:526–535.
41. Legare F, Ratte S, Stacey D, Kryworuchko J, Gravel K, Graham ID, et al. Interventions for improving the adoption of shared decision making by healthcare professionals. *Cochrane Database Syst Rev* 2010;CD006732.
42. Gupta S, Paolucci E, Kaplan A, Boulet LP. Contemporaneous international asthma guidelines present differing recommendations: an analysis. *Can Respir J* 2016.

## SUPPORTING ONLINE INFORMATION

### Appendix: Extended Asthma-PPAQ©

As supporting online information, we present the items that were added to original PPAQ© (please refer to Boulet *et al.* (2011) for details on the original PPAQ©).

First, in addition to the 14 items of original PPAQ©, participants were asked a fifteenth question:

For what percent of your asthma patients do you currently explain the benefits and risks of treatment?

Second, for each of the 15 items of the extended Asthma-PPAQ©, participants were asked:

- Do you know this recommendation? Yes \_\_\_  
No \_\_\_
- Do you believe that the application of this recommendation in primary care would improve asthma patient outcomes? Very much \_\_\_  
Slightly \_\_\_  
No \_\_\_  
Uncertain \_\_\_
- Would you be ready to apply this recommendation more frequently with your patients? Yes \_\_\_  
No \_\_\_  
Uncertain \_\_\_
- Do you agree with this recommendation? Yes \_\_\_  
No \_\_\_

Finally, participants were asked two additional questions:

- In regards to these recommendations, what are the main barriers to their application?
  - Lack of time \_\_\_\_\_
  - Lack of human resources \_\_\_\_\_
  - Insufficient knowledge on how to apply the recommendations \_\_\_\_\_
  - Lack of equipment \_\_\_\_\_
  - the recommendation is not useful \_\_\_\_\_
  - the patient will not implement the recommendation \_\_\_\_\_
  - Other \_\_\_\_\_
- Which of the following would be the most useful for you?
  - Assistance of other health professionals (nurse(s), respiratory therapist(s), etc.) \_\_\_\_\_
  - Financial incentive(s) \_\_\_\_\_
  - Facilitated referral to specialist(s), educators \_\_\_\_\_
  - Easier access to respiratory physiology testing equipment \_\_\_\_\_
  - Help in the implementation of a pulmonary function testing program (spirometry) at the clinic \_\_\_\_\_”