

Compliance with the Canadian Association of Emergency Physicians' asthma clinical practice guidelines at a tertiary care emergency department

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ABSTRACT

Introduction: Although evidence-based clinical practice guidelines (CPGs) exist, emergency department (ED) asthma management remains highly variable. Our objective was to compare asthma management at a tertiary care ED with that advised by the Canadian Association of Emergency Physicians' (CAEP) asthma CPG and current best practice.

Methods: This medical record study enrolled patients between the ages of 19 and 60 years with a previous diagnosis of asthma who were seen for an acute asthma exacerbation at the Vancouver General Hospital ED in 2008. Standard methodology guidelines for medical record review were followed, including explicitly defined criteria and determination of interrater reliability. Primary outcomes were the proportion of cases with the following: objective assessment of severity using peak expiratory flow (PEF), use of systemic corticosteroids (SCSs) in the ED and at discharge, prescription for any inhaled corticosteroids (ICSs), and documentation of outpatient follow-up.

Results: A total of 204 patient encounters were enrolled. Kappa values for interrater assessment ranged from 0.93 to 1.00. Compliance with primary outcomes was as follows: measurement of PEF, 90% (95% CI 85–94); use of SCSs in the ED, 64% (95% CI 57–71); prescription of SCSs at discharge, 59% (95% CI 51–67); prescription of any ICS at discharge, 51% (95% CI 41–61); and documentation of outpatient follow-up, 78% (95% CI 71–84).

Conclusions: This study indicates an improvement in ED asthma care compared to previously published studies; however, discordance still exists between asthma management at a tertiary care ED and the CAEP asthma CPG and current best practice. Further research is warranted to understand the reasons for this finding.

RÉSUMÉ

Introduction: Certes, il existe des recommandations pour la pratique clinique (RPC) fondées sur des données probantes, mais la prise en charge de l'asthme aux services des urgences varie énormément. La présente étude visait à comparer la prise en charge de l'asthme dans un service d'urgence de soins tertiaires avec les RPC de l'Association canadienne des médecins d'urgence (ACMU) sur l'asthme et les pratiques exemplaires actuelles.

Méthodes: L'étude consistait en un examen de dossiers médicaux de patients âgés de 19 à 60 ans, chez qui un diagnostic d'asthme avait déjà été posé et qui ont été traités au service d'urgence du Vancouver General Hospital, en 2008, pour une exacerbation d'asthme. Nous avons respecté les lignes directrices courantes, relatives à l'examen des dossiers médicaux, notamment la définition explicite des critères et la détermination de la fidélité interjuges. Les principaux critères d'évaluation étaient la proportion de cas respectant les points suivants: l'évaluation objective du degré de gravité à l'aide du débit expiratoire maximal (DEM), le recours à des corticostéroïdes généraux (CSG) à l'urgence et au moment du congé, la prescription de tout corticostéroïde en inhalation (CSI), et la documentation du suivi des patients externes.

Résultats: Au total, 204 rencontres de patients ont été retenues. Les valeurs Kappa concernant l'évaluation interjuges variaient de 0.93 à 1.00. La conformité aux principaux critères d'évaluation s'est établie comme suit: la mesure du DEM: 90% (IC à 95% 85–94); l'utilisation de CSG à l'urgence: 64% (IC à 95% 57–71); la prescription de CSG au moment du congé: 59% (IC à 95% 51–67); la prescription de tout CSI au moment du congé: 51% (IC à 95% 41–61); et la documentation du suivi des patients externes: 78% (IC à 95% 71–84).

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Conclusions: L'étude révèle une amélioration de la prise en charge de l'asthme aux services des urgences comparative-ment aux études antérieures publiées, mais il existe encore des écarts entre la prise en charge de l'asthme dans un service d'urgence de soins tertiaires et les RPC de l'ACMU sur l'asthme et les pratiques exemplaires actuelles. Il faudrait

approfondir la recherche pour comprendre les raisons de ces écarts.

Keywords: asthma, corticosteroids, emergency department, guidelines

Asthma is a chronic illness that affects 2.35 million Canadians.¹ Despite recent advances, many asthmatics experience inadequate disease control and preventable disability.²⁻⁵ Asthma is a common emergency department (ED) presentation and often a marker of failed long-term management.⁶

As with most chronic illnesses, clinical practice guidelines (CPGs), which translate evidence-based medicine into best practice, are advocated. National and international asthma CPGs have been available for over a decade,⁷⁻⁹ including the Canadian ED asthma CPG endorsed by the Canadian Association of Emergency Physicians (CAEP).¹⁰ Although published in 1996 and updated in case format in 2010,^{11,12} the management of acute asthma has not markedly changed since this guideline, and it remains relevant to this day. The most significant changes have been in our understanding of asthma as a chronic disease with intermittent exacerbations, whereby management is now viewed as a continuum, with increasingly aggressive add-on therapy to achieve asthma control. Since the publication of the CAEP asthma guideline, best practice has emphasized the role of inhaled corticosteroid (ICS) as a “controller” medication for most asthmatics to decrease their use of “reliever” medications.

