ORIGINAL ARTICLE

Increasing the use of anti-inflammatory agents for acute asthma in the emergency department: Experience with an asthma care map

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PURPOSE: Acute asthma is a common emergency department (ED) presentation and variation in its management is well recognized. The present study examined the use of an asthma care map (ACM) in one Canadian ED to improve adherence to acute asthma guidelines, emphasizing the use of systemic corticosteroids (SCSs) and inhaled corticosteroids (ICSs).

METHODS: Three time periods were studied: the 15 months before ACM introduction (PRE), the 15 months following a three-month introduction of the ACM (POST$_1$) and the 18 months after POST$_1$ (POST$_2$). Randomly selected patient charts from each period were included from patients who were 18 to 60 years of age and presented with a primary diagnosis of acute asthma. A priori criteria were established to determine the degree of completion and success of the ACM. Primary outcomes included documentation, use of SCSs in the ED, and prescription of SCSs and ICSs at ED discharge.

RESULTS: A total of 387 patient charts were included (PRE, n=150; POST$_1$, n=150; POST$_2$, n=87). Patient characteristics in the three groups were similar; however, patients in POST$_1$ and POST$_2$ showed higher use of newer agents than those in the PRE group. Overall, more women (n=209; 54%) than men were seen; the mean age was 32.4 years. The care map was used in 67% of cases during POST$_1$ and 70% during POST$_2$. The use of peak expiratory flow (PEF) was high during the PRE, POST$_1$ and POST$_2$ periods (91%, 89% and 91%, respectively); however, documentation of other markers of severity increased in the POST periods. Use of SCSs occurred earlier (P<0.01) and more often (57% PRE, 68% POST$_1$ and 75% POST$_2$; P<0.01) in the POST$_{1,2}$ periods than the PRE period. There was a significant increase in use of SCSs on discharge (55% PRE, 66% POST$_1$ and 69% POST$_2$; P<0.05), and prescription of ICSs significantly increased (24% PRE, 45% POST$_1$ and 61% POST$_2$; P<0.001) in the POST$_{1,2}$ periods. Discharge without any corticosteroids decreased over the three periods (32% PRE, 21% POST$_1$ and 17% POST$_2$; P<0.05). The length of stay in the ED increased over the study periods (181 min PRE, 209 min POST$_1$ and 265 min POST$_2$; P<0.01) and admissions were infrequent (9% PRE, 13% POST$_1$ and 6% POST$_2$; P=0.50).

CONCLUSIONS: The present study provides evidence that the standardized ED ACM was widely accepted, improved chart documentation, improved some aspects of ED care and increased prescribing of discharge preventive medications.

Key Words: Asthma; Corticosteroids; Guidelines; Prevention

Utilisation accrue d'anti-inflammatoires dans le traitement de l'asthme aigu à l'urgence : l'expérience d'un cheminement clinique pour l'asthme

BUT : L'asthme aigu est un motif fréquent de consultation à l'urgence, et les différences de traitement sont bien connues. La présente étude avait pour but d'examiner l'utilisation d'un cheminement clinique (CC) (« carte de soins ») pour l'asthme dans un service des urgences au Canada afin d'améliorer le respect des lignes directrices sur l'asthme aigu, qui préconisent l'utilisation de corticostéroïdes généraux (CG) et de corticostéroïdes en inhalation (CI).

MÉTHODE : Le temps à l'étude a été divisé en trois périodes : 15 mois avant l'application du CC (PRE), 15 mois suivant une période d'essai de trois mois du CC (POST$_1$) et 18 mois après la POST$_1$ (POST$_2$). Nous avons choisi au hasard des dossiers de patients âgés de 18 à 60 ans, qui provenaient de chacune des périodes et chez qui un diagnostic principal d'asthme aigu avait été posé. Nous avons également établi au préalable des critères afin de déterminer le degré de réalisation et de réussite du CC. Les principaux critères d'évaluation comprenaient la documentation, l'utilisation du CC à l'urgence ainsi que la prescription de CG et de CI au moment du congé de l'urgence.

