Project 18-01: *I*mproving *De*tection of Work-related *A*sthma (IDEA): Validation of the Work-related Asthma Screening Questionnaire-Long Version (WRASQ(L))

Progress Report as of August 28, 2024

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IDEA Project Final Report – August 2024
Prepared by Dr. M. Diane Lougheed

Executive Summary

The IDEA project involved conducting a definitive evaluation of the Work-related Asthma Screening Questionnaire-Long Version (WRASQ(L)™) to provide insight into the feasibility and merit of using this questionnaire in routine practice. During this period of reporting, in-person recruitment is on hold due to the COVID-19 pandemic, which has also delayed the execution of the Manitoba site contract and REB submission. To continue enrolling subjects on the study, we designed a remote recruitment procedure which requires no in-person visits or respiratory testing. This new procedure is well underway with a total of twelve participants enrolled thus far. Madison (MSc. student) and the co-investigators presented an abstract at the American Thoracic Society International Conference in 2021. We conducted a qualitative analysis on our OntarioMD workshop to understand the barriers, benefits and limitations to using eTools, particularly the WRASQ(L) in clinical settings. Our third PAC meeting took place and more dissemination and implementation strategies were brainstormed. Madison defended her thesis using preliminary data. The third PAC meeting was held April 16th, 2021. We received several extensions on the funding spending deadline due to delays in participant recruitment related to the COVID-19 pandemic, to August 31, 2024. Data collection and analysis have been completed. The results manuscript has been submitted for peer-review publication, with a decision pending at the time of preparation of this report (in revision).

Final Report

Project Overview/Introduction

Work-related asthma (WRA), which includes asthma that is induced by the workplace or, preexisting asthma that is exacerbated by the workplace is a major health concern for the public. Approximately 17% of adult onset asthma cases are due to WRA. Early detection of WRA is crucial, as delayed diagnosis is associated with worse outcomes. However, there is a delay in the diagnosis of WRA and a lack of awareness of WRA in primary care settings. Therefore, a tool that improves the screening and awareness of WRA has the potential to improve diagnosis and promote earlier detection.

This project continues the work of the Asthma Research Unit, headed by Dr. Diane Lougheed at Queen's University in Ontario, to create a work-related asthma screening questionnaire for improved screening and awareness of WRA in primary care settings. Funded by AllerGen NCE Inc., in 2009 the Work-Related Asthma Screening Questionnaire (Long version) (WRASQ(L) ™) was developed by an Expert Advisory Committee. The WRASQ(L)™ was based off four questions from the Asthma Care Map, a tool used for asthma management, which asked about the relationship between symptoms and the workplace. Four other symptom-workplace questions and questions on exposures subjects could be sensitized to were added as well. The WRASQ(L)™ was found to have good face and content validity, low respondent burden, good test retest ability and it identified additional work-related asthma symptoms that were not identified in their normal care.

Following this, funding was received from the Ontario Lung Association (OLA), the Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), and the Workers Compensation Board (WCB) of Manitoba to conduct a formal evaluation of the WRASQ(L)™ to demonstrate the merits of its incorporation into routine practice. Additionally, the WCB of Manitoba funded the formation of a Project Advisory Committee (PAC) of stakeholders to contribute to provide strategies for dissemination and implementation of the study findings.

If there is merit in incorporating the WRASQ(L) into practice, then this will promote early assessment, diagnosis and optimal management of WRA. Ultimately, the goal of this study is to reduce the burden of asthma for those affected, improve work performance in employees, reduce absenteeism costs for employers and save the government and compensation boards money.

Work Completed

The Manitoba Research Ethics Board approval was received on August 26th, 2021. Approval from the local Research Review Committee (RRC) of S. Boniface Hospital is the next step, but was still pending as of the time of writing this report. The subcontract between Queen's and St. Boniface Hospital in Manitoba was completed and signed by all parties. Year one payment, previously mailed to St. Boniface hospital for the agreed upon sum of $18,022.00 has not been processed, pending their RCC approval.

Due to the COVID-19 pandemic, all in-person research recruitment activities were halted at Queen's University, so there is a current hold on in-person subject recruitment. However, in an effort to continue enrolling subjects while adhering to the physical distancing guidelines, we designed and received ethical approval to conduct a remote recruitment procedure for our study protocol. Currently, this is the only protocol that is used. Enrollment is well underway, and was the focus of the study over this time period. We have enrolled fourteen subjects thus far on this protocol. This protocol have allowed us to recruit subjects who live outside of Kingston, which has increased our data collection.

Validated classification of the data continued. The two primary investigators have reviewed analyzable data to date and classified subjects as either WRA or non WRA. This has allowed for analysis of preliminary data. The Primary Investigators are sent analyzable data on a rolling basis to ensure data is classified quickly. As of August 1st, 92 subjects had been enrolled, with one on study, 81 of whom have analyzable data. Madison MacKinnon defended her Masters' thesis in Translational Medicine in August 2021 using this preliminary data. She is planning on submitting a final analysis of the data next year for peer review publication once sample sized is reached. As of December 1st, we have enrolled 9 more subjects, with 1 excluded, 2 on study and 6 completed with usable data. A virtual orientation and training call was completed with St. Boniface Hospital on November 22nd. Once final ST. Boniface Hospitals RRC approval is received, the Manitoba site will begin recruitment.

As of November 28, 2022, St. Boniface has yet to receive RRC/local ethics committee approval. Year one payment was received by St. Boniface, but is yet to be deposited into St. Boniface research account, pending completion of their local ethics process.

Queen's University site has continued with remote recruitment. As of November 25, 2022, Queen's University had screened 92 Subjects; four more were currently enrolled and expected to be completed 42 subjects have completed the study in Kingston with usable data. The Montreal site has screened 70 subjects; 7 were excluded or withdrew. 56 subjects had completed the study in Montreal with usable data.

Project spending deadline extension was approved until August 31, 2022, then August 31, 2023, then August 31, 2024.

Final Update - August 2024

St. Boniface, Manitoba, was ultimately unable to be included due to lengthy delays in approval, and with approval from Manitoba WCB, their funds were reallocated to Queen's University for salary, supplies, participant stipends and continued data analysis.

As of spring 2024, recruitment and monitoring of all participants was completed. Potential participants screened: n=189, excluded n=63 (n=23 early withdrawal, n=4 no vacation available, n=13 no formal asthma diagnosis), n=126 enrolled, n=20 excluded (n=13 poor data, n=5 failure to follow-up, n=2 lost PEF device), n=106 participants included in data analysis. Data analysis was completed, and the

manuscript was submitted for peer-review publication on July 25, 2024. As of August 17, 2024 we are awaiting a response from the journal.

Results and Evaluation

The final results manuscript has been submitted for peer-review, and is in revision; as such is embargoed until accepted. The accepted manuscript will be shared with Manitoba WCB as soon as permitted, with appropriate funding acknowledgment. Below is the abstract from the submitted manuscript.

Background: *The Work-related Asthma (WRA) Screening Questionnaire (Long-Version)(WRASQ-L)™ is a screening questionnaire that could improve recognition of WRA.*
Objective: *To conduct a definitive evaluation of the WRASQ-L™ to justify its implementation in clinical settings.*
Methods*: Employed adults aged 18-75 years with asthma confirmed by objective measures and the ability to take time off work were eligible. Participants completed the WRASQ-L™ then monitored their peak expiratory flow at and away from work or completed a specific inhalation challenge test. Data were classified as WRA or non-WRA by two asthma specialists, blinded to WRASQ-L™ answers. Sensitivity (SN), specificity (SP), positive and negative predictive values (PPV and NPV, respectively) and Youden's index were calculated for cut-offs of a positive screen.*
Results*: Of 106 participants (47.1±7.1 years (mean ± SD); 60 (57%) female), 14 (17%) were classified as WRA and were significantly younger in age than non-WRA participants (p=0.043). The questionnaire has high SN and NPV (90.9% and 93.1%, respectively), but low PPV and SP (32.1% and 26.0%, respectively).*
Conclusions*: The WRASQ-L™ has excellent SN and NPV. High SN is of primary interest to ensure that few false negative screens are missed and those with potential WRA are identified and continue to specialist care. The high SN indicates utility of the questionnaire in clinical settings. Further benefits of the tool include its potential to prompt for education on the symptom-workplace relationship, workplace exposures, personal protective equipment use, and collect exposure and occupational history.*

Knowledge Transfer Exchange Activities

Madison (MSc. Student) and the co-investigators submitted an abstract for consideration of a poster or oral presentation at the 2021 American Thoracic Society Conference in May 2021. The abstract was presented as a virtual poster at the conference. The abstract of the poster has been published in the *Am J Respir Crit Care Med*. A second abstract was submitted to The Canadian Thoracic Society in November 2021, and accepted for poster presentation in person at the 2022 Canadian Respiratory Conference (CRC) in April 2022 in Victoria, BC.

Our third PAC meeting was held at the end of April 2022. We provided an overview to the committee on the current enrolment efforts and knowledge translation strategies. We updated the committee on our OntarioMD workshop and presented results. Our other primary investigator and co-investigator provided updates on their site. Implementation and dissemination strategies included: working with the Ministry of Labour and/or the Ministry of Health to bring occupational history into EMRs, potentially through use of the WRASQ(L), leverage healthcare networks like the Certified Respiratory Educators and Canadian Network for Respiratory Care, approach the European Respiratory Society's taskforce that collects questionnaires for WRA surveillance an research.

We partnered with OntarioMD as a way to strategize implementation options for the WRASQ(L) and integration of the electronic version of the WRASQ(L) into EMRs and primary care. OntarioMD supports and promotes implementation of Electronic Medical Records (EMRs) and other electronic health tools. One service they provide is their Peer Leader Program, a network of healthcare workers

who are expert users of EMRs and electronic healthcare tools who provide guidance on implementation and use of such tools and EMRs through workshops. On March 26th, our team and OntarioMD ran a workshop demonstrating and gaining feedback on some of the Asthma Research Unit's eTools. A thematic qualitative analysis was completed by Madison MacKinnon and other members of the ARU. This analysis has been published (see below).

Dr. Lougheed and Madison MacKinnon delivered an invited presentation at the OntarioMD Educates Digital Health Conference in September 2023. The WRASQ(L) was one of the tools highlighted in the presentation.