Despite widespread dissemination, numerous studies have found suboptimal compliance with asthma guidelines,^{6,13-20} both in primary care and in the ED, leading to undertreatment and increasing the likelihood of exacerbations. Although some studies have found a decreased hospital admission rate^{13,14,21-23} and a reduced ED relapse rate^{24,25} with the use of guideline-based ED asthma care maps (ACMs) or clinical pathways, others have not.²⁶⁻²⁸ It appears that the impact of a CPG on acute asthma outcome may vary by location.

The objective of this study was to compare asthma management provided at a tertiary care ED to the management recommended by the CAEP asthma CPG and current best practice.

METHODS

Study setting

This medical record study was conducted on patients seen in the ED at Vancouver General Hospital (VGH), an academic medical centre with 75,000 adult ED visits per year staffed by emergency physicians certified by the Royal College of Physicians and Surgeons of Canada.

Inclusion and exclusion criteria

All patients between the ages of 19 and 60 years who presented to the ED in 2008 because of an acute asthma exacerbation were eligible. Patients could be enrolled only once to avoid violating the analytic principle of independence of observations; however, we recorded relapse visits to the VGH ED within 3 and 28 days of the initial encounter. Patients were excluded if they did not have a previous diagnosis of asthma or if they had a different chronic respiratory illness. We also excluded asthmatics seen directly by a specialist, transferred from another institution, or presenting solely for prescription refill. Additionally, patients seen at another ED within 28 days were excluded as their visit was deemed to be a relapse rather than an exacerbation. Finally, patients with cognitive impairment from substance abuse, mental health issues, or dementia were excluded.

Data sources

Using the VGH ED database, a list was compiled of patients discharged directly from the ED in 2008 with the diagnosis of asthma/asthma exacerbation (International Classification of Diseases [ICD 9], code 493.x). Asthma patients admitted in 2008 were identified based on the hospital discharge diagnosis of asthma/asthma exacerbation (ICD 10, code J45.x) and eosinophilic asthma (ICD 10, code J82).

Data collection

Data were collected in accordance with recommendations for medical record reviews in emergency medicine.^{29,30} A single investigator was trained to abstract the data, both from medical charts and electronic records. Abstracted data were entered into a computer-based standardized spreadsheet, created using *Epidata Entry* (version 3.1)³¹ and developed a priori with explicit data element definitions. A random sample of 15% of charts and the associated electronic records were reviewed by a second reviewer to assess accuracy and interrater agreement using kappa (κ) statistics. Disagreements or uncertainties in coding were resolved by consensus of the two reviewers at weekly meetings.

Outcomes

The primary outcomes were the proportion of cases with the following quality indicators (QIs): 1) objective assessment of airway obstruction with at least one documented peak expiratory flow (PEF); 2) use of systemic corticosteroids (SCSs) (e.g., either oral prednisone or intravenous methylprednisolone) in the ED; 3) discharge prescription for SCS (e.g., prednisone or dexamethasone); 4) discharge prescription for any type of ICS; and 5) documentation of outpatient follow-up. Items 1 through 3 arise directly from the CAEP asthma guideline¹⁰; items 4 and 5 represent current best practice as endorsed by more recent publications.^{11,12} Additionally, for secondary purposes, two logistic regression analyses were performed to identify any factors associated with the prescribing of SCSs and ICSs at discharge.

Statistical analysis

Data was analyzed using *Excel Data Analysis* (Microsoft Corporation, 2007). Categorical values were reported as counts and percentages with 95% confidence intervals, whereas continuous variables were reported as either means \pm standard deviations or as medians with interquartile range (IQR), as appropriate. Logistic regression analyses for prednisone prescription and ICS prescription at ED discharge were fit using the following covariates: age, gender, severity of exacerbation, duration of symptoms \leq 72 hours, absolute change in PEF over the ED visit, number of bronchodilators received in the ED, presentation to

the ED on an alternate form of corticosteroid (i.e., any ICS for the SCS regression and prednisone for the ICS regression), and prescription of an alternate form of corticosteroid at ED discharge.

Ethics and data security

This study was approved by our university Research Ethics Board. Two databases, one for medical records and personal health numbers and the other for abstracted data containing no identifying patient information, were kept on separate password-encrypted data keys. The databases remain securely stored, and only aggregate data have been reported.

RESULTS

A total of 255 asthma patients were identified; 51 were excluded for the following reasons: miscoded ($n = 18$), no ED treatment ($n = 12$), chronic obstructive pulmonary disease ($n = 8$), cognitive impairment ($n = 7$), and no previous asthma diagnosis ($n = 6$). In total, 204 patients, with a single encounter per patient, were included in this study.

