



Implementation of Ontario's emergency department asthma care pathway for adults: determinants of uptake

Chanel Kwok, Linda Levesque, Yvonne DeWit, Jennifer Olajos-Clow, Carole Madeley, Mona Jabbour, Teresa To & M. Diane Lougheed

To cite this article: Chanel Kwok, Linda Levesque, Yvonne DeWit, Jennifer Olajos-Clow, Carole Madeley, Mona Jabbour, Teresa To & M. Diane Lougheed (2019): Implementation of Ontario's emergency department asthma care pathway for adults: determinants of uptake, Journal of Asthma, DOI: [10.1080/02770903.2019.1694940](https://doi.org/10.1080/02770903.2019.1694940)

To link to this article: <https://doi.org/10.1080/02770903.2019.1694940>



Accepted author version posted online: 18 Nov 2019.
Published online: 10 Dec 2019.



Submit your article to this journal [↗](#)



Article views: 13



View related articles [↗](#)



View Crossmark data [↗](#)



Implementation of Ontario's emergency department asthma care pathway for adults: determinants of uptake

Chanel Kwok, MD^a, Linda Levesque, MSc, PhD^b, Yvonne DeWit, MSc^b, Jennifer Olajos-Clow, MSc^a, Carole Madeley, MAppSc (RespSc)^c, Mona Jabbour, MD, MEd^d, Teresa To, MSc, PhD^{b,e}, and M. Diane Loughheed, MD, MSc^{a,b}

^aAsthma Research Unit, Kingston Health Sciences Centre, Department of Medicine, Queen's University, Kingston, Canada; ^bInstitute for Clinical Evaluative Sciences, Toronto, Canada; ^cThe Lung Association-Ontario, Toronto, Canada; ^dDepartments of Pediatrics and Emergency Medicine, University of Ottawa, Ottawa, Canada; ^eDalla Lana Graduate School of Public Health, University of Toronto, Toronto, Canada

ABSTRACT

Objective: The Ontario Government funded the development and implementation of a standardized adult emergency department (ED) asthma care pathway (EDACP). We aimed to describe baseline patterns of ED use by adults for asthma in Ontario, Canada, and determine site characteristics associated with the EDACP implementation workshop attendance and subsequent pathway implementation.

Methods: All Ontario EDs were offered EDACP implementation workshops by the Lung Association-Ontario between 2008 and 2011, and were surveyed regarding site implementation status as of October, 2013. Survey data were linked by site to Ontario's administrative health databases. Logistic regression models investigated the association between site and patient characteristics and: a) workshop attendance; b) pathway implementation.

Results: In the 2 years prior to EDACP implementation, there were 41 143 asthma visits to 167 sites by adults (62.3% female). Asthma-related return visits within 72 h varied by hospital type (teaching 2.1%, community 2.8%, small 4.0%; $p < 0.05$). Implementation workshops were attended by staff from 122 sites (72.6%). Implementation status was known for 108 sites and varied by hospital type ($p < 0.001$), but not workshop attendance ($p = 0.11$). By 2013, 47% of all hospitals were using or planning to use the EDACP. Uptake was more likely in community hospitals.

Conclusions: Ontario adult asthma ED visitors are more often women. Asthma-related return visits are uncommon, but significantly higher in small community hospitals. This provincial QI initiative reached almost 75% of Ontario EDs, and achieved almost 50% implementation rate within 2 years. Factors other than workshop attendance, such as hospital size, were associated with EDACP implementation.

ARTICLE HISTORY

Received 12 May 2019
Revised 13 November 2019
Accepted 14 November 2019

KEYWORDS

Epidemiology;
control/management

Introduction

The burden of asthma globally, nationally and in Ontario is substantial (1,2). Each year, 40–50% of Canadians with asthma experience exacerbations prompting an urgent clinic visit, emergency department (ED) visit or admission to hospital (3). Exacerbations of asthma reflect suboptimal control of the disease, contributing substantially to its morbidity and costs. Return-visit rates are frequently used as a benchmark of ED asthma care (4).

Asthma management guidelines (5,6) summarize evidence-based asthma care. Unfortunately, significant discrepancies between evidence-based guidelines and current practice exist (7,8), which could be adversely affecting morbidity including hospitalizations, quality

of life and healthcare costs. Clinical experts recognize that adoption of guidelines hinges upon successful knowledge translation and implementation initiatives (9–11). Clinical pathways can be an effective means of supporting best practice, as recommended by guidelines, for a variety of conditions and settings, including asthma (12–18).