Publications and Presentations to date:

a) Peer-reviewed Publications

i) MacKinnon M, To T, Ramsey C, Lemiere C, Lougheed MD. Improving detection of work-related asthma: A review of gaps in awareness, reporting and knowledge translation. *Allergy, Asthma & Clinical Immunology*. 2020 Aug 6; 16(73). doi: 10.1186/s13223-020-00470-w. eCollection 2020.

ii) MacKinnon MA, Moloney M, Bullock E, Morra A, To T, Lemiere C, Lougheed MD. Implementation of a Work-related asthma screening questionnaire in clinical settings: Multimethods Study. *JMIR Form Res* 2022 Sep 15;6(9):e37503. URL: https://formative.jmir.org/2022/9/e37503/. doi: 10.2196/37503. PMID 35964327.

iii) MacKinnon MA, Wall T, Morra A, To T, Lemiere C, Lougheed MD. Validation of the Work-related Asthma Screening Questionnaire (Long-Version)(WRASQ-L™). *J Allergy and Clinical Immunology: In Practice.* (Submitted; In Revision).

b) Published Abstracts from Poster Presentations

i) MacKinnon MA, Wall T, L'Archeveque J, To T, Lemiere C, Lougheed MD. Improving detection of work–related asthma: Validation of the Work–related Asthma Screening Questionnaire (Long-version) (WRASQ(L)). Presented at the American Thoracic Society International Conference, May 2021. *Am J Respir Crit Care Med* 2021; 203: A3051.

ii) MacKinnon MA, Moloney M, Bullock E, Morra A, To T, Lemiere C, Lougheed MD. Implementation of a work-related asthma screening questionnaire in clinical settings: Strategies, benefits and barriers. Presented at the Canadian Respiratory Conference, April 2022. Canadian Respiratory Conference Abstracts, *Canadian Journal of Respiratory, Critical Care and Sleep Medicine 2022*, 6:supp2,1-45, DOI: 10.1080/24745332.2022.2059299

c) Master's Thesis Publication

i) MacKinnon MA, Lougheed MD. Improving Detection of Work-related Asthma: Validation of the Work-related Asthma Screening Questionnaire (Long-Version) . Queen's University Graduate Theses and Dissertations, Translation Medicine Graduate Theses. QSpace. August 2021. https://qspace.library.queensu.ca/items/7f1fbefd-30a3-442b-b7b6-6c2317f0dc2c

d) Invited Speaker Presentation

i) Lougheed MD, Moloney M, MacKinnon M. "Asthma Tools and Your EMR: Strategies that Work". (Invited Speaker, OntarioMD Educates: Digital Health Care Conference, Toronto, Ontario, September 2023.)

Ongoing knowledge transfer and exchange initiatives include:

- Dissemination of the main results by peer-review publication in the scientific literature (submitted, in revision)
- Incorporation of the tool into clinical practice, by making it available online: https://www.asthmalife.ca/resources/WRASQ(L)%20for%20AsthmaLife-ca.pdf
- Inclusion in the Lung Health Foundation's Asthma Best Practices Implementation Toolkit (also available online: https://toolkit.lunghealth.ca/lhftools/work-related-asthma-screening-questionnaire-long-version-wrasql/
- Inclusion as recommended WRA screening tool in 2024 report to Ontario Ministry of Labour, prepared by Dr. Linn Holness (a member of the Project Advisory Committee) and Janet Brown entitled, "Occupational Disease Landscape Review". (https://www.ontario.ca/document/occupational-disease-landscape-review).
    - The focus of the review was "…to identify areas for improvement in both workplace prevention and healthcare delivery for the benefit of people working in Ontario. It also considered ways to strengthen the connections between the two systems for mutual benefit and improved impact." Notably, on page 60, a key short-term recommendation of 'Topic 7: Healthcare Journey' is to:
        - *"Pilot the use of tools already developed and evaluation in Ontario for primary and specialist care.*
            - *Implementation guidance**: Start with the asthma screening tool (WRASQ(L)".***

Appendix of Manuscripts

MacKinnon *et al.*
Allergy Asthma Clin Immunol (2020) 16:73
https://doi.org/10.1186/s13223-020-00470-w

Allergy, Asthma & Clinical Immunology

REVIEW

Open Access

Improving detection of work-related asthma: a review of gaps in awareness, reporting and knowledge translation

Madison MacKinnon[1,2*], Teresa To[3], Clare Ramsey[4], Catherine Lemière[5] and M. Diane Lougheed[1,2]

Abstract

Background: Work-related asthma (WRA) accounts for up to 25% of all adults with asthma. Early diagnosis is key for optimal management as delays in diagnosis are associated with worse outcomes. However, WRA is significantly underreported and the median time to diagnosis is 4 years. The objective of this review is to identify the gaps in awareness and reporting of WRA and identify gaps in current knowledge translation strategies for chronic disease in general, and asthma specifically. This will identify reasons for delays in WRA diagnosis, as well inform suggestions to improve knowledge translation strategies for dissemination and implementation of WRA prevention and management guidelines.

Methods: Non-systematic literature reviews were conducted on PubMed with a focus on work-related asthma screening and diagnosis, and knowledge translation or translational medicine research in asthma and chronic disease. In total, 3571 titles and abstracts were reviewed with no restriction on date published. Of those, 207 were relevant and fully read. Another 37 articles were included and reviewed after citation reviews of articles from the initial search and from suggestions from editors. In total, 63 articles were included in the final review.

Results: Patients, employers, and healthcare professionals lack awareness and under-report WRA which contribute to the delayed diagnosis of WRA, primarily through lack of education, stigma associated with WRA, and lack of awareness and screening in primary care. Knowledge translation strategies for asthma research typically involve the creation of guidelines for diagnosis of the disease, asthma care plans and tools for education and management. While there are some prevention programs in place for certain industries, gaps in knowledge translation strategies including lack of screening tools currently available for WRA, poor education of employers and physicians in identifying WRA, and education of patients is often done post-diagnosis and focuses on management rather than prevention or screening.

Conclusion: Future knowledge translation strategies should focus on educating employees and employers well before potential exposure to agents associated with WRA and screening for WRA in primary care to enable health care providers to recognize and diagnose WRA.

Keywords: Asthma, Work-related asthma, Occupational asthma, Work-exacerbated asthma, Work-aggravated asthma, Screening, Diagnosis, Knowledge translation, Implementation

Background

Work-related asthma (WRA) is a term that encompasses two types of asthma: occupational asthma (OA) which describes asthma induced by a sensitizer or irritant in the workplace or work-exacerbated asthma (WEA), also known as work-aggravated asthma (WAA), which

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describes preexisting or concurrent asthma made worse by workplace exposure(s) (Fig. 1) [1]. It is estimated that WRA accounts for up to 25% of all adults with asthma in the population [2]. Industries that have a high prevalence of WRA include educational services, health services, manufacturing, public administration and agriculture. The most common occupations to have workers with WRA are teachers, farm and construction workers, administrators or managers, and cleaners [3].

Workers who are continuously exposed to WRA triggers have significant morbidity, are more likely to have uncontrolled asthma, and display absenteeism and presenteeism, a loss of productivity at work due to illness [4–6]. Those burdened with WRA are significantly more likely to be unemployed, be temporarily unable to work due to their symptoms, and take more sick days than asthmatics without WRA [7]. Patients with WRA are also more likely to have depression and a poorer quality of life than those not burdened with the disease [8, 9]. Subjects with WRA use more medical resources and have more visits to their family doctor, the emergency department and hospitalizations than those not affected, which increase healthcare costs [10, 11]. Workers face a financial burden from the disease and many experience financial barriers, such as loss of income from missing work due to asthma symptoms [12, 13]. Employers can be required to provide compensation for their employees, often through compensation boards or the government, so employers and taxpayers are also financially affected by WRA [14, 15].

Therefore, early detection and diagnosis of WRA is critical for good management and reducing the burden and morbidity of WRA, as delayed diagnosis is strongly associated with worse outcomes [4]. Unfortunately, WRA is severely under-diagnosed and under-reported and the median time to diagnosis of WRA is 4 years after symptoms first appear [13, 16].

Knowledge translation is a term that describes implementing research findings into practice [17]. There are many proposed strategies for knowledge translation, however successful implementation of such strategies and proposals is difficult. Implementation has been called the "Achilles heel" of innovation and is often the limiting factor to successful knowledge translation [17]. Graham et al. [18], attempted to organize this process by creating the Knowledge to Action (KTA) Framework to guide knowledge translation by highlighting key steps and elements in this process.

The KTA process has two phases: Knowledge Creation and Knowledge Action. Knowledge Creation identifies the types of research found in healthcare and organizes it into three levels.: Knowledge Inquiry, the least synthesized research available including primary studies, Knowledge Synthesis, which includes more refined research such as systematic reviews, meta-analyses and syntheses, and finally, Knowledge Tools/Products, the most synthesized tools and research, designed to deliver knowledge in a concise, easy-to-understand way. [18]

The Knowledge Action phase occurs after or sequentially during Knowledge Creation. Knowledge Action is a cycle that identifies eight key steps for implementation [18]. Briefly, the steps are: identifying a problem that needs addressing, reviewing the research available to identify gaps between knowledge and practice, adapt the knowledge and tailor it to the research question, identify the barriers that could affect the use of the knowledge, select, tailor and implement interventions, monitor the intervention post-implementation to see the effects, evaluate the outcomes to determine the impact of the implementation, and

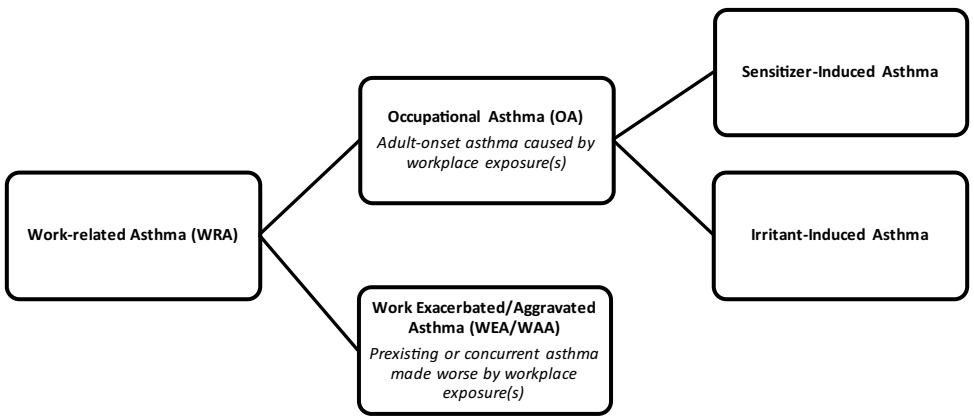

Fig. 1 Classification of Work-related Asthma [1]

assess the barriers to sustainability to promote further use of the research [18].

Chronic conditions, such as asthma, have a high burden on the workplace, greatly affect patient lifestyle and require constant management, so dissemination of research in a way that can educate the public and patients should be a primary objective for researchers [19, 20]. However, knowledge gaps exist in patients with chronic diseases showing a need for more education [21].

Therefore, the objective of this review is to identify the gaps in awareness and reporting of WRA which contribute to the delayed diagnosis by identifying who is under-reporting WRA and why, and what is impeding awareness of WRA in the workplace and healthcare. As well, we aim to identify gaps in current knowledge translation strategies for asthma and chronic disease, and to see if they are successfully targeting and educating those affected by WRA. Finally, we will suggest knowledge translation strategies to address gaps in the assessment and timely diagnosis of WRA.

Methods

Three non-systematic literature searches were conducted on PubMed. The first included key words: "work-related asthma", "occupational asthma", "work-exacerbated asthma" and "diagnosis". The search criteria included original articles, human species and had no date restriction. Two other literature reviews with keywords "knowledge translation" or "translational medicine research" for chronic disease and asthma were conducted with the same criteria as above. Both keywords were applied to obtain a cohesive search of all potential knowledge translation strategies. While "translational medicine research" is a broad term that encompasses research from molecular biology to clinical trials, the authors ensured only articles that specifically mentioned potential knowledge translation strategies were included. In total, the searches returned 3571 articles, and those titles and abstracts were reviewed. Articles were excluded on the basis of not being in English, focusing on child or adult non work-related asthma and not focusing on human species. Of those, 207 were relevant and fully read. An additional 37 articles were included from citation reviews of the articles from the initial search and from feedback from editors. In total, 63 articles were included in the final review, with most of the 207 articles excluded due to repeating information.