Interrater agreement on the primary outcomes was excellent, with the following κ values obtained: 1) at least one documented PEF, 0.94 (95% CI); 2) use of SCSs in the ED, 1.00 (95% CI); 3) discharge prescription for prednisone, 1.00 (95% CI); 4) discharge prescription for any type of ICS, 1.00 (95% CI); and 5) documentation of outpatient follow-up, 0.93 (95% CI).

Table 1 provides patient demographic data and asthma factors, including pre-ED treatment. The mean \pm SD age of the patients seen was 36 ± 11 years. Short-acting β -agonists (SABAs) (68%) were the most common medication used prior to the ED visit, followed by ICSs (28%) and a long-acting β -agonist (LABA) and ICS in a single inhaler (24%). Oral corticosteroids (OCSs) (8%), anticholinergics (4%), LABA alone (2%), and leukotriene receptor antagonists (LTRAs) (2%) were rarely used. No patient presented on theophylline. Pharmanet, an electronic registry of prescriptions filled in community pharmacies of British Columbia, had been searched in 78% of cases.

The majority (80%) of patients arrived using personal transport, with 73% presenting within 72 hours of symptom onset. Table 2 characterizes features of the acute asthma episode in study patients at ED

Table 1. Demographic and asthma factors at ED presentation

Characteristic	% of patient visits*
	(All patients, <i>N</i> = 204)
Age, yr, mean \pm SD	36 \pm 11
Age range, yr	19–60
Female	57
Primary care physician identified	67
Respirologist identified	9
Smoker	44
Previous intubation for asthma	8
Medications on ED presentation	
SABA	68
Anticholinergic	4
OCS	8
ICS	28
LABA	2
LABA and ICS	24
LTRA	2

ED = emergency department; OCS = oral corticosteroid; ICS = inhaled corticosteroid; LABA = long-acting β -agonist; LTRA = leukotriene receptor antagonist; SABA = short-acting β -agonist.
*Unless otherwise indicated.

presentation, including the severity of the exacerbation ($\kappa = 0.91$) as defined by the CAEP asthma CPG.¹⁰ The median initial PEF of study patients was 271 (IQR 192–349) L/min, and initial vital signs (mean \pm SD) were as follows: pulse rate 96 \pm 19 beats/min, respiratory rate 22 \pm 5 breaths/min, and oxygen saturation 96 \pm 3%.

Table 3 summarizes acute asthma management in the ED. Emergency physicians and nurses saw all cases, with respiratory therapists (RTs) involved in 96%. At least one PEF was documented in 90% of cases, a measurement done by the RT at our institution. RT asthma assessment sheets were completed in 64% of cases. SABAs (94%) were the most common medication administered, followed by anticholinergics (81%) and SCSs (64%; oral prednisone, 55%; intravenous methylprednisolone, 9%).

The median (IQR) ED length of stay was 172 (111–282) minutes. Table 4 summarizes asthma management at ED discharge. Provision of follow-up instructions was documented in 78% of encounters, with 56% referred to the asthma clinic, 30% to a family doctor, and 4% to a respirologist; some patients had simultaneous referrals. Of the 56% referred to the VGH asthma clinic, 43% attended within 60 days.

Table 2. Asthma features at ED presentation

Presentation	% of patient visits*
	(All patients, <i>N</i> = 204)
Mode of arrival at ED	
Ambulance	20
Personal transport	80
Duration of symptoms (h)	
\leq 24	39
24.1–72	34
\geq 72.1	27
Canadian Triage and Acuity Scale score	
1	0 (1)
2	25 (50)
3	58 (119)
4	17 (34)
Severity of exacerbation	
Near death	0 (1)
Severe	27 (55)
Moderate	33 (67)
Mild	40 (81)
Initial PEF measurement, L/min, mean \pm SD	274 \pm 114
Near death	N/A
Severe	156 \pm 66
Moderate	230 \pm 51
Mild	370 \pm 87

ED = emergency department; N/A = not available; PEF = peak expiratory flow.
*Unless otherwise indicated.

Table 5 lists new prescriptions given at discharge and clinical outcomes. Twenty-seven patients (13%) were admitted to a ward and two (1%) were admitted to the intensive care unit, one of whom was intubated after failing noninvasive pressure ventilation. Of the 175 (86%) discharged patients, 59% received a new prescription for OCS and 51% received a new prescription for any ICS (ICS alone = 38%, LABA/ICS combination agents = 13%).

The logistic regression analyses revealed that exacerbation of moderate severity, any ICS on arrival, and the number of bronchodilator treatments in the ED were significantly associated with patients receiving a discharge prescription for prednisone ($p < 0.05$). No factors were found to be significantly associated with prescriptions for ICS.