The Ontario Ministry of Health and Long-Term Care, as part of the provincial Asthma Program (9), funded the development of a standardized ED asthma clinical pathway (ACP) for adults to provide an operational version of the Canadian Asthma Consensus Guidelines and Canadian Association of Emergency Physicians/Canadian Thoracic Society guidelines for the management of asthma in the ED (19–21). The

purpose of the EDACP was to increase adherence with evidence-based asthma care in Ontario Emergency Departments with the ultimate goal of reducing health services utilization and improving patient outcomes for asthma.

A pilot project found that implementing the standardized EDACP in diverse EDs was challenging, with only modest uptake (average 26%; maximum 60% of eligible patients) (22,23). Intervention sites had significant improvements in referrals and retention of teaching done during the ED visit. Patients managed on the EDACP had increased documentation of peak expiratory flow (PEF), use of systemic steroids in the ED and on discharge, and involvement of respiratory therapists in ED care. The majority of staff surveyed in the pilot study, favored plans for a province-wide dissemination.

Given the potential for improved care and outcomes, the Government of Ontario funded the The Lung Association-Ontario to design and support a provincial 'roll-out' following knowledge translation principles, making the EDACP available to all Ontario EDs (21,24). The roll-out consisted of multi-disciplinary regional training workshops held from the fall of 2008 until 2011. Workshops provided information on how to implement the EDACP and were held on a regional basis in an attempt to minimize the effect of distance as a barrier to workshop participation.

Since the project began, The Lung Association-Ontario has been regularly surveying the pathway implementation status at all Ontario EDs. The objectives of this study were to: (1) describe baseline patterns of ED use by adult asthma patients in Ontario; and (2) determine hospital characteristics associated with implementation workshop attendance and subsequent pathway implementation. We hypothesized that workshop attendance would increase subsequent pathway implementation.

Methods

Overall design and setting

We conducted a retrospective data linkage study of a cohort of adults who were seen for asthma in an ED or Urgent Care Center (UCC) in Ontario, Canada prior to the 'roll-out' period. We linked site-level data from The Lung Association-Ontario's databases to a population-based administrative health database of all ED visits to determine the association between site characteristics and workshop attendance and pathway implementation. This study was approved by the institutional review board at Sunnybrook Health Sciences

Center, Toronto, Ontario and the Research Ethics Board of Queen's University, Kingston, Ontario, Canada.

Data sources

Records of asthma visits to all EDs and UCCs in Ontario from April 1, 2006 to March 31, 2008, were accessed from the Canadian Institute for Health Information-National Ambulatory Care Reporting System (CIHI-NACRS), an administrative health database housed at the Institute for Clinical Evaluative Sciences (ICES). Our patient cohort consisted of all adults 20 to 64-years old with an ED or UCC visit for asthma, defined as asthma or status asthmaticus (International Classification of Disease [ICD] 10CA codes J45 and J46) as the primary disposition diagnosis or as the secondary diagnoses with a primary diagnosis of wheeze, dyspnea, cough, or respiratory failure (ICD 10CA codes R06.2, R06.0, R05, J96.0). This cohort was used to determine the volume of all patients with asthma at each site and to calculate the propensity of each site to admit adults with asthma. Patients who were missing data or died were excluded from our analysis (0.6% of cohort).

The Lung Association-Ontario monitored workshop attendance by site during the 'roll-out' phase. If a hospital corporation was listed as attending a workshop, it was assumed they were representing all sites within that corporation. Between April, 2008 to October, 2013 The Lung Association-Ontario regularly monitored EDACP implementation status via phone or e-mailed questionnaires. Each site's last known implementation status was used in the analysis.

Data linkage

Unique encrypted identifiers allowed us to identify multiple visits to the ED by the same individual, and extract patient characteristics (gender, age, address) from the Registered Persons Database (RPDB) and records of hospital admissions from the CIHI-Discharge Abstract Database (DAD), for our cohort. These data were housed at ICES and were used to identify the hospital site for each visit. In the event of a transfer, patients were assigned to the ED from where they were discharged. For return visits, patients were assigned to the ED from their index visit. A patient's residence postal code was used to obtain the nearest census-based neighborhood (defined as a census dissemination area-average population of 400–700) income quintile. These income quintiles