Results

Gaps in awareness and reporting of WRA

The literature review identified three groups of people that contribute to the gaps in reporting and awareness of WRA: patients, employers and physicians, both primary care and specialists. Barriers impacting their awareness and reporting of WRA are discussed by group below.

Patients

Patients with WRA face many challenges in managing and reporting suspected WRA, one being that they are unable to identify potential exposures that could cause WRA [13]. Santos et al. reports that only around one-third of employees with OA had previous knowledge that exposure to certain work agents could induce asthma. The workers who were knowledgeable of the effects of work agents on their asthma stated that this knowledge influenced their decision to see a doctor earlier, while most workers only went to see a doctor when their symptoms became unbearable [13]. Similarly, in a study looking at workers with suspected or diagnosed OA, 25% of workers with OA did not recognize the onset of their symptoms, 45% of workers thought that the asthma symptoms they were experiencing were normal, 40 percent of workers ignored their symptoms, and 30% of workers only suspected their workplace was related to their asthma when a serious illness struck them [22]. Another study reported that even though workers noticed their symptoms worsened during the work week and work shifts, they were often still working in the same job, causing exacerbation of their asthma and increasing morbidity [5].

Patients who are aware of their symptoms and the effect of the workplace on their asthma identified other reasons for why they delayed visiting a doctor or reporting exacerbations. Despite having productivity loss at work and increased morbidity, workers avoid calling in sick or taking days off for fear of judgment or stigma from their coworkers [4]. This stigma is further evident as workers are hesitant to report health hazards or request assessments of their workplace for fear of losing their job [23]. Some even avoided a diagnosis for fear it would require them to change jobs [13]. Workers do not discuss their symptoms with fellow employees or their management for fear of job loss or an effect on their income level [22].

The healthy worker effect could influence this delayed diagnosis as well. The healthy worker effect describes employees who leave, change or choose jobs that reduce their symptoms, improve asthma management or reduce the chance of an asthma attack [24]. Thus, this could contribute to the underreporting of WRA because employees with WRA are more likely to quit or alter job duties as a way to cope with their asthma, and nothing is done to change the workplace itself [23, 25]. Conversely, some patients experience reporter fatigue for their symptoms, which could also instigate the healthy worker

effect as they leave the workplace because they feel their concerns are not being heard [26].

WEA versus OA There is a discrepancy in the awareness and diagnosis of WEA and OA. The median waiting time for diagnosis is shorter with WEA patients than OA patients, and OA patients were more likely to change jobs, have more income loss and worse quality of life [13, 27, 28]. WEA patients are more likely to realize their symptoms were work-related, keep their job, and consult a physician than OA patients [13, 27]. Since some WEA patients have preexisting asthma, they might already know or have previously received education on how to manage asthma. Alternatively, it is possible that since they are knowledgeable of asthma symptoms they can make the connection to their workplace earlier, thus reducing exposure and consulting a physician earlier [1].

Employers

Employers and their relationship with their employees can impact the diagnosis of WRA [22]. Poor relationships between employees and their employers over health matters have been described, with employees claiming managers were ignorant or dismissive of their health matters or more focused on the success of the company rather than the health of workers [22, 29]. In one study, 85% of workers described having poor relationships with their managers in terms of health matters and often did not feel encouraged to report health issues for fear of losing their job [22]. Therefore the employees might stay in their position and continue to be exposed to triggers of their asthma to avoid the potential financial downfall if they are subsequently let go [22].

Employers often have limited knowledge of potential triggers in their workplace, which leads to limited healthcare options for employees. In a study surveying the perception of workers with WRA on the follow-up healthcare they received, only 6.5% of workers said that a physician assessed their workplace, and half of those said the physician that completed the assessment was an occupational health specialist [23]. In a study looking at the route people with potential OA took to secondary care, they found the occupational health options available to be variable between the workers [30]. Most of the workers had access to some type of occupational healthcare, but only a little more than half had this service available to them full time. As well, health surveillance was not an option for all workers and very few had an annual health assessment [30]. Finally, few workers have access to workplace health-and-safety programs, which limits their education and awareness of the harmful substances in their workplace [13].

Healthcare practitioners

Primary care Large gaps in knowledge exist in asthma care, management and diagnosis in primary care [31]. Physicians often do not take accurate or detailed workplace histories of their patients which would help identify the link between work exposures and asthma symptoms [5, 25, 32]. Furthermore, few patients are told that their asthma is work-related [5, 33]. This has an effect on the diagnosis and morbidity of patients, as one study surveying workers exposed to welding fumes found that many workers experience symptoms for a long time before receiving their diagnosis [5]. One-third of those workers who were diagnosed did not know they had asthma, and of those with a diagnosis, only two-thirds were told by their physician that their asthma was work-related [5]. Similarly, in a study looking at the prevalence of WRA in the USA, 39% of the patients with lifetime asthma reported work-related exacerbations of asthma at their current or previous job, but only 10.5 to 13.5% of workers were told that their asthma was work related [33]. Patients report having to consult their primary care physicians multiple times, sometimes more than five, before a referral to a specialist is made for their symptoms [29]. Physicians have cited that barriers to referring patients to a specialist include a lack of access to a specialist or simply lack of timely access to one [32]. Both factors can be detrimental to asthma diagnosis and management because primary care physicians are one of the first healthcare practitioners consulted by people experiencing asthma symptoms [13]. These delays have a major impact on asthma management and morbidity and could potentially increase the number of hospitalizations of workers [5].

There are gaps and barriers in the implementation of asthma care guidelines in primary care [34]. An important gap in knowledge is the failure of physicians in using an objective measure, like spirometry, to diagnose asthma [35]. Stanbrook et al., claim that almost half of patients with physician-diagnosed asthma have not completed spirometry, which potentially makes their clinical diagnosis incorrect, as the patients have not undergone any test that specifically distinguishes asthma from other similar conditions. Thus, asthma care guidelines are not implemented as the patients could be misdiagnosed. One study found that some primary care physicians do not implement asthma guideline recommendations when diagnosing asthma in patients, including failing to write a management plan or a referral for asthma education [34]. About half of these physicians said they did not know or failed to remember to talk about their patient's concerns. These gaps in knowledge have in part been explained by barriers these physicians face like lack of time and resources, especially access to

objective tests, they add to the lack of knowledge patients have regarding their asthma management [34, 35].

Specialists Those who present with asthma are often referred to specialists, but specialists can also have difficulty screening and identifying WRA [36, 37]. Specialists fail to ask if symptoms of asthma are work-related, and in one study looking at how occupational aetiology was considered when people with asthma symptoms presented to the emergency department or an acute medical unit, only one-fifth of people were asked about their employment status [38]. Specialists can also be unknowingly biased in their diagnosis of WRA [39]. Specialists tend to diagnose WRA when it is triggered by an irritant or in a workplace with which they are familiar, which can cause them to miss potential irritants of their patient's WRA [36, 39]. Clinics that have occupational specialists or patient representatives who assess their ability to return to work and facilitate successful outcomes between workers and employers had patients with less depression, less anxiety about the workplace and fewer mood disturbances than clinics without workplace specialists [40]. Occupational hygienists sometimes identify potential sensitizers of patient's OA that clinicians missed during their screening, so they can be very beneficial to the diagnosis of WRA and this displays the difficulty specialists can have in identifying WRA [36].

Communication and time Two other factors that seem to contribute to the delays in diagnosis and poor education of WRA are communication between doctors and patients and the time constraints of physicians. A significant number of people fail to mention the potential relationship between their work and asthma symptoms to doctors, and only one in seven asthma patients communicate their workplace might induce their asthma to doctors [41, 42]. This could be due to multiple factors, such as the patients not being aware themselves of the workplace irritants, fear of diagnosis for causing job loss or impact their income, and fear of stigma from the employer [4, 13, 24, 40]. Additionally, a fair proportion of subjects with work-related asthma have delayed isolated reactions to offending agents. This causes a delayed recovery for the subjects and they may miss the association of the workplace with their asthma symptoms [43]. Finally, this could occur because doctors do not take in-depth workplace histories, thus not prompting a discussion of the workplace with their patients [5, 25].

Physicians state limited time in clinic affects how they screen their patients and that there is not enough time to conduct a complete workplace history [32, 39]. Physicians have cited lack of time as the main barrier for implementing asthma care guidelines as well [34]. A study found that physicians often fail to provide written action plans for their patients and reported that though 90% of physicians said they were aware of the asthma guidelines, only 6% of primary and secondary care specialists said they always used them, and around 30% said they used them "most of the time" [44].

Gaps in knowledge translation for WRA

The literature review returned knowledge translation strategies within the Knowledge Creation phase of the KTA cycle. These includes a multitude of primary studies on WRA, which would fall under "Knowledge Inquiry", and could be considered an "unrefined, "unmanageable" amount of information and studies that cannot be easily accessed by all [18]. Therefore, it can be difficult for this research to be translated to the public. However, McElfish *et al.* used a community-based research process to set an agenda for health research that showed involving the public on research initiatives is suggested as a means of ensuring the research, even primary studies, leads to change [45]. The researchers engaged community stakeholders who identified three areas of research they felt were major issues (all of which happened to involve chronic disease), and research protocols and action steps were written. Through this, ten grant proposals were submitted, five of which received funding which lead to publications and presentations [45].

The literature search also returned strategies that fall under the next phase in the Knowledge Creation, termed Knowledge Synthesis. This includes the common strategy of summarizing research through the publication of evidence-based clinical practice guidelines. However, guideline implementation can be difficult or fail if researchers do not properly identify patient or clinical needs [46], which has been an issue for physicians treating patients with asthma who cite many difficulties or barriers to implementing asthma clinical guidelines, as previously discussed [34, 44]. One successful example of implementation occurred in Australia, where a research team identified a gap between evidence and practice in chronic disease management [47]. They created evidence-based resources such as systematic reviews and summaries that clinicians could access for treatment and management of their patients with chronic disease. In 4 years, this team created over one hundred summaries and twenty-six recommended practices for chronic disease management. Further, clinicians have been using these resources to guide their practice and it has made clinicians audit their practice to see if it is in fact evidence-based [47].

Other current knowledge translation strategies actively being used for asthma treatment and management fall under the final stage of Knowledge Creation: Knowledge

Tools or Products and have been further categorized into similar categories.

Prevention programs in industry

Medical surveillance programs of workplaces for sensitizers that could be encountered are a general prevention program found in industries that are at risk for work-related asthma [48]. Some high-risk industries have implemented prevention or surveillance programs. For example, there is a program called the Coal Worker's Health Surveillance Program (CWHSP) put in place for the safety of coal workers to detect respiratory disease early [49]. The CWHSP offers chest radiographs as well as spirometry and health assessment questionnaires to coal miners in an attempt to detect potential lung disease early. This has been expanded and is in an early implementation phase and it is mandatory for all coal miners be take part in this program [49].

Another example is the textile industry in the USA. The Occupational Safety and Health Administration (OSHA) has rules and regulations in regard to those workers exposed to cotton dust. There are exposure limits for an 8 h day, and they have dust control measures such as vacuuming floors, supplying respirators for employees, providing free annual medical exams and trainings [50].