RÉSULTATS : Au total, 387 dossiers de patients ont été retenus (PRE : n=150; POST$_1$: n=150; POST$_2$: n=87). Les malades, dans les trois groupes, avaient des caractéristiques comparables; cependant, l'utilisation de nouveaux médicaments était plus grande dans les groupes POST$_1$ et POST$_2$ que dans le groupe PRE. Dans l'ensemble, plus de femmes (n=209; 54 %) que d'hommes ont consulté, et l'âge moyen était de 32,4 ans. Le CC a été utilisé dans 67 % des cas dans le groupe POST$_1$ et dans 70 % des cas dans le groupe POST$_2$. La mesure du débit expiratoire de pointe s'est révélée un indicateur fréquent pendant les périodes PRE, POST$_1$ et POST$_2$ (91 %, 89 %, 91 % respectivement), mais l'utilisation d'autres marqueurs de gravité a augmenté pendant les périodes POST. Nous avons également noté une utilisation plus précoce (P<0,01) et plus fréquente

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(PRE : 57 %; POST$_1$: 68 %; POST$_2$: 75 %; P<0,01) de CG au cours des périodes POST$_1$ et POST$_2$ qu'au cours de la période PRE. L'utilisation de CG a augmenté de façon significative au moment du congé (PRE : 55 %; POST$_1$: 66 %; POST$_2$: 69 %; P<0,05), de même que la prescription de CI pendant les périodes POST$_1$ et POST$_2$ (PRE : 24 %; POST$_1$: 45 %; POST$_2$: 61 %; P<0,001). Par contre, une diminution du nombre de congés sans prescription de corticostéroïdes a été constatée au cours des trois périodes (PRE : 32 %; POST$_1$: 21 %; POST$_2$: 17 %; P<0,05). Enfin, la durée du séjour à l'urgence a augmenté pendant les périodes à l'étude

(PRE : 181 min; POST$_1$: 209 min; POST$_2$: 265 min; P<0,01), mais le pourcentage d'hospitalisations, lui, est demeuré faible (PRE : 9 %; POST$_1$: 13 %; POST$_2$: 6 %; P<0,50).

CONCLUSION : La présente étude a montré que l'application d'un modèle uniforme de cheminement clinique pour l'asthme à l'urgence avait été très bien acceptée et qu'elle avait permis d'améliorer la documentation au dossier ainsi que certains aspects des soins fournis à l'urgence, en plus d'accroître la prescription de médicaments prophylactiques au moment du congé.

Asthma is a common chronic condition that is characterized by intermittent exacerbations followed by variable periods of 'stability'. Asthma prevalence varies widely with demographics (more common in children and women), geography (regional variation has been noted) and socioeconomic status (1). Asthma exacerbations are common presentations to the emergency department (ED) in many parts of the world (2,3), and the costs associated with asthma treatment are enormous (4-6). The United States spends approximately six billion dollars per year on asthma (4), 25% of which is generated from treating acute exacerbations (ED visits and hospitalizations) (6).

The classical presentation of an asthma exacerbation includes worsening symptoms of dyspnea, wheezing and/or coughing, and increasing need for short-acting beta-agonists. Given the potentially serious nature and high worldwide prevalence of acute asthma, it is not surprising that national and international clinical practice guidelines (CPGs) have been developed to direct management (7-10). Despite the availability of these guidelines, a 'care gap' remains between what is known and what is practised (11), especially in asthma (12-14). The dissemination of best evidence does not always reach or affect practising clinicians for a variety of reasons.

Methods to improve ED asthma care have been poorly studied; however, local CPGs in the form of care maps have been shown to improve care for similar acute respiratory conditions such as community-acquired pneumonia (15). The present study was designed to evaluate the influence of an asthma care map (ACM) on the treatment of acute asthma in a single site within a linked health care system. Specifically, the study compared asthma care delivery during three different time periods: pre-ACM (PRE), during implementation (POST$_1$) and 18 months later (POST$_2$) to determine the ongoing impact of the ACM.

METHODS

Study setting
Charts were selected from patients who attended the ED of the University of Alberta Hospital (UAH), a tertiary care centre located in Edmonton, Alberta, staffed by full-time emergency physicians 24 h a day.

