

INFORMATION TECHNOLOGY

Asthma Electronic Medical Records in Primary Care: An Integrative Review

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Background. Quality management, evaluation, and surveillance of asthma may be enhanced by access to and utilization of an asthma electronic medical record (EMR) in primary care. **Purpose.** To describe the current status, support tools, and utility of asthma EMRs in primary care. **Methods.** An integrative review of the literature published between 1996 and 2008 was completed using Ovid MEDLINE, EMBASE, and CINAHL databases. Key search terms included asthma, medical records, computerized, primary health care, primary care, family physician, family practice, chronic disease, COPD, neoplasm, diabetes mellitus, and cardiovascular disease. Articles related to concepts, systems in development, and sources such as acute care and pharmacy EMRs were excluded. Each article was reviewed by two reviewers. **Results.** Of 309 articles identified, 76 met the inclusion criteria. Twenty-two percent were specific to asthma, 78% pertained to other chronic diseases and/or the overall status of an EMR in primary care. The literature varied in methodology, topics of discussion and value of data. Articles describing an asthma EMR most often reported on decision support tools ($n=3$) and/or utility ($n=14$), specifically the ability to predict mortality and assess severity and timeliness of diagnosis. A primary care EMR containing a validated asthma minimum data set was not found. Three themes emerged from the review: status (description of users, functionalities and adoption issues), tools (decision support tools to enhance knowledge uptake), and utility (data quality, extraction and outcomes). **Conclusions.** There is a paucity of asthma elements in EMRs in primary care, with the exception of discussion of decision support tools and utility. Integration of a more robust asthma EMR in primary care, including a minimum data set, standardized terminology, and validated indicators, may further enhance care and enable outcomes monitoring.

Keywords: asthma; chronic disease; electronic medical record and primary care

BACKGROUND

Asthma is a chronic disease that is largely managed in the primary care setting (1). Approximately 300 million people worldwide have asthma, which affects more than 10% of the population (2). The burden associated with asthma encompasses both direct medical and indirect economic costs, which has implications for health care systems, affected individuals and their families. Presumably, effective disease management at the primary care level will reduce the burden of asthma (3).

Quality management, evaluation, and surveillance of asthma may be enhanced by access to and utilization of an electronic medical record (EMR) in primary care. It is expected that the integration of individual primary care EMRs into one large electronic health care record will improve the quality of patient care, enhance the productivity of health care professionals, and aid clinical and health service research (4). In 2003, the National Alliance for Primary Care Informatics reported EMRs as a necessity for patient and provider satisfaction, enabling the computerization of reminders and prevention guidelines to benefit the quality of care (5).

Many health care settings including primary care are utilizing (EMRs) as the standard method of documentation, communication, and surveillance.

Electronic documentation may eliminate problems related to the use of paper-based records and facilitate the transfer of information between settings across the continuum of care. Other potential benefits include the ability to view, document, prescribe, order, message, analyze and report, bill, and provide patient access (6). High percentages (more than 90%) of general practitioners from Europe, Australia, and New Zealand currently have and use EMRs in their offices for clinical purposes (7). Despite the potential benefits and quality improvement opportunities associated with EMR use, uptake by Canadian primary care physicians has been slow (8).

In 2002 the Ontario Ministry of Health and Long-Term Care (MOHLTC) launched the Asthma Plan of Action (APA) (9). The aim of the APA is to disseminate, implement, and evaluate asthma guidelines within the province to reduce asthma morbidity, mortality, and associated costs. One of the APA's 13 initiatives was the Primary Care Asthma Pilot Project (PCAPP), which evaluated and reported on the implementation of an evidence-based asthma care program in eight primary care settings (10). Implementation of this program led to risk reductions in exacerbations, symptoms, urgent health service use, and asthma-related productivity loss at 6- and 12-month stages. The pilot evolved into the Primary Care Asthma Program (PCAP), which continues to deliver and evaluate the provision of asthma care in primary care settings in Ontario. As a first step towards developing and piloting

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the incorporation of the PCAP asthma care map and action plan (10) into primary care EMRs for use by PCAP providers, we conducted a comprehensive review of the literature to ascertain the availability, status, and utility of asthma EMRs in primary care.

METHODS

Literature Search

A preliminary literature search was performed to determine the status and extent of literature describing asthma EMRs in primary care settings. Three common themes emerged from the search (tools, status, and utility) with very limited results specific to asthma (Figure 1).