DISCUSSION

Our study focused on five ED asthma QIs that were derived from both the original CAEP guideline (published in 1996 and reviewed in 1999 and

Table 3. Asthma management in the ED

ED management	% of patient visits*
	(All patients, <i>N</i> = 204)
Time to emergency physician, min, median (IQR)	35 (17–65)
Preprinted orders used	11
RT involved	96
Time to RT, min, median (IQR)	28 (15–90)
RT flow sheet in chart	64
At least one PEF measurement	90
Respirologist consulted	12
Chest radiography performed	56
Significant findings [†]	15
Arterial blood gas performed	9
Treatment measures in the ED	
SABA	94
Time to SABA, min, median (IQR)	32 (17–74)
No. of SABA treatments first hour, median (IQR)	1 (0–2)
No. of SABA treatments over EDLOS, median (IQR)	2 (1–3)
Anticholinergic	81
Time to anticholinergic, min, median (IQR)	33 (17–74)
No. of anticholinergic treatments first hour, median (IQR)	1 (0–1)
No. of anticholinergic treatments over EDLOS, median (IQR)	1 (1–2)
SCS	64
Time to SCS, min, median (IQR)	71 (27–122)
ICS	3
Magnesium sulphate	4
Antibiotics	8
Sedatives	3

ED = emergency department; EDLOS = emergency department length of stay; ICS = inhaled corticosteroid; IQR = interquartile range; PEF = peak expiratory flow; RT = respiratory therapist; SABA = short-acting β -agonist; SCS = systemic corticosteroid.
*Unless otherwise indicated.
[†]Pneumonia, pneumothorax, pneumomediastinum.

2001)^{10,32,33} and the current best practice as disseminated by the Canadian Thoracic Society with its 2003 asthma consensus guidelines update³⁴ and, most recently, its 2010 asthma management continuum consensus summary.³⁵

The CAEP guideline emphasizes the use of PEF to assess the severity of asthma exacerbations, as well as to guide management both in the ED and at discharge. PEF has been shown to be a more accurate indicator of asthma severity than the history, the clinical examination,¹⁸ or patient self-reporting, yet ED measurement of PEF is highly variable.^{13,16–20,28,36}

A recent Ontario multicentre study that included both academic and community hospitals found that

Table 4. Asthma management at ED discharge

Discharge management	% of patient visits*
	(Discharged patients, <i>n</i> = 175)
Discharged	86
EDLOS, min, median (IQR)	157 (100–211)
Final PEF measurement, L/min, mean \pm SD	332 \pm 116
Near death	N/A
Severe	258 \pm 96
Moderate	330 \pm 90
Mild	414 \pm 102
Change in PEF (absolute), L/min, mean \pm SD	92 \pm 77
Near death	N/A
Severe	132 \pm 66
Moderate	108 \pm 78
Mild	42 \pm 60
Follow-up documented	78
Asthma clinic	56
Referred who attended within 60 days	43
Primary care physician	30
Respirologist	4

ED = emergency department; EDLOS = emergency department length of stay; IQR = interquartile range; PEF = peak expiratory flow.
*Unless otherwise indicated.

documentation of PEF varied from a low of 37% to a high of 57%.²⁸ Ninety percent of our patients had at least one peak flow measured. Our finding is in keeping with the findings of an Alberta study that was also conducted in an academic medical centre with 24-hour access to RT services,³⁶ a resource many smaller centres lack.

The CAEP guideline recommends SCS for all asthma exacerbations, except the mildest, to reduce admissions,³⁷ prevent relapses, and improve outcomes.³⁸ Despite this, SCSs are frequently underused, both during a patient's ED visit and on discharge.^{13,15,16,18,37} Our rate of 64% for SCS administration in the ED is in keeping with the 1997 to 2002 data in the Alberta study, where SCS use ranged from 57% to a high of 75% post-ACM initiation.³⁶ The more recent Ontario study found those same rates to be highly variable, from a low of 34% to a high of 67%, the latter when care plans were used.²⁸ It is arguably correct that not all mild asthma exacerbations require SCSs; in our study, when mild patients were excluded from the data set, SCS administration in the ED increased from 64 to 84%.

The evidence supporting a short course of prednisone on ED discharge for acute asthma is robust.

Table 5. Asthma medication prescriptions at discharge from the ED and clinical outcomes

	% of patient visits (Discharged patients, <i>n</i> = 175)
New prescriptions*	
SABA	71
Anticholinergic	3
OCS	59
Any ICS	51
ICS alone	38
LABA and ICS	13
OCS without any ICS	14
Neither OCS, ICS, or LABA and ICS	15
Antibiotics	9
Clinical outcomes	
Admission	14
Relapse ≤ 3 days	5
Relapse ≤ 28 days	12

ED = emergency department; ICS = inhaled corticosteroid; LABA = long-acting β -agonist; OCS = oral corticosteroid; SABA = short-acting β -agonist.
*Excluding patients who were currently taking or refused the medication.