Self-reporting, self-management and education tools

Many knowledge translation strategies for asthma have focused on improving how patients self-report their symptoms. In as early as 1993, serial peak expiratory flow (PEF) monitoring and patient symptom diaries were compared to see if the diary could identify exacerbations similar to the PEF recordings [51]. Both the symptom diary and PEF recordings were able to detect asthma exacerbations. While the sensitivity and specificity of the diary were not assessed, this study showed that self-reporting symptoms could be useful in identifying exacerbations [51].

Self-management plans are frequently used to facilitate patient education and management. "Asthma eBooks" with information on the disease and management have been created for adults with asthma and parents of children with asthma [52]. An asthma self-management app has been designed to promote self-management behaviours in adolescents by including a diary, reminders, a place for them to document triggers, and information for them to identify their asthma severity [53, 54]. Home visit programs have also been implemented for families in low-income areas. An educator provides the family with information on asthma and assesses their home for potential triggers to help the family adjust to this new diagnosis and promote better management [55]. For WRA specifically, those with WRA are more likely to have received some form of education for their asthma management, most often in the form of written asthma plans which are strongly recommended for those with asthma [56].

Another strategy is to improve the communication of research findings with the public and patients, particularly through disseminating the research into words, actions or items the public can understand. One example is the Boot Camp Translation process, created by a community-based council in Colorado [57]. Simply, this process works to rewrite research into messages and statements that are easy to understand by the public [57]. Often this process will lead to guidelines being created or increase awareness of prevention or management of diseases. The Boot Camp Translation Process applied to asthma diagnosis as well. Asthma care guidelines were disseminated into an "Asthma toolkit" that contained tools for healthcare providers and patients for diagnosis and management of disease [57].

One study looked at the effect of combining asthma education and management plans in one through the Primary Care Asthma Pilot Project (PCAPP) [58]. The PCAPP evaluated a primary care asthma program to see how it affected patient outcomes after patients were on this plan for 1 year. The PCAPP included five components for patients with asthma: an asthma care map created by the Ontario Thoracic Society, a treatment flow chart, program standards, a written action plan for patients and core asthma education. The PCAPP led to patients having better control of symptoms, fewer exacerbations, less healthcare utilization and reduced productivity loss [58].

Asthma care pathway

An asthma care pathway for adults in the emergency department called the Emergency Department Asthma Care Pathway (EDACP) was created to guide emergency physicians in their care of asthma and ensure patient education [59]. Clinicians had a positive response to this. They found it facilitated patient discussion, guided care decisions and was considered useful in managing asthma in the emergency department, but the research team did find some barriers with implementation [59]. Physicians cited lack of training and time to complete the EDACP as barriers, which is a similar barrier claimed by primary care physicians in the delay in diagnosing asthma [34, 59].

Questionnaires

Questionnaires are inexpensive, easily distributed tools that are often used to gather information on symptoms and exacerbations for asthma [60]. Three questionnaires created specifically for WRA were found, two of which

are designed for screening for potential WRA [60–62]. One questionnaire was created to investigate the causes and frequency of exacerbation of WRA through subjects monitoring their PEF at home and work while self-reporting their symptoms. However, when this was validated against serial monitoring of PEF, the questionnaire lacked sensitivity which limits its use in care [60].

The Occupational Asthma Screening Questionnaire–11 Items (OASQ-11), was developed as part of a surveillance program to screen for OA in workers [61]. When the OASQ-11 was evaluated in a clinic for those referred for suspected OA it accurately identified 80% of workers with suspected OA, and identified wheezing at work to be the symptom with highest negative predictive value. However, further validation is required before it can be implemented [61].

Another self-administered screening questionnaire called the Work-related Asthma Screening Questionnaire-Long Version (WRASQ(L)) was developed for use in primary care to improve the screening and recognition of potential WRA [62]. The initial assessment of the WRASQ(L) determined it had content and face validity, good test re-test ability and a low respondent burden, but requires validation against an objective test for WRA to justify its implementation in the workplace [62].

Discussion

This review has identified three target groups that contribute to the gaps in awareness and reporting of WRA which contribute to a delayed diagnosis. Lack of awareness of WRA is seen in patients, employers and healthcare professionals, with patients and healthcare workers under-reporting the disease as well.

Many patients lack awareness and recognition of the onset of asthma and the potential triggers in the workplace, indicating a severe gap in education of workers [13]. The discrepancy in awareness, education and hospital visits between WEA and OA patients emphasize this. Some WEA patients have previously diagnosed asthma, so these patients are likely to already have knowledge of identifying triggers, controlling and managing their symptoms, thus had better outcomes than those with OA [13]. This exemplifies that asthma education for patients improves management, control and outcomes [63], so many current knowledge translation strategies have attempted to improve education by creating educational tools and management plans [52–58]. However, these strategies only benefit patients who are diagnosed with asthma. There is a gap in knowledge translation strategies to increase awareness of WRA in individuals who have no previous experience with asthma or no knowledge of how their workplace could cause it. Without this knowledge, workers could be at risk of being exposed to triggers for years, thus education should focus on educating workers well before potential exposure to improve awareness and subsequent reporting of WRA.

Another important factor contributing to under-reporting of WRA by patients is the fear of stigma from co-workers and employers and potential loss of work and income which can lead to the healthy worker effect [4, 13, 23–26]. Therefore the lack of awareness of employers is another important gap leading to a delayed diagnosis. While few workplaces have health and safety options [13], clinics that had occupational hygienists and patient representatives had patients with improved quality of life [40]. If more occupational specialists or health and safety options could be provided, then workers might feel more comfortable talking about their symptoms and ultimately reporting and diagnosing their WRA earlier. Additionally, poor relationships with employers also contribute to under-reporting of WRA symptoms [22]. Therefore, education of employers in the signs and symptoms of WRA is necessary to improve their awareness of potential causes. This would not only reduce stigma but would potentially reduce the healthy worker effect. Interestingly, while there are some examples of prevention programs for WRA in some industries [49, 50], beyond this few knowledge translation strategies were found specifically targeting employer attitude and knowledge of WRA or the workplace itself.

Both primary care physicians and specialists have difficulty identifying WRA, taking occupational histories, and communicating the potential relationship between the workplace and asthma to their patients [5, 25, 32, 33, 39]. This, as well as lack access to specialists and failure of using objective measures contribute to the under-reporting and delay in diagnosis of WRA and is indicative of a gap in education and strategy for improving preventive or screening measures for clinicians [32, 35]. Current knowledge translation strategies for healthcare practitioners have involved disseminating guidelines for clinicians to easily apply in practice [39]. Strategies have involved standardizing asthma care plans or pathways for the convenience of the clinician and for education of the patient [59].These help with asthma management or controlling or identifying exacerbations to prevent an attack. Similar to patient knowledge translation strategies, these focus on helping clinicians and patients once a diagnosis has been given. Clinicians could benefit from strategies to improve their awareness of potential WRA and screening for WRA in clinic, especially primary care physicians since they can be the first physician seen by a patient with asthma symptoms

[13]. The WRASQ(L) and the OASYS-11 are both tools that are working to help this issue, but since they both still require further validation, the gap in screening and awareness is evident [61, 62].

To improve awareness and reporting of WRA, there should be an increase in education of both employees and employers. If possible, occupational hygenists should be more accessible for workers and clinicians in workplaces and/or clinics, to facilitate WRA awareness for prevention, and screening. Increased employer education and open communication with their employees, especially in high-risk industries is recommended as this will hopefully enable an open conversation between employees and employers and decrease any stigma that might have been associated with it. Improvements are needed in knowledge translation of asthma research moving forward. It is recommended that future knowledge translation strategies focus on improving screening of the workplace and screening in primary care settings to identify potential WRA cases. Particularly, the development and implementation of a validated tool for physicians to use for screening, which would not only improve their awareness and reporting of WRA but would reduce the time to diagnosis, may be a successful knowledge translation strategy . Finally, it is recommended that studies involve the public, since communities prioritize meaningful outcomes from research [45] (Table 1).

Conclusion

A 4-year delay is seen in the diagnosis of WRA [13]. Key reasons for this relate to a gaps in awareness of the disease by physicians, employers and patients, and under-reporting of the disease by physicians and patients. These gaps in awareness arise from poor knowledge and education of patients and employers on triggers for asthma, and lack of awareness of workplace-symptom relationships, discussion of occupational history by physicians. This lack of awareness contributes to the gap in reporting in patients, as well as stigma from the workplace. Lack access to objective tests, specialists and time for contribute to under-reporting by physicians. Current knowledge translation strategies for asthma research focus on improving education and management of the disease through guidelines, information databases or brochures. However, these strategies focus on improving outcomes once a diagnosis has been made, and the screening process and awareness of this disease has yet to improve. Therefore, there is a need to develop and implement strategies that improve the awareness and detection of WRA. Areas of focus should include accurate diagnosis of asthma, screening for possible WRA at the primary care level, and education of employers and workers who work in areas of potential exposure to prevent development and exacerbations of WRA.

Table 1 Summary of gaps, key findings and future steps

Gap to explore	Question to address gap	Key findings	Key messages and future steps
Lack of Awareness of WRA	Who lacks awareness of WRA? What are the knowledge gaps?	Patients, employers and physicians lack knowledge and awareness of potential asthma triggers and workplace-symptom relationships	Increase education of workplace exposures and their relationship to asthma symptoms Improve screening for WRA
Under-reporting of WRA	Who is under-reporting WRA and why is this happening?	Employees fear stigma from employers if symptoms or concerns are expressed Employee-employer relationships affect employees' decisions to report Physicians report lack of time, awareness and access to specialists as barriers to reporting	Encourage discussion of workplace triggers between employer and employees Enable detailed occupational history between health care providers and patients Improve access to specialists and objective testing
Gaps in current KT strategies	Are current KT strategies successful in targeting and educating those affected by WRA?	Most KT strategies focus on asthma management and education post-diagnosis Paucity of tools for screening Limited worker/patient education prior to potential exposure(s)	Focus KT strategies on effective education of workers and employers regarding potentially hazardous workplace exposures and development and implementation of effective screening tools for diagnosis

KT knowledge translation, *WRA* work-related asthma

Abbreviations
CWHSP: Coal Worker's Health Surveillance Program; EDACP: Emergency Department Asthma Care Pathway; KTA: Knowledge to Action; OA: Occupational asthma; OASQ-11: Occupational Asthma Screening Questionnaire-11 Items; OSHA: Occupational Safety and Health Administration; PCAPP: Primary Care Asthma Pilot Project; PEF: Peak expiratory flow; WAA: Work-aggravated asthma; WEA: Work-exacerbated asthma; WRA: Work-related asthma; WRASQ(L): Work-related Asthma Screening Questionnaire (Long Version).

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Original Paper

Implementation of a Work-Related Asthma Screening Questionnaire in Clinical Settings: Multimethods Study

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Abstract

Background: A work-related asthma (WRA) screening questionnaire is currently being validated for implementation in clinical settings. To minimize barriers to integrating tools into clinical practice, a discussion of strategies for the implementation of the questionnaire has begun.

Objective: This study aimed to understand the benefits, feasibility, barriers, and limitations of implementing the Work-related Asthma Screening Questionnaire–Long version (WRASQ[L]) and asthma e-tools in clinical settings and propose dissemination and implementation strategies for the WRASQ(L).