Relevant articles were scanned and briefly summarized. Common topics and themes recorded during the preliminary summary were used to generate variables in the *Data Display Tool* (Figure 2) and the *Synthesis Tool* described in detail and available upon request. The tools were constructed to collect data related to the study objectives and to serve as templates throughout analysis. Data recorded in the *Data Display Tool* included criteria for implementation, system inputs/outputs, sample characteristics, and features of an asthma system. The data variables for the *Synthesis Tool* addressed design, medical record format, setting, theme, variable location, and findings.

As the preliminary search identified few articles describing the tools, status, and utility of asthma primary care EMRs, the scope of the review was broadened to encompass four other chronic diseases that account for a substantial portion of the burden of illness for chronic disease worldwide: cardiac, cancer, diabetes and chronic obstructive pulmonary disease (11). Additional searches were conducted using the electronic databases Ovid MEDLINE, EMBASE, and CINAHL. Table 1 summarizes the search strategy conducted and details the data sources, keywords, and limitations used to ensure relevant information was captured. The following keywords were used: asthma, primary health care, medical records systems, computerized, medical record, electronic, online, compute, e-record, Internet, Web, physicians, family, family practice, primary care, chronic disease, computerized patient record, diabetes mellitus, pulmonary disease,

chronic obstructive, neoplasms, cardiovascular diseases, and case management.

Inclusion and Exclusion Criteria

Titles and abstracts were scanned to identify articles that met the following inclusion criteria: English language articles published between 1996 and 2008 pertaining to the current status, support tools (nonintegrated and integrated within EMRs) and utility of EMRs used in primary care settings. Articles were excluded if the content was related to concepts or systems in development, portals, and non-primary care settings such as acute care and pharmacy EMRs.

Two reviewers critically appraised and summarized retrieved articles using both the *Data Display* and *Synthesis Tools*. Agreement between the reviewers was used to finalize the inclusion and categorization of articles deemed relevant. In cases of disagreement concerning inclusion/categorization, the reviewers thoroughly discussed the topic to reach consensus.

RESULTS

The literature search identified 309 potentially relevant articles. Upon further review there were 287 articles, as an additional 22 did not meet inclusion criteria, of which 61 were included. Ten additional articles retrieved from the preliminary literature search were included in the review, as were four articles that were identified by hand searches of reference lists. One study was obtained through private communication and was unpublished at the time of this review (Figure 3). A total of 76 articles were included in this review.

Twenty-two percent of the identified articles that met inclusion criteria were asthma-specific and 78% of the articles pertained to other chronic diseases and/or the status of an EMR in primary care. A primary care EMR containing a validated asthma minimum data set was not found. Three EMR categories were formulated based on the disease of interest and setting of the respective articles (Primary Care [PC] EMRs, Chronic Disease PC EMRs, and Asthma PC EMRs). Articles were grouped to represent both an EMR category and a theme as indicated in Table 2. The studies varied in both content and design. The most common study designs were cross-sectional

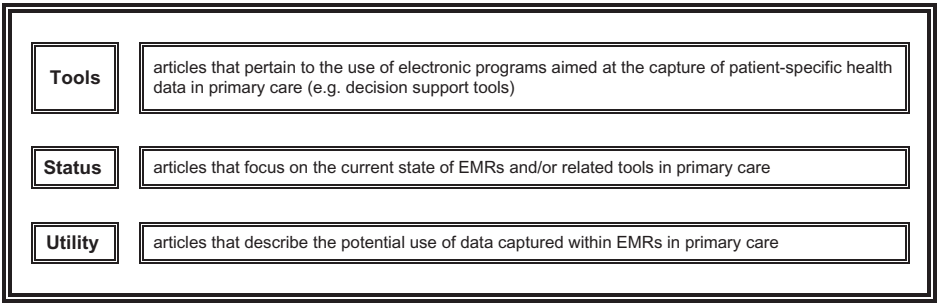


FIGURE 1.— Definitions of common themes which arose during the review. EMRs = Electronic Medical Records.

[illegible]

FIGURE 2.— Data display tool used to record variables for the integrative review.

(21) and descriptive (12), as presented in Table 3. Table 4 details the countries using EMRs in primary care within the reviewed literature.

All 76 articles were briefly described in the Synthesis Tool (available upon request). The number of study participants/patient records ranged from 9 to 2,252,274; the number of primary care sites ranged from one to a nationwide registry, which in 2005 accounted for approximately 370 practices in the United Kingdom (12–14). A condensed version of the data display variables can be viewed in Table 5. A more complete description of this table is presented in Appendix A, available online at <http://informahealthcare.com/jas>.