The CAEP asthma CPG recommends prednisone prescription for “most patients.”¹⁰ This wording is ambiguous when attempting to determine management, particularly for the mild category; however, most asthmatics presenting to the ED for treatment are not controlled on their current regimen and would likely benefit from escalation in therapy. In our study, 59% of discharged patients left the ED with a prescription for prednisone. Again, our finding is in keeping with the Alberta study, where rates ranged from 55 to 69%.³⁶ When mild exacerbations were excluded, our proportion of patients discharged with a prescription for prednisone increased to 70%.

In theory, patients who arrive in the ED on an ICS, who require a number of bronchodilator treatments to show improvement, and who suffer the most severe exacerbations should have a high likelihood of being prescribed prednisone at discharge. Although our regression analysis found that the first two factors were associated with such prescriptions, severe exacerbations were not; only moderate asthma severity was statistically significant. This finding may have arisen from the low number of severe asthma patients discharged in our study (*n* = 35).

Evidence that prescriptions of ICS improve clinical outcomes in acute asthma is less compelling. A Cochrane Review found a nonsignificant trend toward

decreased relapse for acute asthma patients discharged with a prescription for ICS in addition to SCS.³⁹ However, a statistically significant inverse relationship between relapse and prescriptions for ICS was found in a recently published Ontario study.¹⁶ In our study, 51% of patients received a new prescription for any ICS. Our compliance rate falls within the post phase of the Alberta study (45 to 61%).³⁶

Emergency physicians should not relegate the prescription of ICS to the family doctor. A recent multicentre Canadian ED study found that 2 weeks after an ED visit, only 24% of asthma patients contacted had seen their primary care physician.⁴⁰ In addition, when ED asthma patients do see their primary care physician, it is not guaranteed that a controller ICS will be initiated. In a US retrospective cohort study, only 25% of such patients had ICS added to their therapeutic regimen after follow-up.⁴¹ It is thus arguable that to avoid gaps in management and to limit patient morbidity, emergency physicians should ensure that asthma patients leave the ED with appropriate reliever and controller medications.

Discharge plans, including medical follow-up and/or referral to an asthma education clinic, are recommended by the CAEP asthma CPG. Concerns have been raised that medical record studies may fail to capture discharge instructions given at the time of the ED visit.¹⁶ However, a recent Canadian descriptive ED study involving both chart review and patient interviews while in the ED and at 72 hours postdischarge revealed suboptimal compliance with the recommendation for medical follow-up and referral to an asthma education centre.¹⁷ Documentation of outpatient follow-up in previous studies has varied widely from 48 to 62%^{16,36}; follow-up was documented 78% of the time in our study, with 60% of referrals being made to specialized asthma services or specialists. We suspect that this finding is in large part due to the practice of RTs initiating such referrals at our centre. Unfortunately, patient compliance was found to be poor as only 43% of those referred actually attended, a finding consistent with previous data.^{17,40,42}

Our finding of a high percentage of patients presenting with no reliever (33%) or controller (49%) medication suggests that ED asthma education and introduction of an “action plan” could be beneficial. Recent studies have highlighted the feasibility of asthma education in the ED^{43–45} and its

potential to increase compliance with follow-up to the asthma clinic.

Despite improvements in PEF measurements and documentation of follow-up plans compared to the previous literature, differences still exist between asthma management at an academic ED and that advised by the CAEP asthma CPG and current best practice, most notably for SCS use in the ED (64%) and prescriptions of prednisone (59%) and ICS (51%) at ED discharge. The reasons for the discordances we observed are unclear.

ACMs and even simple preprinted orders (PPOs) can facilitate incorporation of CPGs into ED practice. However, for these tools to be effective, EPs must support and embrace them. Some studies have found poor or incomplete uptake in ACM use.^{27,28} In our study, PPOs were used only 11% of the time.

Our study differs from other Canadian ED asthma studies in a number of ways. This was not a “before and after” study following the implementation of an ACM as others have done.^{26,36} Nor was it an asthma care pathway initiative, as recently described in Ontario.²⁸ Our study evaluated where a university-affiliated ED, part of a major tertiary care centre in British Columbia with a long-standing interest in asthma, stood in 2008 with respect to compliance with standardized QIs derived from well-known asthma treatment guidelines and current best practice.

Our study highlights the ongoing need for corticosteroid administration in the ED, as well as prescription at discharge of both OCSs and ICSs for all asthma presentations except the very mildest. One surprising finding was the rate of smokers (44%) among our asthma patients and the high rate of no-shows (57%) at our asthma clinic. Smoking cessation education and improved access to our asthma outpatient clinic should be considered to improve the quality of asthma care in our ED.

LIMITATIONS

Several limitations should be considered when interpreting our results. As the reviewer was a study investigator, he was not blinded to the study hypothesis; however, strict adherence to recommendations for medical record reviews in emergency medicine^{29,30} was performed to avoid bias in this regard.