ACM
The ACM was developed by an interdisciplinary group of emergency physicians, emergency nurses, respiratory therapists, pulmonary specialists and pharmacists at the UAH using evidence-based methods and evidence from the Cochrane Library (16). The final four-page ACM encouraged documentation of history, medications, physical findings, treatment, discharge instructions, peak expiratory flows (PEFs), nursing notes and discharge instructions. Nomograms for PEFs were also included in the care map (available on request from the author).

The interventions were approved by the UAH emergency physician group, and a prototype was used for three months before final printing. The introduction of the ACM was accompanied by extensive continuing medical education sessions, and feedback was returned to ED staff. Respiratory therapists were provided with training and given approval to initiate care before physician assessment; however, physicians were informed and assessed patients soon after ACM initiation.

Inclusion and exclusion criteria
All patients between 18 and 60 years of age who presented to the ED with a primary diagnosis of acute asthma (International Classification of Diseases, Ninth Revision, Clinical Modification, code 493.×) were eligible. Patient charts were excluded if treatment was not provided in the ED (eg, prescription renewals, very mild disease, etc), if diagnosis was miscoded (eg, community-acquired pneumonia, chronic obstructive pulmonary disease, etc), if the patient was transferred from other institutions and if the patient was directly transferred to a specialist.

Data sources
A random sample of patient charts that met inclusion criteria in each of the three time periods was selected using a computer-generated random numbers list (SPSS Inc, USA). The first time period (PRE) selected was the 15-month period (September 1997 to November 1998) before introducing the ACM. The second time period (POST$_1$) was the 15-month period (March 1999 to May 2000) following a three-month introduction period of the ACM. The final time period (POST$_2$) studied was an 18-month period (September 2000 to March 2002) after the second evaluation.

Data collection
Data were abstracted from the patient charts by one of two trained research assistants using a standardized audit form. A priori criteria were established to determine the degree of complete documentation and the success of adhering to the ACM. Physicians were not aware of the study at the time of patient presentation in any of the time periods. Data were collected on demographics, asthma severity, medical history, presenting asthma description, ED treatment, outcome and discharge treatment.

Outcomes
The primary study outcomes were the proportion of patients administered systemic corticosteroids (SCSs) in the ED, and the number of prescribed SCSs and inhaled corticosteroids (ICSs) at discharge during each of the three time periods. Secondary outcomes included the use of the ACM and the changes in monitoring severity and overall documentation.

TABLE 1
Demographic factors, use of asthma care map (ACM) and documentation of prevention in the preimplementation (PRE), postimplementation (POST$_1$) and maintenance (POST$_2$) phases of the asthma guideline implementation project

Demographic factors	PRE (n=150)	POST$_1$ (n=150)	POST$_2$ (n=87)
Age, years, mean ± SD	31.3±10.3	32.9±12.8	33.1±14.2
Female patients, %	54	53	56
Primary care physician identified, %	75	78	77
ACM initiated*, %	8	67	70
Complete documentation, %			
History	–	58	55
Medication lists	–	53	57
Treatments	–	63	69
Discharge	–	7	<1
Nursing record on file†, %	79	48	70
Documentation of preventive measures, %			
Use of spacer device for beta-agonists*	7	49	56
Asthma action plan during exacerbations*	0	8	61
Measurement of PEF in the ED, %	91	89	91

*$P \leq 0.001$; †$P \leq 0.05$. ED Emergency department; PEF Peak expiratory flow; PRE Fifteen-month phase before ACM initiation; POST$_1$ Fifteen-month phase following three months of ACM initiation; POST$_2$ Eighteen-month phase after POST$_1$

TABLE 2
Chronic asthma factors of patients presenting in the preimplementation (PRE), postimplementation (POST$_1$) and maintenance (POST$_2$) phases of the asthma guideline implementation project