Primary Care EMRs

The two themes most often described in the PC EMR literature were status (20/33) and utility (13/33) (Table 2). The five most common data display variables describing the presence or need for system functionalities included online prescription integration (14/33), standardized language (diagnostic codes [e.g., the International Statistical Classification of Diseases and Related Health Problems 10th Revision or ICD-10]; 11/33), prompts (11/33), online order entry (10/33), and guideline-based EMRs (9/33). Barriers (12/33) and facilitators (7/33) to the

implementation of EMRs in primary care settings were addressed in more than 50% of the PC EMR literature (Table 5).

The settings of the PC EMR articles are delineated by site (2/20), region/state (6/20), country (7/20), and/or at a multinational level (5/20) (Synthesis Tool). Primary care was the most common health model described (13/20), whereas the remaining articles depicted a mixture of primary, ambulatory, and hospital settings (Appendix A).

Utility was the second most common theme reported in the PC EMR literature (13/33), including a description of multiple purposes for the data. These descriptions were further categorized into three subthemes of utility: data quality (4/13), outcomes (5/13), and data extraction (4/13).

Chronic Disease Primary Care EMRs

Although all three themes were encountered within the Chronic Disease PC EMR literature, the predominant theme was utility (22/26), with emphasis on outcomes (9/22), data extraction (8/22), and data quality (5/22). The most commonly described data display variables included guideline-based EMRs (14/26), standardized language (diagnostic codes [e.g., ICD-10]; 13/26),

TABLE 1.— Search strategy.

Search date	Database	Keywords	Limits	No. of articles	No. of articles reviewed
July 7, 2008	Ovid MEDLINE	Exp asthma and exp primary health care and exp medical records systems, Computerized	1996 to June Week 4 2008	7	6
July 7, 2008	EMBASE	Exp Asthma and exp primary health care and exp medical record and electronic\$/or online\$/ comput\$/or erecord\$/or internet\$/or web\$	1996 to 2008 week 26, English language	4	2
July 9, 2008	Ovid MEDLINE	Physicians, family/or family practice/or primary care/or primary health care and *medical records systems, Computerized	1950 to June Week 4 2008, English language	93	24
July 9, 2008	Ovid MEDLINE	Physicians, family/or family practice/or primary care/or primary health care and *medical records systems, Computerized and chronic disease	1950 to June Week 4 2008, English language	10	2
Sept 18, 2008	CINAHL	Asthma and computerized patient record	1981–present	15	2
Oct 16, 2008	Ovid MEDLINE	Exp asthma and medical records systems, computerized	1996 to October Week 2 2008, English language and yr = “2000–2008”	19	2
Oct 16, 2008	CINAHL	Exp asthma and medical records systems, computerized	1996 to October Week 2 2008, English language and yr = “2000–2008”	42	11
Oct 16, 2008	Ovid MEDLINE	Medical records systems, computerized and exp primary health care	1996 to October Week 2 2008, English language and “review articles” and yr = “2000–2008”	14	1
Oct 16, 2008	Ovid MEDLINE	Medical records systems, computerized and exp primary health care and exp diabetes mellitus/or exp pulmonary disease, chronic obstructive/or chronic disease/or exp neoplasms/or exp cardiovascular diseases/or case management	1950 to October Week 2 2008, English language and yr = “1998–2008”	58	10
Oct 16, 2008	CINAHL	Focus on computerized patient records and primary health care	Published 2000–present, English language	25	1
Total				287	61

prompts (10/26), online prescription integration (5/26), and templates (4/26).

Most articles that detailed the utility of Chronic Disease PC EMRs originated from the United Kingdom (UK) and the United States (US) (Table 4), describing primary care settings (21/22). There was minimal discussion by the authors on the status of Chronic Disease PC EMRs in the US (2/3) and the UK (1/3). Of these articles, the UK article included a description of the status of primary care within a region; in comparison to the two US articles, which more narrowly focused on primary/ambulatory sites.

A decision support tool for PC EMRs was described by Johnson et al. (15) and was in use in the UK for hypertension. This EMR integrated system was guideline-based, and contained an optional template to describe potential action plans (including decision-making and education) for clinicians during patient visits.

Asthma Primary Care EMRs

Although a PC EMR containing a validated asthma minimum data set was not found, of the 76 included articles in this review, 17 were specific to asthma and PC EMRs, of which 14 described utility and 3 focused on tools.