This study was not immune to the common challenges of medical record reviews such as illegibility,

incomplete documentation of interventions, disposition management, and refusal of treatment or referral. However, a US study found that chart abstraction was similar to direct observation with respect to the ED documentation of assessment, treatment, and referral for asthma exacerbations, with the κ coefficient ranging from good to excellent.⁴⁶

Assessment of compliance with guidelines depends on appropriate severity classification. When available, we based severity on pretreatment PEF measurements. Although pre-PEF is a helpful clinical tool, it is effort dependent and more useful when patient baseline measurements are known. In addition, some may argue that the 1-hour PEF may be more valid.⁴⁷

Two limitations with regard to ICSs merit highlighting. First, a multinational study found that only 36% of patients with persistent asthma were prescribed an adequate dose of ICS.⁴⁸ Our design did not allow us to assess the adequacy of ICS dosages prescribed; hence, some patients may have been discharged with an inadequate dosage of controller medication. Second, we recognize that ICSs and LABA/ICS combination medications have different indications but accepted prescriptions of either as satisfying compliance with prescriptions of ICS.

Our study was not powered to assess clinical outcomes; however, our observed relapse rate (defined as an unscheduled return visit precipitated by the patient’s perceived worsening of asthma symptoms) merits mention: 12% of patients returned to VGH with acute asthma within 28 days of discharge.

Finally, as our study was conducted in a single academic medical centre, our findings may only be generalizable to similar institutions.

CONCLUSIONS

This study indicates an improvement in ED asthma care compared to previously published studies; however, discordance still exists between asthma management at a tertiary care ED and that advised by the CAEP asthma CPG and current best practice. Further research is warranted to understand the reasons for this finding. Specific quality improvement initiatives may improve guideline compliance and, ultimately, patient outcomes. Individual EDs should consider evaluating their own compliance with asthma CPGs and current best practice to identify local care gaps.

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Competing interests: Dr. FitzGerald is a member of the advisory boards for GlaxoSmithKline, AstraZeneca, Novartis, Pfizer, Boehringer Ingelheim, Altana, Merck, and Topigen. He is also a member of the Canadian Thoracic Society Asthma Committee and the Global Initiative for Asthma (GINA) Executive and chair of the GINA Science Committee. He belongs to the Speakers Bureau for GlaxoSmithKline, AstraZeneca, Boehringer Ingelheim, Pfizer, and Merck. He has had research funding paid directly to the University of British Columbia (UBC) from the Canadian Institutes of Health Research, AstraZeneca, GlaxoSmithKline, Boehringer Ingelheim, Merck, Wyeth, Schering, Genentech, and Topigen. Mr. David Harriman was supported by a UBC Summer Student Research Grant. The other authors have no financial disclosures or conflicts of interest to declare.