Chronic asthma factors	PRE (n=150)	POST$_1$ (n=150)	POST$_2$ (n=87)
Smoker, %	24	29	18
Number of years with asthma, mean ± SD	17±11	17±13	16±12
Ever intubated for asthma, %	10	4	10
Medications on ED presentation, %			
Theophylline	11	10	3
Oral corticosteroids	14	15	14
Inhaled beta-agonist	82	81	80
Inhaled corticosteroid	53	60	45
Inhaled long-acting beta-agonist*	9	13	20
Inhaled ipratropium bromide	15	19	6
Leukotriene modifier†	3	15	13
Other asthma medications	10	7	0

*$P \leq 0.05$; †$P \leq 0.01$. ED Emergency department; PRE Fifteen-month phase before asthma care map initiation; POST$_1$ Fifteen-month phase following three months of asthma care map initiation; POST$_2$ Eighteen-month phase after POST$_1$

Validity of collected data

Data extracted from a random selection of 60 charts in the PRE and POST$_1$ periods were assessed by a second coder to determine data validity; intraclass correlation coefficient (ICC) and kappa (κ) were calculated. Levels of agreement were assessed as excellent (ICC or κ, 0.8 or greater), good (ICC or κ, 0.6 or greater and less than 0.8), moderate (ICC or κ, 0.4 or greater and less than 0.6), fair (ICC or κ, 0.2 or greater and less than 0.4) or poor (ICC or κ less than 0.2) (17).

Statistical analysis

Data were analyzed using the SPSS-PC (version 14.0) statistical software program (SPSS Inc, USA). Categorical values are reported as counts and percentages, and continuous variables are reported as mean ± SD or as median and interquartile range. Comparisons among periods were made using ANOVA or Kruskal-Wallis rank tests, as appropriate, for continuous variables or Cochran's test for trends in categorical variables.

An analysis was undertaken to identify factors associated with receiving SCSs in the ED and ICSs after discharge. Univariate logistic regression models were developed. Any predictor that was significant (P<0.05) was entered into a stepwise logistic regression model (P$_{[to\ enter]}$=0.05; P$_{[to\ stay]}$=0.10).

Ethics

The present study was approved by the University of Alberta Health Research Ethics Board. No informed consent was obtained for this retrospective study as per the Ethics Committee approval. Patient names and identifying characteristics were not kept, records remained stored in a secure area and only aggregate data are reported.

RESULTS

Chart selection

Overall, ED volumes increased from 58,930 visits in 1997 to 1998, to 69,166 visits in 2001 to 2002. In total, 460 asthma charts were retrieved (PRE, n=185; POST$_1$, n=174; POST$_2$, n=101). A similar number of charts were excluded from each of the three study periods for the following reasons: no treatment (n=24), miscoded (n=31) and other exclusions (n=18). The final evaluation was based on 387 patient records (PRE, n=150; POST$_1$, n=150; POST$_2$, n=87).

Reliability

For key continuous variables, the agreement between chart abstractors was excellent (ICC 0.86 to 1.0). For key dichotomous variables, the agreement between chart abstractors was very good to excellent (κ 0.79 to 1.0).

Use of care map

The use of the prototype care map was observed in a small percentage of charts (8%) before the official launching. Following official implementation, 101 POST$_1$ (67%) and 61 POST$_2$ (70%) period charts had evidence of ACM use (Table 1). While asthma history, medication lists, treatments and PEF measurements were well documented, documentation of discharge plans on the ACM was infrequent.

Patient demographics

The mean (± SD) age of patients was similar across the study periods (32.4±12.2 years); more women (n=209; 54%) than men were seen (Table 1). Most patients had a 16- or 17-year history of asthma, and 18% to 29% were smokers (Table 2). The majority of patients (77%) identified a primary care physician (PCP).