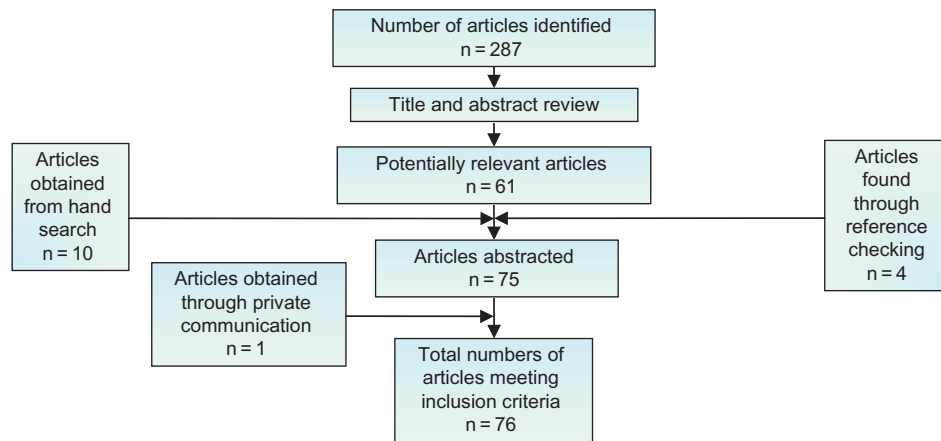


FIGURE 3.— Search results process of the integrative review.

TABLE 2.— Summary of articles categorized by type of EMR and theme.

Categories	Themes			Total
	Tools	Status	Utility	
Primary Care EMRs	0	20	13	33
Chronic Disease PC EMRs	1	3	22	26
Asthma PC EMRs	3	0	14	17
Total	4	23	49	76

Note. EMRs = electronic medical records; PC = primary care.

TABLE 3.— Study design types of included articles.

Study design	Number of articles
Cross-sectional	21
Descriptive	12
Retrospective	7
Randomized controlled trial	6
Case study	5
Comparison	4
Before-after	4
Systematic review	3
Cohort study	3
Prospective	3
Validation	2
Pilot	2
Evaluation	2
Trial	2
Total	76

The data variables described throughout the literature included guideline-based EMRs (11/17), prompts (8/17), extractable data including the need for data over time and the ability to trend results (7/17), diagnostic codes (6/17), alerts (4/17), and educational linkages (3/17).

An asthma decision support tool “AsthmaCritic,” developed in The Netherlands designed to analyze asthma and chronic obstructive pulmonary disease (COPD)

patient records in daily practice settings was described as a guideline-based program (16). The system, which relies on the data it receives and does not ask for additional data entry, generates comments on physician diagnoses and treatments, and adds them to the patient record. Information is analyzed when the patient visit is over and then provides overall comments ranking the urgency and suggesting possible treatments. If the physician asks for additional information, AsthmaCritic responds with a suggestion based on the best available evidence. Users can interrupt the system when required and/or review the information at a future time. At the time of the authors’ publication, the system was being clinically evaluated.

A chronic asthma management system was described within a guideline implementation approach for ambulatory and pediatric patients in New Haven, Connecticut, USA (17). The decision support system prompts clinicians to obtain patients’ symptom data and provides customized asthma advice based on guidelines, including the severity of asthma, level of control, appropriate medication(s), and referral as needed. Upon review of the article, it was undetermined whether results of using this chronic asthma management system had been published.

An integrated information system for the purpose of patient-centered monitoring, case management, and decision support at the point of care was developed in Massachusetts, USA, for children aged 5–16 with mild to persistent asthma and their parents (18). Data obtained from automated-telephone communication with patients was sent overnight to a Web-based alert and nurse case management system and then to EMR providers for clinical support at the point of care. The system also provided education to patients and care providers. At the time of the authors’ publication, the system was being evaluated in a clinical trial of 300 children with persistent asthma.

The utility of asthma data held within PC EMRs and associated tools was described within 14 articles. The care settings of these EMRs were mostly primary care

TABLE 4.—A list of countries using EMRs in primary care settings.

Country	Categories						
	Primary Care EMRs		Chronic Disease Primary Care EMRs			Asthma Primary Care EMRs	
	Status	Utility	Tools	Status	Utility	Tools	Utility
Australia	6						
Austria	1						
Canada	1	1					
China					1		
Denmark	2						1
Finland					1		
Germany	2						
Israel					1		
Netherlands	2	1			1	1	3
New Zealand	2	1			1		
Norway	2				1		
Sweden	2				1		
United Kingdom	3	5(*2)	1	1	8		3
United States	12	5	2		7(*1)	2	10

* Article was a systematic review. EMRs = electronic medical records.

(9/14), the remainder being a combination of primary, ambulatory, and hospital settings. The majority of systems using asthma PC EMRs/tools examined either the patient and/or provider outcomes associated with system use (10/14). The quality of asthma data held within PC EMRs was examined for the predictability of mortality (19), the ability to detect the degree of over- and underreporting of diagnoses (20), and the reliability of records to identify asthma patients (21). The Netherlands reported on the feasibility of a decision support system for asthma and COPD care. They sampled the number of records triggered by the support tool and found that asthma diagnosis and medication were the two most common requests from providers (22).