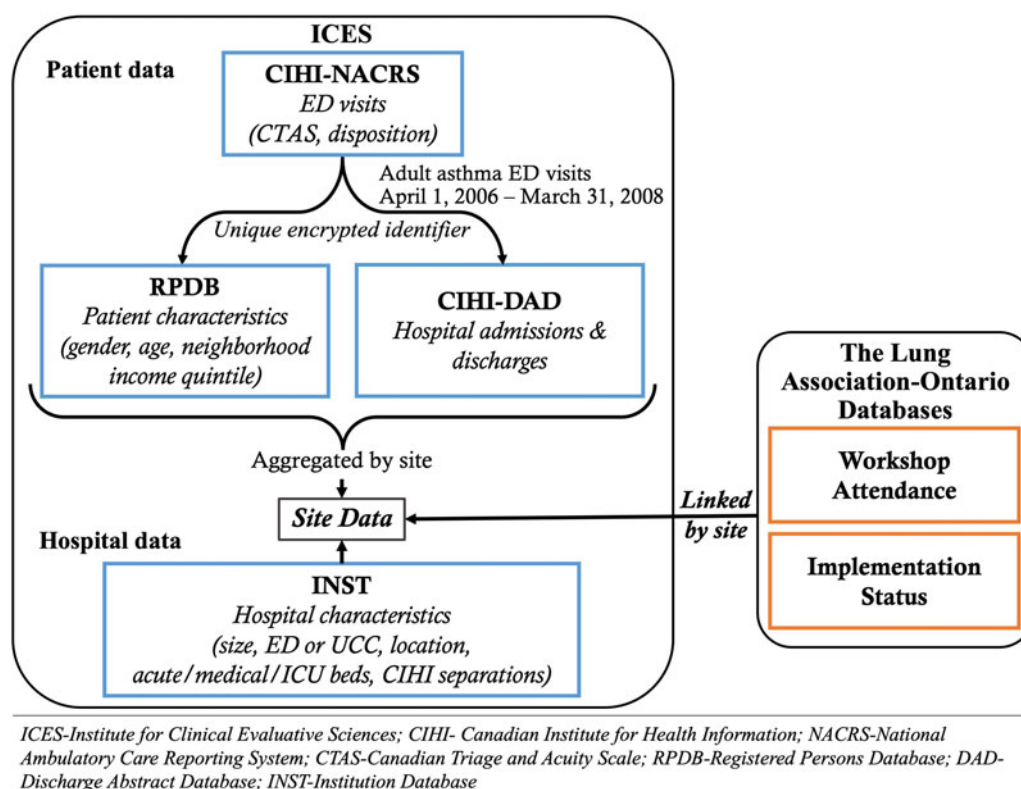


Figure 1. Linkage of data sources.

were determined by ranking the average income per single-person equivalent from the 2011 census of each dissemination area within each census metropolitan area or census agglomeration. As such, these income quintiles are relative to the area surrounding the neighborhood, rather than to the province as a whole.

ICES hospital characteristic data from the Institution Database (INST) was linked by site to the patient data, as well as to all site-level data from The Lung Association-Ontario (workshop attendance, implementation status) (Figure 1). We described hospitals as being either teaching, community, or small as defined within the INST database. The overall number of ED visits and hospital admissions were used as markers of hospital volume.

Statistical analysis

Hierarchical logistic regression models, patients nested within hospitals, were initially used to investigate the association between patient and site characteristics and: a) workshop attendance; b) pathway implementation.

Patient-level factors studied were gender, age, neighborhood income quintile, exacerbation severity, disposition, and recent ED visit or hospitalization for asthma prior to the index ED visit. Neighborhood

income quintiles were based on the average income per single-person equivalent in a dissemination area obtained from 2011 census data.

Site-level factors studied were hospital type, propensity to admit, proportion of asthma-related ED patients (per 100 ED patients), volume of all ED visits, and hospital admissions. The ED visit disposition was used to determine propensity to admit. The numerator was the number of ED visits for asthma that resulted in an inpatient admission (ED visit disposition was admission to hospital) divided by the total ED visits for asthma. This was calculated over a two-year lookback period. Sites with missing data were excluded from the analysis.

All patient-level variables changed effect estimates by less than 10%, indicating no confounding effects were observed on either workshop attendance or implementation status. As such, nonhierarchical multi-variable logistic regression was performed using only hospital-level characteristics. A change-in-estimate approach was used for variable selection for multivariate regression models. Only variables that changed the effect estimate for the relationship between the exposure (e.g. implementation status) and outcome (e.g. return visits within 72 h) by more than 10% were included in the multivariate models. All analyses were conducted within ICES.

Table 1. Characteristics of adults 20–64 years old seeking care for asthma in EDs, according to hospital type: April 2006 to March 2008.