Pre-ED treatment

Overall, beta-agonist use was very common (81%) and ICS use was moderate (54%), while oral corticosteroids (14%) and theophylline (9%) use were low; these proportions did not vary among study periods (Table 2). The use of long-acting beta-agonists (9% PRE, 13% POST$_1$, 20% POST$_2$) and leukotriene modifiers (3% PRE, 15% POST$_1$, 13% POST$_2$)

TABLE 3
Acute asthma presentation of patients during the preimplementation (PRE), postimplementation (POST$_1$) and maintenance (POST$_2$) phases of the asthma guidelines implementation project

Presentation	PRE (n=150)	POST$_1$ (n=150)	POST$_2$ (n=87)
Arrival by ambulance, %	13	10	13
Onset of symptoms, %			
<24 h*	70	64	56
24–72 h	19	25	12
>72 h	11	11	32
Initial respiratory rate*, breaths/min	24.7±8.4	22.2±6.1	22.8±7.6
Initial oxygen saturation, %	95.0±4.2	95.0±4.3	95.1±3.5
Initial systolic blood pressure, mmHg	124.1±15.6	124.3±16.5	129.6±20.3
Initial pulse rate, beats/min	99.6±19.5	99.9±18.9	98.3±18.0
Initial PEF (earliest peak flow), L/min	279±125	249±105	281±107

Values are expressed as mean ± SD unless otherwise specified. *P≤0.05. PEF Peak expiratory flow; PRE Fifteen-month phase before asthma care map initiation; POST$_1$ Fifteen-month phase following three months of asthma care map initiation; POST$_2$ Eighteen-month phase after POST$_1$

was higher in POST$_1$ and POST$_2$ periods than in the PRE period.

Asthma severity
Patients presented with moderate to severe asthma using traditional measures of severity such as median PEF (250 L/min; interquartile range 190 L/min to 340 L/min), mean vital signs (pulse rate 99±19 beats/min, respiratory rate 23±8 breaths/min, systolic blood pressure 125±17 mmHg) and mean O$_2$ saturation (95±4%). Most patients were ambulatory; however, approximately 12% arrived by ambulance. Time from symptom onset to presentation and assessment increased, with more patients delaying longer than 72 h before ED presentation (Table 3).

Treatment in the ED
The timing of first treatments with beta-agonists and anticholinergics were similar among the study periods; however, the total number of anticholinergic treatments during the ED stay was higher in the POST$_1$ and POST$_2$ periods than the PRE period (Table 4). SCSs were administered with increasing frequency (57% PRE, 68% POST$_1$ and 75% POST$_2$; P<0.01) and earlier (less than 60 min; P<0.01) over the study periods. PEF change and admission proportions were not statistically different among the study periods.

Disposition and discharge treatments
The total time asthma patients spent in the ED increased (181 min PRE, 209 min POST$_1$ and 265 min POST$_2$; P<0.001) (Table 5). Admission proportions did not statistically differ among the study periods (9% PRE, 13% POST$_1$, 5% POST$_2$). Prescribing of SCSs at discharge increased over the study periods (55% PRE, 66% POST$_1$ and 69% POST$_2$; P<0.05). Use of ICSs increased (24% PRE, 45% POST$_1$ and 61% POST$_2$; P<0.001) while the frequency of discharge without any ICS or SCS decreased (32% PRE, 21% POST$_1$ and 14% POST$_2$; P<0.05) over time.

TABLE 4
Acute asthma treatment in the emergency department (ED) during the preimplementation (PRE), postimplementation (POST$_1$) and maintenance (POST$_2$) phases of the asthma guidelines implementation project

Treatment measures in the ED	PRE (n=150)	POST$_1$ (n=150)	POST$_2$ (n=87)
Time from presentation to first inhaled treatment, min, median (IQR)	41 (26–65)	40 (16–70)	42 (13–95)
Number of inhaled beta-agonists in the first hour, median (IQR)	1 (0–2)	1 (0–2)	1 (1–2)
Number of inhaled beta-agonists over the ED stay, median (IQR)	3 (1–4)	3 (2–4)	3 (2–4)
Number of inhaled anticholinergics in the first hour, median (IQR)	1 (0–1)	2 (1–2)	1 (1–2)
Number of inhaled anticholinergics the ED stay*, median (IQR)	2 (1–3)	3 (1–3)	3 (1–3)
Given corticosteroid treatment in the ED*, %	57	68	75
ED corticosteroid treatment less than 60 min*, %	36	50	55
Given IV MgSO$_4$ treatment in the ED, %	3	6	6
Given ICS treatment in ED, %	6	9	5
Administered O$_2$ in the ED*, %	24	21	7
Final PEF (absolute), L/min, mean ± SD	403±133	369±122	378±109
Change in PEF (absolute), L/min, mean ± SD	128±97	118±95	108±106
Admitted, %	9	13	5