Methods: This study was conducted in Kingston, Ontario, Canada, from September 2019 to August 2021. A workshop and 2 questionnaires were used to understand the benefits of and barriers to implementing the questionnaire in clinical settings. An expert advisory committee was established to develop the implementation and dissemination strategies. Workshops were semistructured and used thematic qualitative analysis to identify themes that provided an understanding of the benefits and limitations of and barriers to using the WRASQ(L), and e-tools in general, in clinical settings. Workshop participants included patients and health care providers, including physicians, nurses, and asthma educators, who were implementation specialists and expert electronic medical record users. A questionnaire focusing on providers' knowledge and awareness of WRA and another focusing on WRASQ(L) feedback was administered at the workshops. Advisory committee members from relevant stakeholders met 3 times to strategize implementation opportunities.

Results: A total of 6 themes were identified in the workshop: involving and addressing patient needs, novel data collection, knowledge translation, time considerations, functional and practical barriers, and human limitations. Questionnaire responses yielded positive feedback on the utility of the WRASQ(L) in clinical settings. All participants agreed that it is an easy way of collecting information on occupational and exposure history and could prompt a discussion between the health care provider and patient on how the workplace and exposures could affect one's asthma, increase awareness of WRA in patients and providers, and increase awareness of exposures in the workplace. Implementation and dissemination strategies were generated with input from the advisory committee.

Conclusions: Stakeholders and workshop participants consider the WRASQ(L) to be a useful tool that satisfies many provider needs in their clinical settings. Once validated, dissemination strategies will include developing educational materials that include the WRASQ(L), linking the questionnaire to stakeholder websites or e-toolkits, translation into other languages, leveraging health care and research networks, conference presentations, and peer-reviewed publications. Implementation strategies will include integration into electronic medical records; designing multifaceted interventions; and targeting nontraditional settings such as

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workplaces, pharmacies, and research settings. The WRASQ(L) addresses many benefits of and barriers to implementation, as identified in the workshop themes. These themes will guide future implementation and dissemination strategies, noting that human limitations identified in providers and patients will need to be overcome for successful implementation.

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KEYWORDS

work-related asthma; asthma; dissemination; implementation; e-tools; barriers; limitations; electronic medical records; EMRs; knowledge translation; mobile phone

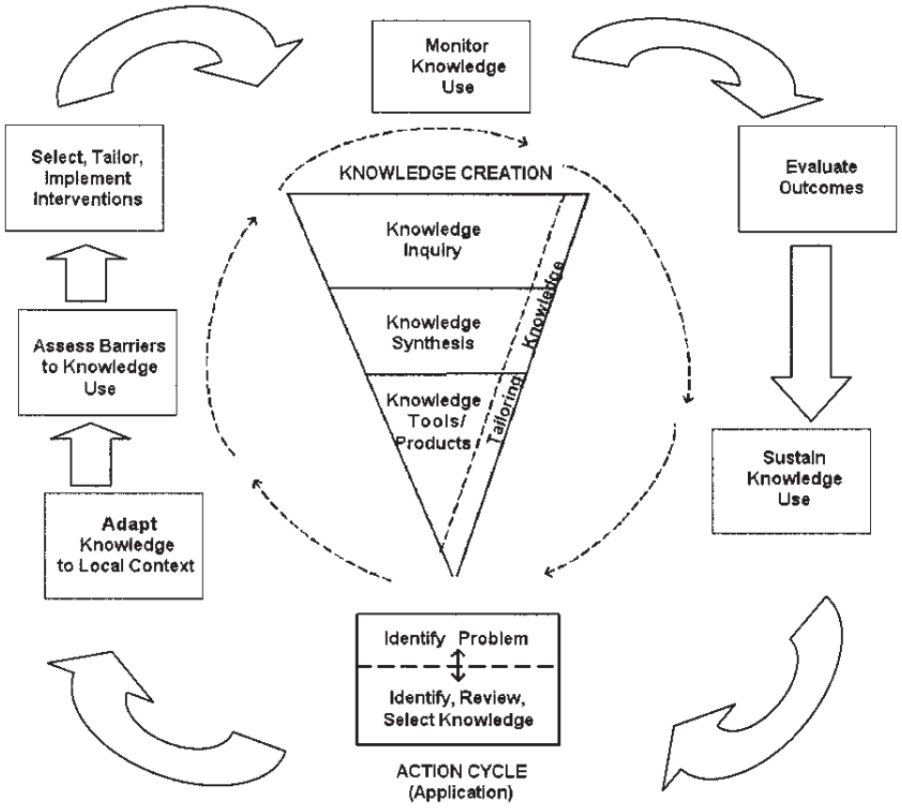
Introduction

Background of Work-Related Asthma and Knowledge Translation

Work-related asthma (WRA) is identified as asthma that is exacerbated or caused by workplace exposure and is estimated to affect as many as 25% of adults with asthma [1]. The most effective way of diagnosing WRA is through a detailed occupational history and objective measurement of lung function [2,3]. However, physicians, particularly at the primary care level, often do not have the time and resources to take a detailed occupational history, and objective measures are expensive, time consuming, and often only available in specialized centers [3,4]. This gap in screening and awareness of WRA is believed to contribute to an average of 4 years of delay between symptom onset and diagnosis, which is associated with increased morbidity [4,5]. The diagnosis of WRA has been shown to improve patient outcomes, including health service use [6].

The knowledge-to-action (KTA) framework created by Graham et al [7] (Figure 1) outlines the elements involved in the KTA process to facilitate the implementation of research findings. The KTA framework is split into 2 dynamic concepts, called knowledge creation and knowledge action, each with its own respective phases [7]. Knowledge creation identifies the different types of knowledge and research available, and the knowledge action cycle identifies the pathway and steps to implementation, which, briefly, includes identifying a problem, adapting local knowledge to a particular context, assessing barriers, implementation, monitoring and evaluating interventions, and sustaining knowledge use [7].

Figure 1. The knowledge-to-action process created and reproduced from Graham et al [7], which is published under CC-BY-SA license.



In an effort to improve the accessibility, quality, and efficiency of the Canadian health care system, the Government of Canada has invested in eHealth [8]. eHealth describes the use of information and communication technology in health care and includes a wide range of technologies, including electronic patient records, telemedicine, chronic disease–monitoring systems and management tools, electronic prescribing, and decision support tools [8-10]. In general, eHealth tools have been found to reduce symptoms, improve self-management, improve patient-provider communication, and improve overall clinical outcomes [11]. Barriers to the implementation of health tools include poor accessibility, conflicts with a practice or the

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practice setting, financial incentives, individual beliefs and characteristics of health care professionals, and patient factors [12].

Integrated knowledge translation is defined as the knowledge exchange and collaboration between researchers and end users of research (eg, providers, patients, and policy makers) [13,14]. This process sees end users as partners in the research study and ensures that the asked research questions are of importance to end users rather than researchers [13,14]. End user involvement can vary widely among studies. A review examined the involvement of users in designing and evaluating self-monitoring applications for bipolar disorder. Across these studies, end user involvement ranged from just the evaluation stage of the application to all stages of research such as the evaluation, prototype design, and the concept of the application generation phases [15]. The involvement of stakeholders in the design process of interventions has been considered the "holy grail" for improvement and has been found to develop the capacity of researchers and decision-makers to engage in integrated knowledge translation processes and enhance the value of research for decision-makers [16,17]. However, few studies have included integrated knowledge translation strategies in the health care sector, and there are no clear guidelines or methodologies for end user involvement in research [16,17].

Current implementation and knowledge translation strategies for WRA, and asthma in general, have focused on the management and education of patients after their diagnosis [4]. These include prevention programs in high-risk industries [18-20], tools for patients to self-report asthma symptoms [21], and self-management plans in the form of digital applications or electronic books [22-24]. Many tools for clinicians have focused on disseminating guidelines into clinical practice to help with asthma management [4]. These include asthma care maps at the primary care level [25] and asthma care pathways in the emergency department [26]. There is a paucity of strategies or tools that focus on increasing awareness of potential WRA in individuals with asthma and few strategies or tools that are targeted to providers to increase awareness and screening of WRA [4].

Background of the Work-Related Asthma Screening Questionnaire

The Work-related Asthma Screening Questionnaire–Long version (WRASQ[L]) was designed for implementation in clinical settings, particularly primary care, as a way of increasing awareness of WRA and screening for suspected WRA cases [27,28]. The WRASQ(L) collects occupational and exposure history, information on workplace-asthma symptom relationships, and personal protective equipment use. It includes an interpretation guide to prompt the provider on what steps to take if the patient screens positive for suspected WRA. The WRASQ(L) is available as a paper PDF, and it can be accessed through a patient or provider web-based portal via a kiosk or tablet in the waiting room or through a fillable PDF file linked to our hospital's electronic medical record (EMR).

During its development, the WRASQ(L) was found to have good content and face validity, good test-retest reliability, and low respondent burden [28]. Although its final validation is underway, our research team has begun to strategize the implementation and dissemination opportunities for the questionnaire. We also aimed to understand the perspectives of providers and patients on the current gaps in asthma and WRA screening and management and their perspectives on the implementation of e-tools, particularly the WRASQ(L), into clinical settings.

Purpose and Objectives

The purpose of this paper was to report the dissemination and implementation strategies we brainstormed to maximize the impact of the research findings of the WRASQ(L)'s final validation. Using workshops, questionnaires, and an expert advisory committee, we aimed to understand the benefits, feasibility, and limitations of and barriers to implementing the WRASQ(L), and asthma e-tools in general, in clinical settings, as seen by both patients and providers, to provide valuable insights into the most effective and efficient way of implementing the screening questionnaire.

Methods

This study was conducted in Kingston, Ontario, Canada, from September 2019 to August 2021. The participants in the project advisory committee (PAC) were from the provinces of Ontario and Manitoba. The workshop participants were all from Ontario.

PAC Role and Engagement

Although the final validation of the WRASQ(L) is underway, a PAC was formed to oversee the questionnaire's final validation and strategize how to implement and disseminate the questionnaire once validated. The committee was engaged at the outset, during, and at the conclusion of the validation of the questionnaire to identify the integrated and end-of-grant strategies. Stakeholders from relevant groups were invited to participate, including but not limited to Health Canada; compensation boards; professional societies; provincial and national lung, asthma, and allergy associations; public agencies; nonprofit organizations; and research groups. Potential stakeholders were invited to join the committee via email. Terms of reference were developed, and the committee met approximately biannually from 2019 to 2021 for 1 hour. The first and seventh authors cochaired the committee and led the meetings. A total of 14 members joined, including physicians, researchers, asthma educators, and nurses, from Ontario and Manitoba. A project update on the validation of the questionnaire and current knowledge translation initiatives was presented at the beginning of each meeting, after which it was opened to discussion among members. Each member was given an opportunity to provide feedback on current knowledge translation initiatives and suggestions for other end-of-grant dissemination or implementation strategies. Meeting minutes were recorded and sent to members after each meeting. Summaries of the meetings and strategies are presented.