In Denmark, 98% of citizens are registered with a specific general care practice. Citizens are provided with a civil registry number and must use the practice they are assigned to. All health care information using this number is sent to an electronic National Patient Registry (23). This information was used to describe Denmark's experience in being able to extract data to determine the sensitivity and specificity of identifying asthma patients aged 6 to 14 years. Eighty-one percent of the children in this study were treated in primary care. Three models were created using redeemed antiasthma drug prescription combinations in order to identify asthma. Investigators used discharged asthma diagnosis using ICD-10 or general practitioner-confirmed asthma diagnosis as the gold standard. The best model produced to identify asthma patients was a prescription for any type of drug except liquid β_2 -agonists, inhaled β_2 -agonists only once, or inhaled steroid only once. The model had a specificity of .86 and a sensitivity of .63.

DISCUSSION

This integrative review of the English literature revealed a paucity of published reports on the status, support tools,

and utility of asthma-specific EMRs. A validated minimum asthma data set was not found. Approximately 20% of the articles retrieved were specific to Asthma PC EMRs, reporting most often on utility, followed by status. The variables most often described were evidence-based guidelines, diagnostic codes (standardized language), prompts, and online prescription integration. The variables least reported on were community resources, program reports, and the ability to conduct individual report queries and generate action plans. Gaps in the Asthma PC EMR literature included facilitators and barriers, order entry, online prescription integration, linkages to community resources and education, report capabilities both at a program level and individual patient level, and the ability to generate an action plan.

There were a number of limitations encountered with this literature review. The search was conducted in English only, possibly limiting the available information. The scope of the review was extremely broad. Each of the concepts' "status, support tools, and or utility" are broad topics that could warrant separate reviews. There was no limit to the number of countries included in the search. It may have been more beneficial to limit the search to countries who are known to be leaders in health informatics for example Australia, United Kingdom, Denmark, and Sweden (24).

Other sources of literature were not searched (e.g., white papers, grey papers, health informatics literature, etc.). In contrast, a research team from Alberta, Canada (24), set out to identify lessons learned from health systems implementation experiences in seven countries to better understand the state of knowledge about health information systems adoption in primary care. The search of the literature included Web sites from grey sources, medical colleges, and professional associations, as well as government/commission Web sites, likely providing a broader review of the available research and/or experiences.

TABLE 5.—Total data display results. All 76 articles summarized by (i) theme (tools, status, utility); (ii) type of primary care EMR (primary care, chronic disease, or asthma); and (iii) the type of variables (implementation, inputs etc.).

	EMR + PC				EMR + PC + CD				Asthma			
	Status	Utility	Total	frequency	Tools	Status	Utility	Total	frequency	Tools	Utility	Total
Implementation	11	1	12	0.36	0	0	0	0	0.00	1	0	1
-Barriers	6	1	7	0.21	0	0	1	1	0.04	0	0	0
-Facilitators												
Inputs	7	2	9	0.27	1	1	12	14	0.54	3	9	12
Evidence Based	5	6	11	0.33	0	1	12	13	0.50	1	5	6
Standardized Language	3	3	6	0.18	1	2	1	4	0.15	1	1	2
Template	9	2	11	0.33	0	2	8	10	0.38	2	6	8
Prompts	6	2	8	0.24	0	0	1	1	0.04	1	3	4
Alerts	10	0	10	0.30	0	1	0	1	0.04	0	0	0
Online Order Entry	12	2	14	0.42	0	1	4	5	0.19	0	2	2
Online Prescription Integration	1	0	1	0.03	0	0	0	0	0.00	0	0	0
Linkages	0	0	0	0.00	0	0	0	0	0.00	0	0	0
-Community Resources	5	1	6	0.18	1	0	2	3	0.12	2	1	3
-Education	7	1	8	0.24	0	1	0	1	0.04	1	0	1
Process for Referral												
Outputs	1	2	3	0.09	0	1	1	2	0.08	1	1	2
Extractable Data	0	3	3	0.09	0	1	1	2	0.08	1	4	5
-Longitudinal	0	0	0	0.00	0	0	1	1	0.04	0	2	2
-Result Trending	0	0	0	0.00	0	1	0	1	0.04	0	0	0
Program Reports Patient Outcomes	1	0	1	0.03	0	0	1	1	0.04	0	1	1
Individual Report Queries	0	0	0	0.00	0	0	0	0	0.00	0	0	0
Generate Action Plan	0	0	0	0.00	0	0	0	0	0.00	0	0	0
-Auto fill Action Plan	0	0	0	0.00	1	0	0	1	0.04	0	0	0
-Customize Action Plan	0	0	0	0.00	0	0	0	0	0.04	0	0	0
-Print Action Plan	0	0	0	0.00	0	0	0	0	0.00	0	0	0
Total		33			Total	26		0		Total	17	

*One article did not recommend a decision support tool. EMR = electronic medical record; PC = primary care; CD = chronic disease.