Characteristic	Hospital type, n (%)			Overall (N = 41143), n (%)
	Teaching (n = 6551)	Community (n = 29027)	Small (n = 5565)	
Male	2524 (38.5%)	10942 (37.6%)	2062 (37%)	15528 (37.7%)
Age group, y				
20–34	3072 (46.8%)	12067 (41.5%)	2024 (36.3%)	17163 (41.7%)
35–49	2156 (32.9%)	10423 (35.9%)	2121 (38.1%)	14700 (35.7%)
50–64	1323 (20.1%)	6537 (22.5%)	1420 (25.5%)	9280 (22.5%)
Neighborhood income quintile				
1 (lowest)	2158 (32.9%)	7695 (26.5%)	1312 (23.5%)	11165 (27.1%)
2	1482 (22.6%)	6431 (22.1%)	1232 (22.1%)	9145 (22.2%)
3	1089 (16.6%)	5733 (19.7%)	1142 (20.5%)	7964 (19.3%)
4	904 (13.7%)	5057 (17.4%)	1032 (18.5%)	6993 (16.9%)
5 (highest)	918 (14%)	4111 (14.1%)	847 (15.2%)	5876 (14.2%)
Canadian triage assessment score				
1–2 (resuscitation, emergent)	1403 (21.4%)	5329 (18.3%)	287 (5.1%)	7019 (17%)
3 (urgent)	3444 (52.5%)	14791 (50.9%)	1410 (25.3%)	19645 (47.7%)
4–5 (semiurgent, nonurgent)	1704 (26%)	8907 (30.6%)	3868 (69.5%)	14479 (35.1%)
Disposition				
Admitted	320 (4.8%)	1312 (4.5%)	101 (1.8%)	1733 (4.2%)
Discharged	6070 (92.6%)	27242 (93.8%)	5422 (97.4%)	38734 (94.1%)
Transferred	16 (2%)	62 (2%)	11 (1%)	89 (0.2%)
Left before visit complete	144 (2.1%)	410 (1.4%)	30 (0.5%)	584 (1.4%)
Died	<6	<6	<6	<6
History of asthma admission ^a	423 (6.5%)	1802 (6.2%)	202 (3.6%)	2427 (5.9%)
Recent ED visit for asthma ^a	456 (7%)	2076 (7.2%)	425 (7.6%)	2957 (7.2%)
Return visit within 72h	137 (2.1%)	814 (2.8%)	202 (3.6%)	1153 (2.8%)

^aWithin 12 months preceding index ED visit.

Results

ED visits for asthma

Characteristics of our patient cohort by hospital type are shown in Table 1. There were 41 143 asthma visits to 167 sites (156 EDs and 11 UCCs; 19 teaching, 94 community and 54 small hospitals) by adults. Most visits (29 027 [70.6%]) occurred in large community hospitals, were by females, and from low-income neighborhoods. Teaching and community hospitals tended to treat younger patients, those with higher triage acuity scores, and those with an admission for asthma within the preceding 12-months of their index ED visit. They also had higher admission rates and higher rates of patients leaving before their visit was completed, compared to small hospitals.

There were 1 153 (2.8%) asthma-related return visits within 72 h of the index ED visit. Return visit rates differed significantly by hospital type, with the highest rate being at small hospitals (3.6%) and the lowest at teaching hospitals (2.1%; $p < 0.001$).

Hierarchical models

No patient characteristics were found to be associated with either workshop attendance or implementation status and the ICC was less than 0.1 for all hierarchical models. Therefore, results of separate multi-variable logistic regression analyses for examining factors associated with the outcomes (workshop attendance

and implementation status) using site-level hospital characteristics are presented.

Workshop attendance

Implementation workshops were attended by staff from 122 sites (73%: 15 teaching, 69 community, and 38 small hospitals). Site characteristics by workshop attendance are detailed in Table 2. There were no statistically significant differences between sites that attended workshops and the overall hospital cohort. Site characteristics, including hospital type, were not found to be associated with an increased odds of attending an implementation workshop (Table 3). No confounding effects of patient-level variables were observed.

EDACP implementation status

As of October 2013, implementation status was known for 108 sites (65%) and is outlined in Table 4. Seventy-three percent of sites whose implementation status was known were either using or planning to use the pathway. Overall, including sites with missing/unknown implementation status, 47% of hospitals were using or planning to use the EDACP. Implementation status varied overall by hospital type ($p < 0.001$), but not by workshop attendance ($p = 0.11$). Over half of the province's teaching hospitals were not planning to use the pathway, whereas over half of community hospitals were planning to

Table 2. Site characteristics according to workshop attendance.