*P≤0.01. ICS Inhaled corticosteroids; IQR Interquartile range; IV Intravenous; MgSO$_4$ Magnesium sulphate; PEF Peak expiratory flow; PRE Fifteen-month phase before asthma care map initiation; POST$_1$ Fifteen-month phase following three months of asthma care map initiation; POST$_2$ Eighteen-month phase after POST$_1$

TABLE 5
Acute asthma treatment after discharge from the emergency department (ED) during the preimplementation (PRE), postimplementation (POST$_1$) and maintenance (POST$_2$) phases of the asthma guidelines implementation project

	PRE (n=112)	POST$_1$ (n=116)	POST$_2$ (n=71)
Sent home on systemic corticosteroids*, %	55	66	69
Sent home on any ICS†, %	24	45	61
Sent home on prednisone plus ICS†, %	11	31	46
Sent home on neither prednisone nor ICS*, %	32	21	17
Sent home on beta-agonists‡, %	51	59	73
Sent home on antibiotics, %	9	8	0
PCP follow-up documentation, %	56	59	62
Total ED time in minutes†, median (IQR)	181 (123–281)	209 (140–317)	265 (160–367)

*P≤0.05; †P≤0.001; ‡P≤0.01. ICS Inhaled corticosteroids; IQR Interquartile range; PCP Primary care physician; PRE Fifteen-month phase before asthma care map initiation; POST$_1$ Fifteen-month phase following three months of asthma care map initiation; POST$_2$ Eighteen-month phase after POST$_1$

Multivariate analysis
There was an increase in SCS use in the ED over the study periods. This time period effect was maintained in the multivariate model (adjusted OR 1.6, 95% CI 1.0 to 2.7); first PEF and previous ICS use were also significant contributors to the

final model. Similarly, the proportion of patients discharged on ICS increased during the study and only this time period effect was maintained in the multivariate model (adjusted OR 3.4, 95% CI 1.5 to 7.6).

DISCUSSION

Asthma presentations to North American EDs are common, and previous research has demonstrated that many patients receive poor care, often with unsatisfactory outcomes (18). Despite the development and dissemination of numerous guidelines on recommended treatment for acute asthma, care gaps remain. An important care gap has been the suboptimal use of anti-inflammatory agents in the emergency setting (18-20). The present three-period chart audit examined the effects of introducing an ACM in a large, urban ED to improve acute asthma care; it represents one of the most comprehensive ED-based studies ever published. Overall, acceptance of the ACM was high and, unlike other CPGs, its use and adherence has been sustained since its introduction. In fact, the ACM has now largely replaced nursing notes and is used almost exclusively to document the progress of asthma patients through their ED treatment. Despite this acceptance, however, there is one component of the ACM that physicians consistently do not use – the discharge planning section. Guidelines stress the importance of discharge planning for asthma patients, and despite an effort to enhance this, the ACM made minimal inroads here. Clearly, the role of education remains under-appreciated in this setting (21,22). This multidisciplinary care plan has received suggestions for feedback, and updates have been accomplished; the iterative nature of the ACM must be recognized.

In addition, the ACM has had an important and impressive effect on the treatment of patients in the ED because more patients are receiving optimal treatment with anti-inflammatory agents. Systematic reviews have demonstrated that SCSs should be administered early and often in the ED to reduce admission to the hospital (23). The ACM significantly increased SCS use in the ED from 57% (PRE) to 75% (POST$_2$). Furthermore, SCSs were administered earlier (ie, during the first 60 min) in a significantly higher proportion of patients after the introduction of the ACM (36% PRE versus 55% POST$_2$). High-quality evidence also supports the use of SCSs following discharge (24) and suggests that most patients should have a trial of ICSs as well (25,26). The number of patients sent home on SCSs remained relatively stable (55% PRE versus 69% POST$_2$); however, the number sent home on ICSs increased from 24% PRE to 61% POST$_2$. Finally, there were other beneficial changes in care that were observed, such as a reduced use of antibiotics and oxygen in the ED. Use of repeated doses of anticholinergic agents has been advocated (27), and the ACM also increased the use of this class of drugs in the ED.