REFERENCES

1. Statistics Canada. *Persons with asthma, by sex, by province and territory*. 2008. Available at: <http://www40.statcan.ca/01/cst01/health50a-eng.htm> (accessed November 15, 2009).
2. Chapman KR, Ernst P, Grenville A, et al. Control of asthma in Canada: failure to achieve guideline targets. *Can Respir J* 2001;8 Suppl A:35A-40A.
3. Public Health Agency of Canada. *Life and breath: respiratory disease in Canada*. 2007. Ottawa: Public Health Agency of Canada; 2007.
4. FitzGerald JM, Boulet LP, McIvor RA, et al. Asthma control in Canada remains suboptimal: the Reality of Asthma Control (TRAC) study. *Can Respir J* 2006;13:253-9.
5. Chapman KR, Boulet LP, Rea RM, et al. Suboptimal asthma control: prevalence, detection and consequences in general practice. *Eur Respir J* 2008;31:320-5, doi:[10.1183/09031936.00039707](https://doi.org/10.1183/09031936.00039707).
6. Self TH, Usery JB, Howard-Thompson AM, et al. Asthma treatment protocols in the emergency department: are they effective? *J Asthma* 2007;44:243-8, doi:[10.1080/02770900701246691](https://doi.org/10.1080/02770900701246691).
7. Becker A, Lemiere C, Bérubé D, et al. Summary of recommendations from the Canadian Asthma Consensus guidelines, 2003. Asthma Guidelines Working Group of the Canadian Network For Asthma Care. *CMAJ* 2005;173(6 Suppl):S3-11.
8. Bateman ED, Hurd SS, Barnes PJ, et al. Global strategy for asthma management and prevention: GINA executive summary. *Eur Respir J* 2008;31:143-78, doi:[10.1183/09031936.00138707](https://doi.org/10.1183/09031936.00138707).
9. British Thoracic Society Scottish Intercollegiate Guidelines Network. British guideline on the management of asthma. *Thorax* 2008;63 Suppl 4:iv1-121.
10. Beveridge RC, Grunfeld AF, Hodder RV, Verbeek PR. Canadian Association of Emergency Physicians and the Canadian Thoracic Society Asthma Advisory Committee: guidelines for the emergency management of asthma in adults. *CMAJ* 1996;155:25-37.
11. Hodder R, Loughheed D, Rowe BH, et al. Management of acute asthma in adults in the emergency department: nonventilatory management. *CMAJ* 2010;182:E55-67, doi:[10.1503/cmaj.080072](https://doi.org/10.1503/cmaj.080072).
12. Hodder R, Loughheed D, Rowe BH, et al. Management of acute asthma in adults in the emergency department: assisted ventilation. *CMAJ* 2010;182:265-72, doi:[10.1503/cmaj.080073](https://doi.org/10.1503/cmaj.080073).
13. Tsai CL, Sullivan AF, Gordon JA, et al. Quality of care for acute asthma in 63 US emergency departments. *J Allergy Clin Immunol* 2009;123:354-61, doi:[10.1016/j.jaci.2008.10.051](https://doi.org/10.1016/j.jaci.2008.10.051).
14. Emond SD, Woodruff PG, Lee EY, et al. Effect of an emergency department asthma program on acute asthma care. *Ann Emerg Med* 1999;34:321-5, doi:[10.1016/S0196-0644\(99\)70125-3](https://doi.org/10.1016/S0196-0644(99)70125-3).
15. Krym VF, Crawford B, Macdonald RD. Compliance with guidelines for emergency management of asthma in adults: experience at a tertiary care teaching hospital. *CJEM* 2004;6:321-6.
16. Loughheed MD, Garvey N, Chapman KR, et al. Variations and gaps in management of acute asthma in Ontario emergency departments. *Chest* 2009;135:724-36, doi:[10.1378/chest.08-0371](https://doi.org/10.1378/chest.08-0371).
17. Gervais P, Larouche I, Blais L, et al. Asthma management at discharge from the emergency department: a descriptive study. *Can Respir J* 2005;12:219-22.
18. Reid J, Marciniuk DD, Cockcroft DW. Asthma management in the emergency department. *Can Respir J* 2000;7:255-60.
19. Salmeron S, Liard R, Elkharrat D, et al. Asthma severity and adequacy of management in accident and emergency departments in France: a prospective study. *Lancet* 2001;358:629-35, doi:[10.1016/S0140-6736\(01\)05779-8](https://doi.org/10.1016/S0140-6736(01)05779-8).
20. Grunfeld A, Beveridge RC, Berkowitz J, et al. Management of acute asthma in Canada: an assessment of emergency physician behavior. *J Emerg Med* 1997;15:547-56, doi:[10.1016/S0736-4679\(97\)00093-0](https://doi.org/10.1016/S0736-4679(97)00093-0).
21. Lesho EP, Myers CP, Ott M, et al. Do clinical practice guidelines improve processes or outcomes in primary care? *Mil Med* 2005;170:243-6.
22. Schneider SM. Effect of a treatment protocol on the efficiency of care of the adult acute asthmatic. *Ann Emerg Med* 1986;15:703-6, doi:[10.1016/S0196-0644\(86\)80429-2](https://doi.org/10.1016/S0196-0644(86)80429-2).
23. Norton SP, Pusic MV, Taha F, et al. Effect of a clinical pathway on the hospitalization rates of children with asthma: a prospective study. *Arch Dis Child* 2007;92:60-6, doi:[10.1136/adc.2006.097287](https://doi.org/10.1136/adc.2006.097287).
24. McFadden ER, Elsanadi N, Dixon L, et al. Protocol therapy for acute asthma: therapeutic benefits and cost savings. *Am J Med* 1995;99:651-61, doi:[10.1016/S0002-9343\(99\)80253-8](https://doi.org/10.1016/S0002-9343(99)80253-8).
25. Guttman A, Zagorski B, Austin PC, et al. Effectiveness of emergency department asthma management strategies on return visits in children: a population-based study. *Pediatrics* 2007;120:e1402-10, doi:[10.1542/peds.2007-0168](https://doi.org/10.1542/peds.2007-0168).