There were different terms in the literature having the same or similar definitions, making it difficult to understand what was being communicated. Some examples were primary care, general practitioner, community care, ambulatory care, and the differences between an EMR and electronic health record (EHR).

The content in the articles often had overlapping themes. Even with two reviewers, it was difficult to come to a consensus on the theme of the article. A search of this scope may have benefited from a larger review team with a variety of critiquing skills, meeting on a regular basis. There was an attempt to offset this need by consulting members of the asthma research team on an as-needed basis.

This literature review did not inform the authors on standardized data definitions for the asthma elements (e.g., asthma diagnosis, parameters for asthma control, smoking history, work-related asthma, spirometry, and asthma medications, etc.). Furthermore, there was no literature on how these data could be extracted and/or should be captured in order that the information is readily extractable for analysis by clinicians, administrators, researchers, and policy makers. The need for standardized data definitions, capture, and extraction is critical and will help inform program evaluation, development of performance measures, and surveillance.

A more recent literature search on the status of EMRs in primary care (24) described challenges, including general practitioners' concerns around costs, time and training, patient safety and quality of care, need for standardization of clinical terms, and efficiency. This review identified the lack of studies aimed at evaluating the utility of EMRs in primary care. There were no studies found that reviewed the drawbacks or benefits of health information systems, how these systems decrease gaps in supply and demand of human resource, and how the system could facilitate quality assurance processes.

Healthcare Information and Management Systems Society (25), a global enterprise task force, was asked to investigate initiatives to implement an EHR in a number of countries around the world, including feedback from countries in Europe, Scandinavia, Asia Pacific, Middle East, and North America. They studied security, quality, financing sources, and barriers to adoption. The four common threads were funding, governance, standardization and interoperability, and communication. All countries experienced a lack of health care information technology (IT) standards, creating barriers for IT adoption. Cost and fear of technology were the major barriers reported. These two reviews further demonstrate the complex task of describing the status of an EMR in primary care.

Although a minimum asthma data set for primary care could not be identified in this review, there is an abundance of literature on EMRs in primary care. Asthma and PC EMRs reported most often on decision support tools and utility. Asthma and PC EMRs helped to inform the authors of the potential benefits of decision support tools that support the uptake of asthma guidelines and knowledge translation. As well, the asthma literature reinforced the importance and benefits of prompts, alerts,

diagnostic codes, data trended over time, and data that are extractable. Integration of a more robust asthma EMR in primary care including a minimum data set, standardized terminology, and validated indicators may enhance care and enable outcomes monitoring.

ACKNOWLEDGMENT

The authors acknowledge the support of the Government of Ontario.

DECLARATION OF INTEREST

M.D. Lougheed has received funding for the research, development and/or pilot testing of an asthma electronic medical record and questionnaires from Health Canada, Queen's University William M Spear Foundation and Start Memorial Fund, the Ontario Thoracic Society, the Government of Ontario and AllerGen NCE. The authors alone are responsible for the content and writing of the paper.

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Appendix A: Data Display Summary Table for the Primary Care (PC), PC Chronic Disease and PC Asthma EMR Categories

Article Number	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Theme	Status	Status	Status	Status	Status	Status	Status	Status	Status	Status	Status
Implementation											
-Barriers			X		X	X			X	X	M
-Facilitators		X	M		X						
Inputs											
Guideline-based		M			M						X
Diagnostic Codes											
Template		X		X			X				X
Prompts	X	X	M				X			X	
Alerts					M		X				X
Online Order Entry		X		X	M					X	X
Online Prescription Integration	X			X	M	X		X			X
Linkages											
-Community Resources											
-Education	X	X								X	X
Process for Referral		M		X						X	
Outputs											
Extractable Data											
-Longitudinal											
-Result Trending											
Program Reports Patient Outcomes											
Individual Report Queries			M								
Generate Action Plan											
-Auto fill Action Plan											
-Customize Action Plan											
-Print Action Plan											
Sample Characteristics:											
Setting											
-Country	US	US	2	NO	US	AU	US	AU	US	AU	US
-Health Care Model	1,2,3,4	1	1	1	1,2	1	1	1	1,3	1	1
Population											
-No. of Participants/Records	65	1	595	229	2758	1319	526	122	672	1186	4203
-Age Group	a/p	a/p	a/p	a/p	a/p	a/p	p	a/p	a/p	a/p	a/p
Illness											