Asthma e-Tools Workshop and Questionnaires

We conducted 2 web-based workshops to understand health care providers' and patients' perspectives on the benefits and limitations of and barriers to using e-tools, including the WRASQ(L), in clinical settings. The first workshop aimed to

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understand how to best integrate an asthma surveillance system, asthma indicators, and clinical guidelines in general into primary care EMRs. The second workshop focused on asthma e-tools developed by the Asthma Research Unit (ARU), including the WRASQ(L), with the aim of understanding the benefits and limitations of and barriers to using these e-tools in clinical settings. During the second workshop, there were presentations and demonstrations of the ARU's e-tools, and participants were familiarized with WRASQ(L)'s purpose, formats, and goals for implementation.

Each workshop lasted 2 hours and was conducted via Microsoft Teams. Workshops followed a semistructured question guide (Multimedia Appendices 1 and 2). The question guide was separated into different sections, each with its own individual topic or topics of discussion. Each section was allotted a specific amount of time during the 2 hours to ensure that all topics were discussed. Workshops were led by a skilled moderator—a family physician from OntarioMD who was not an asthma expert. Each participant was encouraged to speak, and the moderator moved on to the next question only once the participants had nothing more to contribute. A notetaker was also present, and the entire workshop was recorded.

The first workshop included 7 attendees. A total of 6 attendees were selected by the organization (OntarioMD) that facilitated the workshop because of their expertise in EMR use and implementation. Of the 6 attendees, 5 (83%) attendees were family physicians, and 1 (17%) was a nurse practitioner. Our research team recommended that another family physician with a special interest in respiratory health participate as a guest expert. The second workshop contained 6 participants, of whom 4 (67%) were selected by OntarioMD, 2 (33%) were family physicians, 1 (17%) was a nurse practitioner, and 1 (17%) was a patient. Our team recommended that the same family physician and nurse practitioner who was also an asthma educator participate. The practitioners were all based in Ontario and had a wide range of locations of practice, from rural to urban centers. The guest participants added by our research team were purposeful and had extensive knowledge of asthma e-tools and EMRs in Ontario. Some participants knew the researchers and were familiar with previous work, whereas others were unfamiliar.

Questionnaires were sent to the participants before and after the second workshop (Multimedia Appendices 3 and 4). The first questionnaire, which was sent before the workshop, aimed to assess the providers' knowledge and awareness of WRA. Providers were first asked whether they discussed occupational history with patients with suspected or confirmed asthma. If so, providers were asked whether this information was recorded (in EMRs, paper charts, or not at all). If this information was not recorded, providers were asked to provide a reason for not recording it. Subsequently, providers were asked whether they discussed potential WRA, workplace exposures, and the potential relationship between workplace exposures and asthma symptoms in the workplace with their patients. The second questionnaire, which was sent after the workshop, asked for specific feedback on the WRASQ(L). One of the questions used a Likert scale to understand how much participants agreed with statements about the WRASQ(L)'s utility in prompting a discussion on the relationship between workplace exposures and asthma, raising awareness of WRA and potentially harmful exposures, collecting occupational history, improving screening, and increasing referral time to a specialist for WRA. We then asked whether providers would consider administering the WRASQ(L) in their practice and, if so, asked for which purpose (screening for WRA, collecting occupational history, collecting information about the relationship between the patient's asthma symptoms and workplace exposures, initiate a conversation about the topic of workplace-symptom relationship with patients, or others) and in what format.

The questionnaire responses were tallied by frequency and percentage. A total of 3 team members from the ARU participated in the thematic qualitative analysis of the workshops [29]. All the team members engaged in reflexivity throughout the research process [30]. The team members met at the beginning of the data analysis to discuss and record how their personal experiences and biases could influence their interpretation of the results. All were a part of the ARU and familiar with the e-tools, literature related to WRA diagnosis, and reporting and implementation of asthma e-tools. One of the team members took notes at all research team meetings, and all members recorded notes in a memo throughout the analysis.

The workshop audio was transcribed verbatim and rechecked by a different team member. All team members reviewed the transcripts multiple times, rewatched the recorded workshops, and reviewed their notes taken during the workshops to familiarize themselves with and obtain a general and descriptive sense of the data.

All members were engaged in the coding of the data. Coding was conducted separately, followed by regular team meetings to discuss codes, overarching themes, and impressions from the data. Codes were added to a codebook that was refined and narrowed down with subsequent coding sessions. Transcripts were reviewed and recorded until they agreed that data saturation had been met.

Relationships between codes were identified using tables and mind maps to organize the codes into overarching preliminary themes. Themes were reviewed over multiple group meetings with input from all team members and refined until the key themes that defined the essence of the data were agreed upon. The key themes were named and defined, and quotations that provided sufficient evidence of the themes were selected. Any disagreement during the coding or identification of themes was discussed and resolved by the group.

Ethics Approval

The study was reviewed for ethical compliance by the Queen's University Health Sciences and Affiliated Teaching Hospitals Research Ethics Board (approval numbers: TRAQ# 6029444 and 6019013).

Results

PAC Strategies

A total of 2 members affiliated with the Workplace Safety and Insurance Board Champions Program, a program working to

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implement occupational health modules in Ontario medical schools, suggested discussing the WRASQ(L) with a Queen's University representative. There was also a discussion of partnering with the Lung Health Foundation as they are creating an e-module for providers on WRA. The PAC noted that translation into other languages should be considered, particularly in Chinese, as asthma is prevalent in the Asian community. They also suggested using the WRASQ(L) as a validated tool for research and as a way of placing occupational information that is clinically useful and relevant into EMRs, as 1 member mentioned that the Ministry of Labor was working on such an initiative.

One of the members noted that the European Respiratory Society Task Force was examining validated questionnaires to be used clinically and in research for WRA surveillance. Other health care provider networks were suggested to be leveraged, such as patient advocacy through the Lung Health Foundation and certified respiratory educators through the Canadian Network for Respiratory Care. A final suggestion was to consider implementing the WRASQ(L) in pharmacy settings for patients with suspected WRA who are yet to see a physician.

Questionnaires

The questionnaire asking providers about their awareness of WRA was provided to those participants of the second workshop who were health care practitioners. Therefore, it was filled out by 83% (5/6) of participants. The questionnaire had a response rate of 100%. All participants (5/5, 100%) said they discussed their occupational history with patients with suspected or confirmed asthma, and most (4/5, 80%) stated that they recorded their occupational history in their EMR. One of the participants said that they asked the patient whether they wanted the detailed work history recorded or whether they just wanted an overview of it but did not specify where they placed it. Approximately 80% (4/5) of participants reported that they routinely discussed the potential relationship between workplace and asthma symptoms with patients with suspected or confirmed asthma. Approximately 20% (1/5) of participants said whether they are going to discuss depends on the age and stage of their asthma. All participants (5/5, 100%) reported inquiring about the exposures with which patients were in contact at their workplace in those with suspected and confirmed asthma. Finally, all participants except 20% (1/5) said that they discussed the management of asthma in relation to the workplace with patients with confirmed or suspected asthma.

The questionnaire that asked for WRASQ(L) feedback had a response rate of 80%. Overall, participants felt it was beneficial and could prompt a discussion between the health care provider and patient on how the workplace and exposures could affect one's asthma, increase awareness of WRA in patients and providers, and increase awareness of exposures in the workplace. All participants strongly agreed that it was an easy way of collecting information on occupational and exposure history. Approximately 75% (3/4) of participants strongly agreed that the WRASQ(L) could improve the screening of WRA at the primary care level, speed the time to referral to a specialist, and decrease the time to diagnosis.

Asthma e-Tool Workshops

Overview

A total of 6 themes explained health care provider preferences regarding the use of e-tools, particularly the WRASQ(L), in clinical settings, with subthemes that organize the narrative. These themes can be categorized into 3 benefits, 2 key barriers or limitations, and 1 considered both a benefit and a barrier or limitation. The themes were as follows: (1) involve and address patient needs, (2) novel data collection, (3) knowledge translation, (4) time considerations, (5) functional or practical barriers, and (6) human limitations (Table 1).

Table 1. Brief description of themes.

Theme	Benefit or barrier	Description
Involve and address patient needs	Benefit	It is important for patients to feel involved in their care, and thus, tools should enable this. This can be done by having flexibility regarding when the tool can be used and the format of the tool by providing feedback to patients and considering their fatigue and fears.
Novel data collection	Benefit	Tools should fill a gap in data collection or provide a unique way of collecting data.
Knowledge translation	Benefit	Tools are beneficial when they translate knowledge from the specialist to the primary care provider or the provider to the patient.
Time considerations	Benefit and barrier	Any tool that saves the provider time is incredibly beneficial; however, if it takes too much time to learn, use, and implement, it is a barrier.
Functional and practical barriers	Barrier	Limitations in technology, particularly seamless integration of tools into electronic medical records and for patient use, and resources will impede the use of the tool in practice.
Human limitations	Barrier	Provider and patient attitudes and behaviors, such as mistrust of tools and personal biases and fears, and the tendency to not reuse tools by stakeholders are all human limitations to the uptake of tools.

Involve and Address Patient Needs

The participants noted that e-tools that involve or inform patients about their care are beneficial to clinical practice. Patients take pride in and give importance to being involved in their care and seeing themselves as "partners" with providers in their care. Tools are not considered useful to the patient population if there is "no clear follow-up," and a feedback loop to inform patients is beneficial:

> *I think the idea of the feedback loop is [a] really important one...Because many times we just collect*

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> *data and we don't actually let you know, or to what end, or to let you give any sort of response on to what we've done as a result of that. So, I think that there's potential for the applications or these tools to do that in real-time.*

Flexibility in when patients use e-tools or the format in which they are administered has been frequently discussed. Questionnaire fatigue was mentioned, with concern over how fatigue can affect the authenticity or accuracy of the answers. Another concern was the mistrusted answers from patients who complete questionnaires in stressful situations as they are just trying to get the questionnaire "out of the way."

In discussing potential solutions, a popular option from both patient and physician peer leaders was flexibility, both in the timing and format of the questionnaire or e-tool administration. The options discussed were before visits, in the waiting room, or during the visit while the provider was doing other clinical activities, ultimately wherever made the patient most comfortable:

> *...in the waiting room I would love to have something to fill out...It is the perfect opportunity. I think the way I would prefer it to happen would [be] to get an email a couple days before an appointment and have the opportunity to fill out but if I don't, then I'm handed a tablet at the appointment visit to fill it out right. I think you gotta use both strategies, not one or the other.*

Novel Data Collection

Tools must fill a certain gap in data collection or provide a unique aspect to data collection to be considered beneficial by providers. In the workshops, participants mentioned the underreporting and undermanagement of asthma in the population. For example, they found it difficult to document occupational history in the EMRs. A tool that fills these gaps and provides an opportunity for these data to be recorded would provide a major benefit to clinical practice.

Tools that present data in a unique manner, such as through visualizations of the data, benefit practice. The asthma educator participant emphasized that tools that can show novel trends in the data for patients are very beneficial:

> *I've had patients say it is really helpful to see how that tool is able to give me a visual on how this has improved my life...*

Knowledge Translation

Tools must facilitate the translation of knowledge from specialists to generalists or from providers to patients. Participants noted this comes from a clear understanding of what the tool does and how to use it and, ultimately, how to use it to improve their care:

> *I think that part of it needs to be solved just in...the knowledge translation, what is this tool actually for*

The providers discussed that the integration of the tools into clinical settings is an incredibly important step in the knowledge translation process. It facilitates the movement of information to the provider or patient and helps physicians and patients "manage their issues in the most optimal way."