26. Mackey D, Myles M, Spooner CH, et al. Changing the process of care and practice in acute asthma in the emergency department: experience with an asthma care map in a regional hospital. *CJEM* 2007;9:353-65.
27. Sucov A, Veenema TG. Implementation of a disease-specific care plan changes clinician behaviors. *Am J Emerg Med* 2000;18:367-71, doi:[10.1053/ajem.2000.7321](https://doi.org/10.1053/ajem.2000.7321).
28. Lougheed MD, Olajos-Clow J, Szpiro K, et al. Multicentre evaluation of an emergency department asthma care pathway for adults. *CJEM* 2009;11:215-29.
29. Gilbert EH, Lowenstein SR, Koziol-McLain J, et al. Chart reviews in emergency medicine research: where are the methods. *Ann Emerg Med* 1996;27:305-8, doi:[10.1016/S0196-0644\(96\)70264-0](https://doi.org/10.1016/S0196-0644(96)70264-0).
30. Worster A, Bledsoe RD, Cleve P, et al. Reassessing the methods of medical record review studies in emergency medicine research. *Ann Emerg Med* 2005;45:448-51, doi:[10.1016/j.annemergmed.2004.11.021](https://doi.org/10.1016/j.annemergmed.2004.11.021).
31. Lauritsen JM, Bruus M. *EpiData Entry (Version 3.1). A comprehensive tool for validated entry and documentation of data*. Odense (Denmark): The EpiData Association; 2010.
32. Boulet LP, Becker A, Bérubé D, et al. Management of patients with asthma in the emergency department and in hospital. In: Canadian Asthma Consensus Report, 1999. *CMAJ* 1999;161(11 Suppl):S53-9.
33. Boulet LP, Bai T, Becker A, et al. What is new since the last (1999) Canadian Asthma Consensus Guidelines? *Can Respir J* 2001;8 Suppl A:5A-27A.
34. Lemièrre C, Bai T, Balter M, et al. Adult Asthma Consensus Guidelines Update 2003. *Can Respir J* 2004;11 Suppl A:9A-18A.
35. Lougheed MD, Lemièrre C, Dell SD, et al. Canadian Thoracic Society asthma management continuum—2010 consensus summary for children six years of age and over, and adults. *Can Respir J* 2010;17:15-24.
36. Rowe BH, Chahal AM, Spooner CH, et al. Increasing use of anti-inflammatory agents for acute asthma in the emergency department: experience with an asthma care map. *Can Respir J* 2008;15:20-6.
37. Rowe BH, Keller J, Oxman A. Steroid use in the emergency department treatment of asthma exacerbations: a meta-analysis. *Am J Emerg Med* 1992;10:301-10, doi:[10.1016/0735-6757\(92\)90007-K](https://doi.org/10.1016/0735-6757(92)90007-K).
38. Rowe BH, Spooner CH, Ducharme FM, et al. Corticosteroids for preventing relapses following acute exacerbations of asthma. *Cochrane Database Syst Rev* 2007;(3):CD000195.
39. Edmonds M, Brenner BE, Camargo CA, Rowe BH. Inhaled steroids for acute asthma following emergency department discharge. *Cochrane Database Syst Rev* 2000;(3):CD002316.
40. Rowe BH, Villa-Roel C, Sivilotti ML, et al. Relapse after emergency department discharge for acute asthma. *Acad Emerg Med* 2008;15:709-17, doi:[10.1111/j.1553-2712.2008.00176.x](https://doi.org/10.1111/j.1553-2712.2008.00176.x).
41. Cydulka RK, Tamayo-Sarver JH, Wolf C, et al. Inadequate follow-up controller medications among patients with asthma who visit the emergency department. *Ann Emerg Med* 2005;46:316-22, doi:[10.1016/j.annemergmed.2004.12.024](https://doi.org/10.1016/j.annemergmed.2004.12.024).
42. Rowe BH, Voaklander DC, Wang D, et al. Asthma presentations by adults to emergency departments in Alberta, Canada: a large population-based study. *Chest* 2008;135:57-65, doi:[10.1378/chest.07-3041](https://doi.org/10.1378/chest.07-3041).
43. Szpiro KA, Harrison MB, Van Der Kerkhof EG, et al. Patient education in the emergency department: a systematic review of interventions and outcomes. *Adv Emerg Nurs J* 2008;31:34-49.
44. Szpiro KA, Harrison MB, Van Der Kerkhof EG, et al. Asthma education delivered in an emergency department and an asthma education centre: a feasibility study. *Adv Emerg Nurs J* 2009;31:65-77.
45. Lougheed MD, Olajos-Clow JG. Asthma care pathways in the emergency department. *Curr Opin Allergy Clin Immunol* 2010;10:181-7, doi:[10.1097/ACI.0b013e328339731d](https://doi.org/10.1097/ACI.0b013e328339731d).
46. McDermott MF, Lenhardt RO, Catrambone CD, et al. Adequacy of medical chart review to characterize emergency care for asthma: findings from the Illinois Emergency Department Asthma Collaborative. *Acad Emerg Med* 2006;13:345-8, doi:[10.1111/j.1553-2712.2006.tb01705.x](https://doi.org/10.1111/j.1553-2712.2006.tb01705.x).
47. Kelly AM, Kerr D, Powell C. Is severity assessment after one hour of treatment better for predicting the need for admission in acute asthma? *Respir Med* 2004;98:777-81, doi:[10.1016/j.rmed.2004.01.008](https://doi.org/10.1016/j.rmed.2004.01.008).
48. Burney P, Potts J, Ait-Khaled N, et al. A multinational study of treatment failures in asthma management. *Int J Tuberc Lung Dis* 2008;12:13-8.