Characteristic	Attended workshop		p-value
	Yes	No	
Hospital type			0.76
Teaching, n (%)	15 (12.2%)	4 (8.8%)	
Community, n (%)	69 (56.5%)	25 (55.5%)	
Small, n (%)	38 (31.1%)	16 (35.5%)	
Urgent care center			0.17
Yes, n (%)	6 (4.9%)	5 (11.1%)	
No, n (%)	116 (95%)	40 (88.8%)	
Bed information			
Has Acute Beds, n (%)	117 (95.9%)	41 (91.1%)	0.25
Medical Beds, mean (SD)	48 (62.3)	38.5 (67.2)	0.41
ICU Beds, mean (SD)	10.9 (16.4)	8 (16.1)	0.32
Total Beds, mean (SD)	120.4 (133.8)	95.3 (142.8)	0.31
Level of activity			
ED visits, mean (SD)	31211.5 (19930.8)	26020.8 (22019)	0.15
Hospital admissions, mean (SD)	7208.9 (8200.1)	5975.8 (9157.7)	0.42
OHIP Claims, mean (SD)	264774.7 (361229.9)	208248.3 (446988.5)	0.42
Open 24/7	116 (95.0%)	42 (93.3%)	0.70
Propensity to admit per 100 patients, mean (SD)	3.7 (3.3)	2.8 (3.0)	0.10

Table 3. Unadjusted and adjusted ORs of workshop attendance according to hospital characteristics.

Characteristic	Unadjusted OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
Hospital type				
Teaching	ref		ref	
Community	0.74 (0.22–2.43)	0.84	0.93 (0.21–4.18)	0.86
Small	0.63 (0.18–2.21)	0.48	1.01 (0.17–5.92)	0.94
Propensity to admit	1.11 (0.98–1.26)	0.11	0.9 (0.23–3.54)	0.25
Proportion of asthma-related ED patients (per 100 ED patients)	0.68 (0.2–2.28)	0.53	1.09 (0.94–1.27)	0.88
ED visits	1.01 (1.00–1.02)	0.15	*	–
Hospital admissions	1.00 (0.99–1.01)	0.42	1.00 (0.99–1.01)	0.95

*Results did not meet the change-in-estimate criteria for inclusion in the multivariate models.

Table 4. Site characteristics according to implementation status (as of October, 2013).

Characteristic	Missing/unknown	Not planning to use	Planning/ considering to use	Using, approved, or in progress	p-value
Hospital type					<0.001
Teaching	5 (26.3%)	11 (57.8%)	1 (5.2%)	2 (10.5%)	
Community	32 (34.0%)	10 (10.6%)	18 (19.1%)	34 (36.1%)	
Small	22 (40.7%)	8 (14.8%)	9 (16.6%)	15 (27.7%)	
Workshop attendance					0.11
Yes	38 (31.1%)	21 (17.2%)	25 (20.4%)	38 (31.1%)	
No	21 (46.6%)	8 (17.7%)	3 (6.6%)	13 (28.8%)	

use the pathway, were in the process of implementing it, or had already approved the pathway for use.

Table 5 describes the association between hospital characteristics and pathway implementation status. Adjusting for other site-level characteristics, compared with teaching hospitals, community hospitals were more likely to be using, have approved the pathway, or be in the process of implementing the pathway (OR: 6.69; 95% confidence interval: [CI] 1.06–42.1). In the adjusted models, propensity to admit, proportion of asthma ED patients (per 100 ED patients), and workshop attendance were not associated with higher implementation.

Discussion

This provincial adult asthma quality improvement initiative reached the majority of Ontario hospitals. By

2013, almost half of Ontario hospitals indicated they were using or planning to use the EDACP. While implementation status did not differ overall by workshop attendance, sites where staff attended workshops were more likely to be planning to implement or considering use of the EDACP.

In Ontario, Canada between 2008 and 2011, there were over 40 000 ED visits for asthma, with the vast majority of patients discharged home. Health care utilization for asthma in Ontario EDs during this study was very similar to that documented previously in the Ontario Asthma Regional Variation study conducted in 2001–2002 (25), and analyses of ED visits in Alberta, Canada from 1999–2011 (26,27). Return visit rates were lower in the adult population analyzed, than previously studied pediatric cohorts in North America (28–30).

We found no significant hospital characteristics that seemed to influence workshop attendance,

Table 5. Adjusted ORs (95% CI) of implementation status according to hospital characteristics .

Characteristic	Missing/unknown (n = 56)	Not planning to use (n = 28)	Planning/considering to use (n = 27)	Using, approved, or in progress (n = 49)
Hospital type				
Teaching	ref	ref	ref	ref
Community	0.79 (0.19–3.35)	0.11 (0.03–0.47)	6.53 (0.59–71.81)	6.69 (1.06–42.1)
Small	0.64 (0.12–3.44)	0.21 (0.03–1.39)	7.37 (0.48–112.8)	5.49 (0.68–44.3)
Propensity to admit	1.02 (0.91–1.15)	1.14 (1.00–1.30)	0.95 (0.8–1.12)	0.89 (0.76–1.04)
Propensity of all asthma patients (per 100 patients)	1.02 (0.91–1.15)	0.71 (0.12–4.32)	1.48 (0.28–7.86)	0.71 (0.18–2.86)
ED visits	*	*	*	*
Hospital admissions	0.99 (0.99–1.0)	1.00 (1.00–1.01)	1.00 (1.00–1.01)	1.00 (1.00–1.01)
Workshop attendance	0.58 (0.28–1.21)	0.7 (0.25–1.97)	3.46 (0.97–12.3)	1.22 (0.55–2.69)