Time Considerations

Time was a central theme in both workshops, particularly for providers. Participants emphasized that tools with time-saving features were incredibly helpful and more likely to be used. Automated features, such as drop-down menus or a proactive reminder to use the tool, were viewed favorably by the participants. Participants emphasized that tools should be efficient and easy to use so that they do not affect their practice:

> *We have to make it as easy as possible; I think that's kind of the key...otherwise people are not going to do it.*

Conversely, if a tool takes too much time to learn or use, then it is a major limitation or barrier to using the tool. One of the participants noted that time constraints in the clinic could prevent them from using the tool, even if it was already implemented.

Practical and Functional Limitations

One of the main limitations discussed by the participants was practical or functional limitations, in other words, a lack of resources and technological limitations in accessing, using, and implementing e-tools. Almost all participants emphasized that tools need to be seamlessly linked or integrated into the EMR. A seamless linkage in practice and in using e-tools is considered when the provider does not have to leave their EMR or patient charts to access e-tools or other programs. It also includes the transfer of data from the tool or program back to patient charts. Many participants said that having to leave their EMR to use a tool is a major barrier, and the interconnectedness of tools is currently lacking:

> *I meant the integration itself is just so important...I mean, beyond just leaving the environment you're in, which would be a real pain and is certainly a barrier to adopting these things, but like the integration piece allows you to bring data in...But nobody's really figured this out or I don't know of anybody that's figured this out...*

Providers frequently noted that a lack of physical, human, technological, and financial resources are major barriers to implementation. Managing the data that comes from these tools was noted to be difficult if there were not as many resources available, causing more work for the provider, which may ultimately stop providers from using the tool.

Human Limitations

Provider Behavior

Providers' behaviors and preconceived ideas or biases are major limitations to the use and implementation of e-tools. Fear and apprehension about how e-tools could negatively affect providers were mentioned many times:

> *I think on the other side there's always this fear that the data is somehow going to be used for, you know, negotiations or if it's in the wrong hands is going to*

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> *be used against the physician in some sort of way which, which is obviously far from the truth.*

Participants corroborated this from their own experiences when they implemented their own e-tools in the form of a dashboard. They noted that stakeholders asked how the information would be used to "punish" them, and there was a "suspicion" they were sharing the data.

Convincing providers to try a new tool was another barrier. It was considered difficult to market a new tool to providers, and providers were noted as having a "defeatist attitude" that new e-tools are "not useful at all" when they do not work perfectly, meet the providers' expectations immediately, or are slow to be implemented. Behavior change is required for providers to adopt and implement a new tool. Incentives, such as funding, and quick turnaround of information have been mentioned as ways of inciting behavior change.

Trust and Proof of Value

Trust must be established between the tool and the patient or provider. The user needs to feel that they can trust the tool and the information provided and that it will make a difference in their practice. Trust was established by determining whether the provided data were accurate. One of the participants mentioned that when discussing new e-tools or implementations with providers, "the immediate discussion goes to 'well that's not accurate.'" Providers prioritize and need to see clear and accurate data to adopt a new tool as this is proof that the tool will be valuable to them. If providers and patients do not see the value of the tool, then it is unlikely to be reused. Both provider and patient participants expressed that tools or apps can be forgotten if not deemed useful:

> *I use a lot of apps in my practice on my mobile devices and the good ones I use regularly and the ones that aren't that great you stop using.*

If patients and providers can see how it improves practice, it will establish a level of trust and change behavior. Seeing and understanding the proof of value of the tool can lead to the desired outcome of sustained use of the tool in practice. Overcoming alert fatigue, which was mentioned twice by participants, and "rewarding good outcomes and good behaviour" are the means to achieve this outcome.

Discussion

Principal Findings

We aimed to understand the benefits, feasibility, limitations of and barriers to implementing asthma e-tools in general and, specifically, the WRASQ(L), in clinical settings, as seen by both patients and providers. Through the focus groups and PAC, we gained information from both end users and specialists in the field. Our findings provide insights into the potential implementation and dissemination opportunities for WRASQ(L). Our findings suggest that the questionnaire, and e-tools in general, are considered useful in clinical settings and have the potential to greatly improve practice. The identified key barriers need to be overcome to facilitate the adoption of asthma e-tools.

Through the preworkshop survey, we found that workshop participants reported discussing relevant information with their patients who had suspected and confirmed asthma, such as symptom-workplace relationships and management and recording occupational history. These results contrast with those found in the literature, which identifies a major gap in care in primary care settings for WRA, especially in taking detailed occupational history, workplace exposure history, or discussion on how asthma might be work related [4,31]. Our results may differ because of the selection bias of the participants. Some participants had a keen interest in respiratory health and were expert users of EMRs; hence, they may ask for and record this information in their practice. The postworkshop questionnaire results were encouraging; all participants agreed that the WRASQ(L)'s implementation would be beneficial, that it could speed up the time to referrals to a specialist to ultimately decrease the delays in diagnosis, and that it was a useful tool to collect occupational history.

Our workshop concentrated on the benefits and limitations of and barriers to implementing e-tools in clinical practice. We used an inductive approach to understand the health care provider and patient perspectives on e-tools [29]. The themes pertained to involving patients in their care, creating a new type of data collection, facilitating knowledge translation, saving and not taking up too much time, and overcoming functional barriers and human limitations. The findings suggest that, overall, e-tools are considered beneficial in clinical settings but only if their implementation and use can overcome the identified barriers. The findings also provide important context and knowledge on how to best implement WRASQ(L) and ensure the future use of the tool.

Although many of the themes identified in our workshops have been reported in the literature, the WRASQ(L) addresses and expands on these themes in the context of implementing a WRA tool in primary care EMRs (Figure 2). The workshop results also established a novel theme of knowledge translation. It was established that patients take pride in their care, want to be involved in their care, and want feedback. This has been noted in the literature, particularly in studies involving patients with chronic diseases [32,33]. A benefit of the WRASQ(L) is its ability to easily collect occupational history and its many different forms. It can be filled out on paper, electronically, or via a kiosk that is accessed from a portal via a smartphone or tablet. This allows flexibility in how patients complete the WRASQ(L). If completed in the clinic, the questionnaire can be interpreted immediately, which would provide immediate feedback to the patient. These benefits address the themes of "Involve and Address Patient Needs" and "Novel Data Collection." The WRAQS(L) addresses questionnaire fatigue as well, as it has a low respondent burden and takes, on average, <10 minutes to complete (mean 7.2, SD 3.8 minutes), which makes it a timely questionnaire to complete [28].

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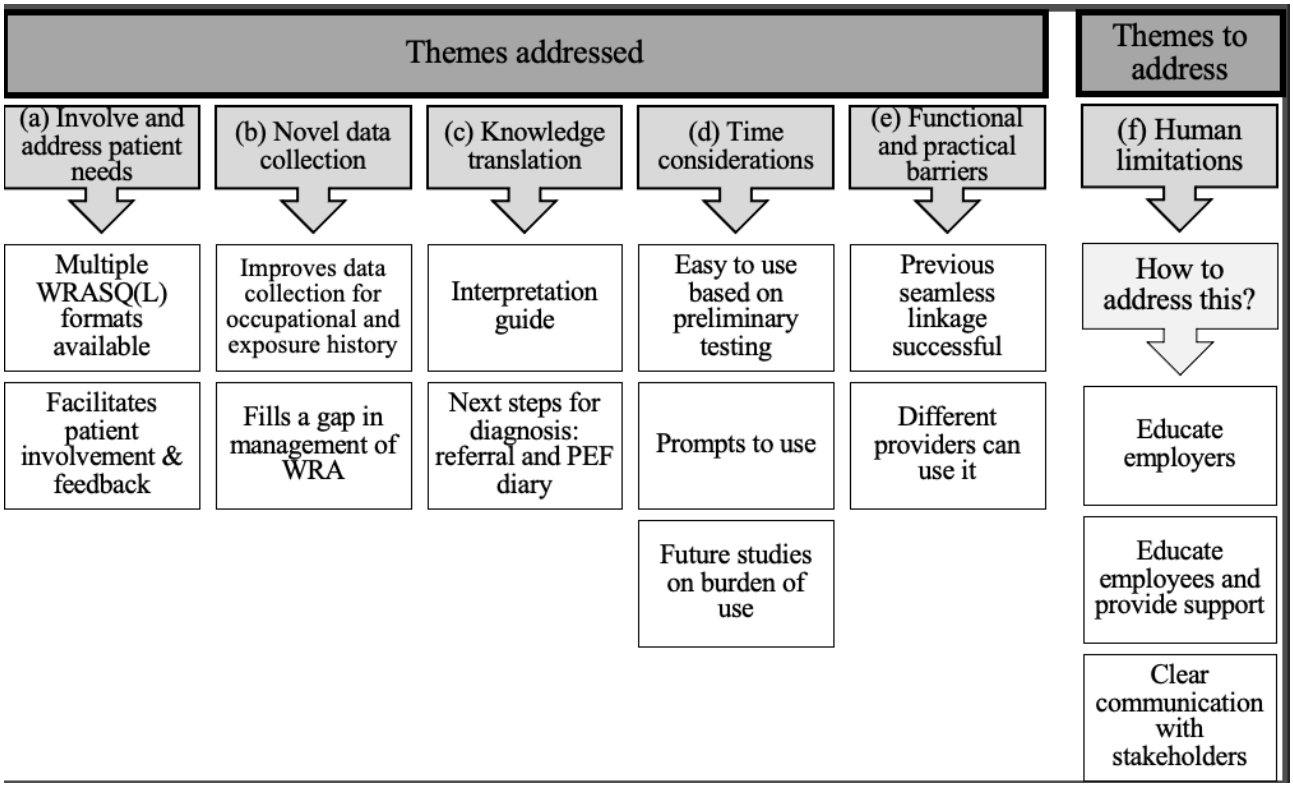
Figure 2. Themes addressed and themes to address by the WRASQ(L). PEF: peak expiratory flow; WRA: work-related asthma; WRASQ(L): Work-Related Asthma Screening Questionnaire–Long version.



Time constraints have been stated as the most important barrier to taking an occupational history; therefore, this theme emulates one of the key barriers to diagnosing WRA [4,31]. Our participants showed enthusiasm for automatic features, and it has been found that successful implementation strategies previously included the use of reminders for the tool [12]. Although the WRASQ(L) does not have reminders, it has easy-to-fill options and a prompt to fill out the questionnaire in the asthma management systems to which it is seamlessly linked. The literature, and workshop findings, suggest that implementation should occur within a realistic time frame and that the clinical utility of tools is maximized when the tool is time efficient and easy to use [12,34]. The WRASQ(L) has been found to have a low respondent burden and good test-retest ability; therefore, it has been deemed easy to administer. No studies have examined the burden of using the questionnaire in clinics; however, this leads to future studies after implementation. Our participants greatly emphasized the vertical integration of tools into EMRs. The WRASQ(L) has already been successfully integrated into an asthma management system that seamlessly links to a fillable PDF file and kiosk version.