Despite many years of evidence that substantiates the importance of anti-inflammatory agents in asthma, the lag in uptake of this evidence can still be demonstrated (28,29). Reasons for the lack of uptake of evidence in general, and CPGs specifically, are now well documented (11,30). Evidence-based guidelines have met with considerable obstacles, and little research can be found on ways to overcome them. A MEDLINE search for articles describing the impact of the care map or guideline use in adults was unproductive. While some publications documented guideline use in pediatric asthma

(31), their impact has only been modestly successful. One before and after study in a single United States adult ED indicated that a CPG improved processes of care and improved care in acute asthma (32). This study was conducted almost a decade ago, and our study differs in the focus of the intervention (anti-inflammatories), the study delivery and the influence of ED overcrowding on the results. Despite these differences, both studies suggest an ACM will improve process and care in the ED setting.

The success of the current ACM may be due to the multifaceted approach taken in its development and dissemination, which conforms with current knowledge about effective methods of changing practice (29). First, development took an evidence-based approach through a close-working, multidisciplinary team, including generalist and specialist clinicians. The group exercised ready acceptance of quality suggestions and sought feedback from all staff – suggestions that were reflected in the updates of the ACM form before final printing. The tool is easily available throughout the ED and assists decisions and care at the bedside. Its introduction was accompanied by frequent education sessions until all ED staff were aware of its existence. Though there is work still to be done, the ongoing popularity of the ACM leaves room for further improvements. For example, work is underway on a fully electronic interactive ACM that will be tested in this environment.

Limitations

Every attempt was made in the present study to eliminate bias; however, there are several possible limitations that should be considered. First, this study was a time series and, therefore, we cannot rule out the possibility that clinical advances may have influenced the results over time. We are relatively confident, however, that this did not occur because other 'newer' evidence has not influenced this field. No new guidelines for ED management of asthma were developed in Canada during the study period, and an updated version of the CTS/CAEP Guidelines has not resulted in a change in recommended anti-inflammatory agents in the ED or at discharge (33). In addition, mulitvariable models consistently identified time period as a significant factor associated with the increase use of SCS and ICS. Second, it is also possible that data collection was biased toward favourable results; however, this is unlikely, because there was excellent agreement between the two independent data collectors. Third, as with all chart reviews, legibility and inadequate documentation were problems. Although this made some categories of data extraction more difficult, it did not significantly affect the primary outcome results because treatment choices are well documented in all hospital-based patient charts. Fourth, we did not follow up patients to determine the influence of these changes on clinical outcomes; this would have dramatically increased the cost and complexity of the study (13). Moreover, the design (retrospective) precluded valid clinical outcome ascertainment. Our goal, however, was to enhance the use of anti-inflammatories in the ED and following discharge, not to re-prove the effectiveness of this mode of treatment. Fifth, while the use of evidence-based treatments increased, so did the ED length of stay. There are many potential explanations for this, including the crisis of ED overcrowding; further research on this is needed. Finally, the study was also limited to a single centre (UAH) and the

generalizability of these results in other centres awaits confirmation. For example, large randomized controlled trials of ACM, as have been performed in primary care, are needed to enhance the validity and applicability of ACMs (34).

CONCLUSIONS

Notwithstanding the above concerns, the findings from the present study suggest that the development of an evidence-based, multidisciplinary ACM for acute asthma was associated with widespread acceptance, without the traditional decay period seen in other forms of CPGs. In this setting, the ACM has produced impressive improvements in administering recommended anti-inflammatory treatment.

There is a substantial opportunity to improve management and reduce morbidity caused by asthma among these high-risk patients, and care maps represent one method of knowledge translation at the point of care. An evaluation of the effect of these interventions is important in the ongoing effort to provide optimal, timely care in busy ED settings. Future studies should focus on measures of improving process of care and evaluation of long-term clinically relevant outcomes.

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