*Results did not meet the change-in-estimate criteria for inclusion in the multivariate models.

including hospital type. Sites were asked to identify a ‘site champion’ to attend the workshop in order to help push the initiative forward locally, a previously identified barrier (13,23). These included nurses, respiratory therapists and physicians. Despite numerous workshops being held in different locations throughout the province over a 3 year period, over one quarter of sites still did not attend. This was possibly due to time, financial and personnel constraints (23).

This study also evaluated pathway implementation at diverse institutions across a large geographic area. To our knowledge this is one of the largest scale attempts to implement a standardized pathway across such a variety of sites, from small rural hospitals, to large academic centers. Even up to two years after the last implementation workshop, some sites were still in the process of implementing the pathway or considering implementation. It was surprising that workshop attendance was not associated with subsequent pathway implementation. This was likely due to barriers that exist following workshop attendance and not the power of the study. It has also been shown that implementation of pathways can vary by site characteristics (31).

It can be difficult for large knowledge translation initiatives to overcome the many barriers to implementation which may be variable at each site (23,32,33). Perceived barriers to pathway uptake have previously been identified including lack of training on pathway use, failure to initiate the pathway at triage, insufficient time to complete the care pathway when the ED was busy, lack of spirometry or peak flow meters in the ED and lack of a site champion (23). These perceptions may stall efforts to push forward pathway implementation locally. Some of these barriers may be compounded in large teaching hospitals where a large number of individuals would have to be educated about the pathway, accounting for the lower rates of implementation.

This study has a few notable limitations. Regular surveys by The Lung Association-Ontario monitored pathway uptake, but without a central contact database, implementation status could not be obtained for all sites. Difficulties with maintaining a central contact database included staff turnover and staff in different positions being the local site champion. Implementation status was self-reported and not independently confirmed, potentially introducing recall and social desirability biases (34,35). Assuming sites whose implementation status was unknown had not implemented the pathway, the overall actual and planned uptake was 47%. If on the other hand some whose implementation status was unknown had actually implemented the pathway, this percent uptake would be an underestimation.

This study identified key baseline data, including return visit rates and hospital admissions, of patients visiting the ED for asthma preceeding the implementation of a standardized EDACP across the province. Nearly three-quarters of all hospitals attended an implementation workshop, and these sites were more likely to be planning to implement or considering use of the EDACP. Future research will focus on updating the implementation status to assess the impact of implementation on health services utilization, including hospital admissions and return ED visits throughout all Ontario hospitals.

Conclusion

Regional workshops allowed implementation training tools to be accessed by all Ontario EDs. Implementation of a standardized adult EDACP has been variable across hospital sites, but was more common in large community hospitals, where the majority of ED visits for adult asthma occurred. Future research will evaluate the impact of implementation of the EDACP on health services utilization and other patient outcomes.

Declaration of interest

The authors alone are responsible for the content and writing of the paper.

In the past 3 years, M. Diane Loughheed has received grants outside the submitted work paid directly to Queen's University from The Lung Association-Ontario, Ontario Thoracic Society, the Government of Ontario's Innovation Fund, AllerGen NCE, Queen's University, GlaxoSmithKline, AstraZeneca, Hoffman LaRoche, Janssen, and Novartis, honoraria from the The Lung Association-Ontario and the Canadian Thoracic Society for preparation and review of educational materials, and honoraria from AstraZeneca for participation in the Precision Program Advisory Board.

Funding

This study was funded by the Queen's University William M. Spear Endowment/Start Memorial Fund. The Government of Ontario funded the Emergency Department Asthma Care Pathway development and province-wide dissemination. This study was supported by ICES, which is funded by an annual grant from the Ontario Ministry of Health and Long-Term Care (MOHLTC). The opinions, results and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by ICES or the Ontario MOHLTC is intended or should be inferred. Parts of this material are based on data and information compiled and provided by CIHI. However, the analyses, conclusions, opinions and statements expressed herein are those of the author, and not necessarily those of CIHI.

M. Diane Loughheed and Jennifer Olajos-Clow participated in the development of the EDACP, and design and delivery of the implementation workshops.

Carole Madeley was an employee of The Lung Association-Ontario, responsible for the pathway implementation workshops.

Chanel Kwok, Linda Levesque, Yvonne DeWit, Jennifer Olajos-Clow, and Teresa To have no conflicts of interest to declare.