(Continued)

Appendix A: Data display table of included articles from the Primary Care EMR category Article:											
Theme	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
Implementation	Status	Status	Status	Status	Status	Status	Status	Status	Status	Utility	Utility
-Barriers	M					X	X	M	X		
-Facilitators						X	X		X		
Inputs											
Guideline-based	X		M	X	M	X		M	M	X	X
Diagnostic Codes			X								
Template											
Prompts	X					X	X	M		X	
Alerts							X	M	M	X	
Online Order Entry	X		X	X			X	M	M		
Online Prescription Integration	X		X	X	M		X		M		
Linkages			X								
-Community Resources											
-Education	X		X	X						X	
Process for Referral											
Outputs											
Extractable Data			X								
-Longitudinal											
-Result Trending											
Program Reports Patient Outcomes											
Individual Report Queries											
Generate Action Plan											
-Auto fill Action Plan											
-Customize Action Plan											
-Print Action Plan											
Sample Characteristics:											
Setting											
-Country	US	US	DE	3	10	US	7	US	US	US	NE
-Health Care Model	1	1,2	1,2,3,4	1	1	N/A	1	1	1,2	1	1
Population											
-No. of Participants/Records	4203	4203	1800	3	10	9	7	738	847	1221	89
-Age Group	a/p	a/p	a/p	a/p	a/p	a/p	a/p	a/p	a/p	p	a/p
Illness						AD,H,O					

Appendix A: Data display table of included articles from the Primary Care EMR category												
Article:	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)	(31)	(32)	(33)	
Theme	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	
Implementation												
-Barriers												M
-Facilitators												M
Inputs												
Guideline-based								M				
Diagnostic Codes	X			X		S		X			X	
Template								X				
Prompts					X							
Alerts	M		X									
Online Order Entry												
Online Prescription Integration												M
Linkages												
-Community Resources												
-Education												
Process for Referral								M				
Outputs												
Extractable Data		X		X								
-Longitudinal		X			X			M				
-Result Trending												
Program Reports Patient Outcomes												
Individual Report Queries												
Generate Action Plan												
-Auto fill Action Plan												
-Customize Action Plan												
-Print Action Plan												
Sample Characteristics:												
Setting												
-Country	US	UK	NZ	UK	US	RE	UK	US	US	CA	RE	
-Health Care Model	1	1	1	1	1	1	1	1	1	1	1	
Population												
-No. of Participants/Records	5464		124	29492	51	24	9/49658	1	1	42/3	52	
-Age Group	p	a/p	p	a/p	a/p		a	a/p	a/p	a/p		
Illness		A, O		A, H, D, O			H					

Appendix A: Data display table of included articles from the Chronic Disease Primary Care EMR category											
Article:	(34)	(35)	(36)	(37)	(38)	(39)	(40)	(41)	(42)	(43)	(44)
Theme	Status	Status	Status	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility
Implementation											
-Barriers											
-Facilitators											
Inputs											
Guideline-based			M	M				X		X	X
Diagnostic Codes	X				X						X
Template		X	X								
Prompts		X	X	R			X		M		X
Alerts											
Online Order Entry			M								X
Online Prescription Integration		X									
Linkages											
-Community Resources											M
-Education											
Process for Referral		X									
Outputs											
Extractable Data		X									
-Longitudinal		X									
-Result Trending											
Program Reports Patient Outcomes			M								
Individual Report Queries											
Generate Action Plan											
-Autofill Action Plan											
-Customize Action Plan											
-Print Action Plan											
Sample Characteristics:											
Setting											
-Country	UK	US	US	UK	UK	UK	RE	FI	UK	UK	US
-Health Care Model	1	1	1, 2	1	1	1	1	1	1	1	1
Population											
-No. of Participants/Records	17/2512	1	1	1	10975	2252274	30	20	4834	52	122
-Age Group	a/p	a/p	a/p	a/p	a	a			a	a	a
Illness	D	H, D	A, D, O	A, D, H, O	C	H	O	D	H	H	D

Appendix A: Data display table of included articles from the Chronic Disease Primary Care EMR category Article:											
	(45)	(46)	(47)	(48)	(49)	(50)	(51)	(52)	(53)	(54)	(55)
Theme	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Utility
Implementation											
-Barriers											
-Facilitators								X			
Inputs											
Guideline-based											
Diagnostic Codes	X	X	M		X	X		X	X	X	X
Template		X		X							
Prompts		X				M					
Alerts							X				M
Online Order Entry											
Online Prescription Integration			X	X							
Linkages											
-Community Resources								X			
-Education											
Process for Referral											
Outputs											
Extractable Data			X								
-Longitudinal								X			
-Result Trending								X			
Program Reports Patient Outcomes											
Individual Report Queries							X				
Generate Action Plan											
-Auto fill Action Plan											
-Customize Action Plan											
-Print Action Plan											
Sample Characteristics:											
Setting											
-Country	US	US	US	UK	IS	US	SW	NO	NE	UK	NZ
-Health Care Model	1	1	1,2	1	1	1	1	1	1	1	1
Population											
-No. of Participants/Records	205755	23	336401	1	1300	148	2591	14	145866	50756	3564
-Age Group	H	a	a/p	D,H	a	H	a	a/p	a	a	a
Illness		H	A,D,H,O		H,D		D,H,O	A,D,H,O	O	H	H

Appendix A: Data display table of included articles from the Chronic Disease and Asthma Primary Care EMR categories											
Article:	(56)	(57)	(58)	(59)	(60)	(61)	(62)	(63)	(64)	(65)	(66)
Theme	Utility	Utility	Utility	Tools	Utility	Utility	Utility	Utility	Utility	Utility	Utility
Implementation											
-Barriers											
-Facilitators											
Inputs											
Guideline-based	X			X	X		X	X	X	X	X
Diagnostic Codes	X	X	X			X			X	X	X
Template				X					y, f		
Prompts							NR		X	X	
Alerts	X				X				X	X	
Online Order Entry											
Online Prescription Integration			X								
Linkages											
-Community Resources											
-Education				X	X						
Process for Referral											
Outputs											
Extractable Data						S			X	X	
-Longitudinal									X	X	
-Result Trending									X	X	
Program Reports Patient Outcomes											
Individual Report Queries											
Generate Action Plan											
-Autofill Action Plan											
-Customize Action Plan				X							
-Print Action Plan											
Sample Characteristics:											
Setting											
-Country	US	UK	CH	UK	US	US	UK	UK	NE	NE	US
-Health Care Model	1	1	1	1	1,2,3	1,2,3,4	1	1	1	1	1,4
Population											
-No. of Participants/Records	10608	35	1096282		158	7583	60	264258	8784	40	100
-Age Group					p	a	a	p	a/p	a/p	p
Illness	D,H	D	H	A,H,O	A	A	A,O	A	A,C	A,C	O

Appendix A: Data display table of included articles from the Asthma Primary Care EMR category										
Article:	(67)	(68)	(69)	(70)	(71)	(72)	(73)	(74)	(75)	(76)
Theme	Utility	Utility	Utility	Utility	Utility	Utility	Utility	Tools	Tools	Tools
Implementation										
-Barriers									M	
-Facilitators										
Inputs										
Guideline-based		X	X			X	R		X	X
Diagnostic Codes									X	
Template		X	X		X			R	y	
Prompts				R				X	X	
Alerts								X		
Online Order Entry					X		R			
Online Prescription Integration										
Linkages										
-Community Resources										
-Education								X		X
Process for Referral										M
Outputs										
Extractable Data				X				X		
-Longitudinal	S							X		
-Result Trending										
Program Reports Patient Outcomes							R			
Individual Report Queries										
Generate Action Plan										
-Autofill Action Plan										
-Customize Action Plan										
-Print Action Plan										
Sample Characteristics:										
Setting										
-Country	DE	US	US	US	US	UK	US	US	NE	US
-Health Care Model	1	1	1	1	1,2,3	1	1,2,3,4	1	1	1,2
Population										
-No. of Participants/Records	9695	9	9	1536	706	1664	839			
-Age Group	p	p	p	a	a	a/p	p	p	a/p	
Illness	A	A	A	A,C	A,C	A	A	A	A,C	A

*X = present; R = recommended; NR = not recommended; S = Suggested; M = Mentioned, y = yes; f = free text; 1 = primary care; 2 = ambulatory care (clinic); 3 = specialist clinic; 4 = hospital; AU = Australia; SW = Sweden; US = United States; NO = Norway; DE = Denmark; NE = Netherlands; NZ = New Zealand; UK = United Kingdom; CA = Canada; IS = Israel; CH = China; RE = Review Article; p = pediatric, a = adult, A = asthma; C = COPD; H = Heart/Hypertension; D = Diabetes; O = Other.