References

- To T, Stanojevic S, Moores G, Gershon AS, Bateman ED, Cruz AA, Boulet LP. Global asthma prevalence in adults: findings from the cross-sectional world health survey. *BMC Public Health*. 2012; Dec. 12(1):204. doi:10.1186/1471-2458-12-204.
- To T, Gershon A, Tassoudji M, Guan J, Wang C, Estrabillo E, Cicutto L. The burden of asthma in Ontario. IC/ES Investigative Report. 2006.
- Public Health Agency of Canada. Fast facts about asthma: data compiled from the 2011 Survey on living with chronic diseases in Canada. 2013. http://www.phac-aspc.gc.ca/cd-mc/crd-mrc/asthma_fs_asthme-eng.php [last accessed 30 April 2018].
- Canadian Institute for Health Information. Hospital report 2007: emergency department care. 2007. Available from: http://www.hospitalreport.ca/downloads/2007/EDC/ed_report_2007.pdf [last accessed 21 February 2017].
- Loughheed MD, Lemiere C, Ducharme FM, Licskai C, Dell SD, Rowe BH, FitzGerald M, Leigh R, Watson W, Boulet LP. Canadian thoracic society asthma clinical assembly. Canadian thoracic society 2012 guideline update: diagnosis and management of asthma in preschoolers, children and adults. *Can Respir J*. 2012; 19(2):127–64. doi:10.1155/2012/635624.
- Global Initiative for Asthma. Global strategy for asthma management and prevention. 2018. Available from: www.ginasthma.org.
- 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(5):321–6. doi:10.1017/S1481803500009581.
- McIvor RA, Boulet LP, FitzGerald JM, Zimmerman S, Chapman KR. Asthma control in Canada: no improvement since we last looked in 1999. *Can Fam Physician*. 2007;53(4):672–7.
- Garvey N, Loughheed MD. Asthma in Ontario: Ontario's asthma plan of action. *Can Respir J*. 2006; 13(Suppl A):32A–4A.
- Boulet L-P, Becker A, Bowie D, Hernandez P, McIvor A, Rouleau M, Bourbeau J, Graham ID, Logan J, Légaré F, 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):5A–47A. doi:10.1155/2006/287125.
- Davis DA, Taylor-Vaisey A. Translating guidelines into practice - A systematic review of theoretic concepts, practical experience and research evidence in the adoption of clinical practice guidelines. *CMAJ*. 1997;157(4):408–16.
- Loughheed MD, Olajos-Clow JG. Asthma care pathways in the emergency department. *Curr Opin Allergy Clin Immunol*. 2010;10(3):181–7. doi:10.1097/ACI.0b013e328339731d.
- Jabbour M, Curran J, Scott SD, Guttman A, Rotter T, Ducharme FM, Loughheed MD, McNaughton-Filion ML, Newton A, Shafir M, et al. Best strategies to implement clinical pathways in an emergency department setting: study protocol for a cluster randomized controlled trial. *Implementation Sci*. 2013;8(1):55. doi:10.1186/1748-5908-8-55.
- Rotter T, Kinsman L, James E, Machotta A, Gothe H, Willis J, Snow P, Kugler J. Clinical pathways: effects on professional practice, patient outcomes, length of stay and hospital costs. *Eval Health Prof*. 2010;1(3): CD006632–1. doi:10.1177/0163278711407313.
- Bailey R, Weingarten S, Lewis M, Mohsenifar Z. Impact of clinical pathways and practice guidelines on the management of acute exacerbations of bronchial asthma. *Chest*. 1998;113(1):28–33. Jan 1doi:10.1378/chest.113.1.28.
- de Tarso Roth Dalcin P, Da Rocha PM, Franciscatto E, Kang SH, Menegotto DM, Polanczyk CA, Menna Barreto SS. Effect of clinical pathways on the management of acute asthma in the emergency department:

- five years of evaluation. *J Asthma*. 2007;44(4):273–9. doi:10.1080/02770900701247020.
17. Bekmezian A, Fee C, Weber E. Clinical pathway improves pediatrics asthma management in the emergency department and reduces admissions. *J Asthma*. 2015;52(8):806–14. doi:10.3109/02770903.2015.1019086.
18. Kaiser SV, Rodean J, Bekmezian A, Hall M, Shah SS, Mahant S, Parikh K, Auerbach AD, Morse R, Puls HT, et al. Effectiveness of pediatric asthma pathways for hospitalized children: a multicenter, national analysis. *J Pediatr*. 2018;197:165–71. doi:10.1016/j.jpeds.2018.01.084.
19. Beveridge RC, Grunfeld AF, Hodder RV, Verbeek PR. Guidelines for the emergency management of asthma in adults. CAEP/CTS Asthma Advisory Committee. Canadian Association of Emergency Physicians and the Canadian Thoracic Society. *CMAJ*. 1996;155(1):25–37.
20. Boulet LP, Becker A, Berube D, Beveridge R, Ernst P. Canadian Asthma Consensus Group. Canadian asthma consensus report, 1999. *CMAJ*. 1999;161(11 Suppl):S1–S5.
21. Boulet L-P, Bai TR, Becker A, Bérubé D, Beveridge R, Bowie DM, Chapman KR, Côté J, Cockcroft D, Ducharme FM, et al. What is new since the last (1999) Canadian Asthma Consensus Guidelines? *Can Respir J*. 2001;8(Suppl A):5A–27A. doi:10.1155/2001/278435.
22. Loughheed MD, Olajos-Clow J, Szpiro K, Moyse P, Julien B, Wang M, Day AG. Multicentre evaluation of an emergency department asthma care pathway for adults. *CJEM*. 2009;11(3):215–29. doi:10.1017/S1481803500011234.
23. Olajos-Clow J, Szpiro K, Julien B, Minard J, Loughheed MD. Emergency department adult asthma care pathway: healthcare providers' perceived utility and barriers to implementation. *Adv Emerg Nurs J*. 2009;31(1):44–53. doi:10.1097/TME.0b013e3181946f76.
24. Harrison MB, Légaré F, Graham ID, Fervers B. Adapting clinical practice guidelines to local context and assessing barriers to their use. *Can Med Assoc J*. 2010;182(2):E78–84. doi:10.1503/cmaj.081232.
25. Loughheed MD, Garvey N, Chapman KR, Cicutto L, Dales R, Day AG, Hopman WM, Lam M, Sears MR, Szpiro K, et al. The Ontario Asthma Regional Variation Study: emergency department visit rates and the relation to hospitalization rates. *Chest*. 2006;129(4):909–17. doi:10.1378/chest.129.4.909.
26. Rowe BH, Voaklander DC, Wang D, Senthilselvan A, Klassen TP, Marrie TJ, Rosychuk RJ. Asthma presentations by adults to emergency departments in Alberta, Canada: a large population-based study. *Chest*. 2009;135(1):57–65. doi:10.1378/chest.07-3041.
27. Rosychuk RJ, Youngson E, Rowe BH. Presentations to Alberta emergency departments for asthma: a time series analysis. *Acad Emerg Med*. 2015;22(8):942–9. doi:10.1111/acem.12725.
28. Guttman A, Zagorski B, Austin PC, Schull M, Razzaq A, To T, Anderson G. Effectiveness of emergency department asthma management strategies on return visits in children: a population-based study. *Pediatrics*. 2007;120(6):e1402–10. doi:10.1542/peds.2007-0168.
29. Li P, To T, Parkin PC, Anderson GM, Guttman A. Association between evidence-based standardized protocols in emergency departments with childhood asthma outcomes: a Canadian population-based study. *Arch Pediatr Adolesc Med*. 2012;166(9):834–40. doi:10.1001/archpediatrics.2012.1195.
30. Akenroye AT, Thurm CW, Neuman MI, Alpern ER, Srivastava G, Spencer SP, Simon HK, Tejedor-Sojo J, Gosdin CH, Brennan E, et al. Prevalence and predictors of return visits to pediatric emergency departments. *J Hosp Med*. 2014;9(12):779–87. doi:10.1002/jhm.2273.
31. Kaiser SV, Rodean J, Bekmezian A, Hall M, Shah SS, Mahant S, Parikh K, Morse R, Puls H, Cabana MD. Pediatric Research in Inpatient Settings (PRIS) Network. Rising utilization of inpatient pediatric asthma pathways. *J Asthma*. 2018;55(2):196–207. doi:10.1080/02770903.2017.1316392.
32. Evans-Lacko S, Jarrett M, McCrone P, Thornicroft G. Facilitators and barriers to implementing clinical care pathways. *BMC Health Serv Res*. 2010;10(1):182. doi:10.1186/1472-6963-10-182.
33. Jabbour M, Newton AS, Johnson D, Curran JA. Defining barriers and enablers for clinical pathway implementation in complex clinical settings. *Implementation Sci*. 2018;13(1):139. doi:10.1186/s13012-018-0832-8.
34. Coughlin SS. Recall bias in epidemiologic studies. *J Clin Epidemiol*. 1990;43(1):87–91. doi:10.1016/0895-4356(90)90060-3.
35. Nederhof AJ. Methods of coping with social desirability bias: a review. *Eur J Soc Psychol*. 1985;15(3):263–80. doi:10.1002/ejsp.2420150303.