An interesting result was that providers and patients themselves could be barriers to adoption. Providers' preconceived fears, notions, and attitudes regarding the implementation and use of new tools were very evident. Behavior, or more specifically, attitude change, is very important for implementation as it is unlikely that the tool will be implemented if the provider is not receptive to change or their concerns are not addressed [12]. Therefore, although human limitations are a general barrier to implementation reported in the literature, researchers should identify the specific human limitations that relate to the conditions they are studying, which could affect their implementation of the e-tool. Behaviors by providers and participants specific to occupational diseases are foreseeable barriers to implementing our questionnaire. Providers hesitate to diagnose and manage occupational diseases because of the burden of submitting a compensation claim [35,36]. Patients avoid discussing their health concerns in the workplace for fear of the stigma associated with injured workers; in particular, fear that coworkers or managers will think they are abusing the system or malingering [35,37]. There is a hesitancy to file claims or report health issues, as well as the fear of losing their jobs [4,35,38]. Thus, we need to address these specific concerns regarding human behaviors in work-related conditions when moving forward with our implementation. In addition, this theme showed that clear communication about the purpose of the tool is needed, and providers need to feel that they understand and trust the tool. This is established by longevity; if patients or providers continually use the tool, then this is the desired outcome. Ultimately, sustained use of the tool in clinical settings is the overall goal.

A novel theme identified by our focus groups was that it would be ideal if a tool could be a conduit for knowledge translation; that is, tools were considered beneficial when they provided knowledge exchange between providers and from providers to patients. This is particularly beneficial for an underreported disease such as WRA, and we believe that the WRASQ(L) is able to address this. The WRASQ(L)'s interpretation guide outlines the recommended steps in the care of the patient; thus, it conducts knowledge translation by bringing this expert knowledge from specialists to the primary care level and the patients. In addition, by simply using the WRASQ(L) once, patients and providers are made aware of the potential harmful exposures that could cause WRA, the relationship between

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asthma symptoms and the workplace that could indicate WRA, and the importance of taking an occupational history. Thus, the creation and implementation of e-tools should prioritize an element of knowledge transfer between users and the literature for ideal and long-term implementation.

Our workshops identified how the WRASQ(L) could benefit clinical practice from the viewpoint of end users. Once limitations are addressed, the strategies from the specialists in the PAC can be used to implement the questionnaire in the field. Discussions from our PAC focused on leveraging and connecting with other health care networks and stakeholders with whom many members were affiliated or had worked with before. Ultimately, we proposed several strategies for use once the final validation of the WRASQ(L) was completed (Textbox 1).

Textbox 1. Summary of implementation and dissemination strategies.

Implementation strategies

- Integrate into electronic medical records
  - OntarioMD's dashboard
  - Collaborate with electronic medical record vendors, Ministry of Labor, and Ministry of Health
- Design multifaceted interventions
  - Prompts and reminders
  - Performance indicators
  - Audit and feedback
- Target nontraditional settings
  - Workplaces
  - Pharmacies
- Implement in research settings as well as clinical

Dissemination strategies

- Develop educational material
  - Workplace Safety and Insurance Board Champions Program
  - Lung Health Foundation's e-module for providers on work-related asthma
- Link to websites or electronic toolkits
- Lung Health Foundation's "current educational strategies" for providers
- Canadian Thoracic Society toolkit
- Translate to other languages
- Leveraging existing health care and research networks:
  - Certified respiratory educators: Canadian Network for Respiratory Care and Primary Care Asthma Program
  - Canadian Thoracic Society Asthma Clinical Assembly
  - American Thoracic Society and European Respiratory Society Work-Related Asthma Taskforces
  - Center for Research Expertise in Occupational Disease
- Conference presentations
- Peer-reviewed publication

The dissemination strategies proposed by the PAC included common actions such as conference presentations and peer-review publications; however, members also suggested implementing the WRASQ(L) as educational material and linking it to websites or e-toolkits. These strategies have the potential to have a 2-fold effect. They could not only increase the use of the WRASQ(L) by providers but could also increase awareness of WRA. This would address a major concern with WRA by addressing the paucity of strategies or tools that focus on increasing awareness and screening for potential WRA among providers [4]. The translation of the questionnaire into other languages would further contribute to this. This would allow the administration of the questionnaire to populations at a higher risk of asthma, such as many Asian communities. Furthermore, it would increase the accessibility of the questionnaire to other providers in Canada and around the world,

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thus, potentially increasing the use of the questionnaire and increasing awareness of WRA in these places. Finally, the PAC members noted that other health care networks could be included more frequently in the dissemination process. Certified respiratory educators were particularly noted as a key network to leverage as they are imperative to the education of patients. In addition, focusing efforts on leveraging other research networks such as the Centre for Research Expertise in Occupational Disease would provide the opportunity for the questionnaire to be used in other research settings (a noted implementation strategy discussed in the following paragraph) and to be seen by other researchers, which has the potential to increase the use and awareness of the questionnaire.

Implementation strategies were more general than dissemination strategies but still provided guidance on how to increase the use of the questionnaire and awareness of WRA. Targeting nontraditional settings such as workplaces, pharmacies, and research settings has the potential to increase awareness of WRA in these places when it might be lacking. For example, placing the questionnaire in a workplace that has a high risk of WRA could inform workers and employers of the potential for WRA in the setting. This would not only create awareness of the issue but could also prompt employers to be aware of their workers' conditions, mitigate risk with the provision of personal protective equipment, increase communication of the potential for WRA between employers and employees, and decrease stigma or fear of reporting WRA. Similarly, implementing the questionnaire in pharmacies and research settings would make other health care professionals such as pharmacists and other researchers more aware of WRA, despite not using the questionnaire for clinical purposes. Integration into EMRs was a concrete strategy that was proposed, and partnering with existing dashboards such as OntarioMD's Insights4Care dashboard would allow for easy implementation. As stated, one of the members suggested that the Ministry of Labor was working on a way of including clinically useful occupational information in EMRs. Approaching bodies such as this early in their implementation process would ensure the WRASQ(L) is included as well. As implementation is a lengthy process, it is wise to explore these options so that implementation and dissemination can be timely once the questionnaire is validated. To the best of our knowledge, this method of approaching end users through our workshops and experts via the PAC before the actual implementation of the questionnaire is novel. Obtaining this knowledge will not only allow the implementation to be timely but also create and guide a robust implementation strategy for the questionnaire to maximize its use.

Our findings address both the action cycle and knowledge creation concepts in the KTA framework. Each phase of the knowledge creation concept allows researchers to tailor their activities to the needs of their ideal stakeholders and customize their methods of dissemination [7]. The workshop provided valuable insights into how we can tailor the WRASQ(L) to satisfy the concerns of stakeholders (patients and providers). Both the PAC and workshop findings addressed the steps "Adapt Knowledge to Local Context" and "Assess Barriers and Knowledge Use" in the action cycle. By reviewing current KTA knowledge and initiatives with the PAC and discussing gaps in management in the workshop, we adapted current knowledge to our context, which is the improvement of asthma management with e-tools. Many barriers were assessed by both groups. This will allow us to move confidently into the "Select, Tailor and Implement Interventions" phase to implement our concrete strategies while noting the barriers we may face.

A limitation of this study is that it does not include a theoretical framework for assessing the determinants of successful implementation of the questionnaire; however, we believe that the specific tool and context in which we aim to implement the tool benefited from an inductive approach. There is some concern that the use of frameworks can influence deductive analysis, bias researchers, and unconsciously force themes discovered into preconceived categories [39,40]. This was a potential concern because of the context of our study and our tool. WRA is a subtype of asthma that is unfamiliar to many patients and providers [4,5], and we aimed to understand the use of a tool for this specific disease if implemented in EMRs in primary care. In addition, we are at a very preliminary stage in the implementation process, and to the best of our knowledge, a similar study has not been completed previously for WRA screening tools. Thus, an open-ended approach allowed us to gather as much information as possible from stakeholders about the benefits of and barriers to implementing the tool in this context. The identified barriers and themes, along with a theoretical framework, could guide a robust and efficient implementation strategy once the validation is complete.

Our methods and findings allow the research team to approach these ideas and address potential limitations and barriers early to ensure efficient and timely implementation of WRASQ(L). These methods may be applied to other studies that validate e-tools, particularly studies that consider the involvement of end users and experts to discuss implementation strategies before the completion of the validation.

Limitations

This study has several limitations. The small sample size and lack of use of the theoretical framework in this study may have reduced the generalizability of the results. Selection bias was present in our participants, as 33% (2/6) of participants with a keen interest in respiratory health (a family physician and an asthma educator) were invited. This decision was made to address what we felt was a serious limitation in the peer leaders selected by OntarioMD, as they lacked practical primary care expertise in asthma. A total of 3 workshop participants were familiar with the WRASQ(L) and ARU e-tools. Despite this, we felt that their contribution to the focus groups was beneficial, as they brought practical primary care asthma expertise into the discussion. Of the 3 participants, 2 (67%) had no experience using the WRASQ(L) in clinical settings, nor had they been asked whether they would use the tool in their practice. One of the participants who had used the questionnaire before in clinical settings was considered an important contributor as they could provide a unique perspective of how patients responded to the tool. All 3 participants were expert EMR users; thus, their insight was valuable. The use of a third-party moderator for the workshops mitigated bias by ensuring that all participants had

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an equal chance of contributing to the discussion. Finally, only one-half of a workshop focused on the WRASQ(L), making it challenging to identify a clear overarching implementation strategy. This was offset by the PAC, whose sole purpose was to discuss the implementation and dissemination of the questionnaire; however, the PAC members were not implementation specialists. It may be beneficial to conduct another workshop for only the questionnaire with a larger sample size.

Conclusions

By addressing both the knowledge action and knowledge creation phases in the KTA framework, we identified key strategies to support the implementation of the WRASQ(L). Participants perceived the high utility of this WRA screening questionnaire in clinical settings and that it addressed many themes identified in our workshops relating to the implementation of e-tools in primary care EMRs. The workshop results and PAC recommendations will guide future dissemination and implementation initiatives and may be generalizable to other asthma e-tools.

Dissemination strategies will include incorporating the questionnaire in educational material, linking the questionnaire to websites or e-toolkits, translating it into other languages, and leveraging health care and research networks. Implementation strategies will include the integration of the WRASQ(L) into EMRs; designing multifaceted interventions; and targeting nontraditional settings such as workplaces, pharmacies, and research settings. The theme or barrier of human limitations may require more time and effort to overcome once the implementation of the questionnaire begins.

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Authors' Contributions

M MacKinnon and MDL conceived the study questions and design. The workshops were organized by AM. Data collection and entry were performed by M MacKinnon, M Moloney, AM, and EB. Data analysis was led by M MacKinnon with inputs from M Moloney and EB. M MacKinnon wrote the first draft of the manuscript, with revisions by MDL, M Moloney, EB, and AM. TT and CL provided expert feedback on the draft and made revisions to the manuscript. All authors have read and approved the final manuscript.

Conflicts of Interest

MDL has received grants outside the submitted work paid directly to Queen's University from the Canadian Institutes of Health Research (subgrant from Ottawa Health Research Institute), Manitoba Workers Compensation Board, Queen's University, and GlaxoSmithKline, as well as honoraria from the Canadian Thoracic Society for codevelopment and copresentation of a Severe Asthma PREP course and honoraria from AstraZeneca for participation in the Precision Program Advisory Board. CL sits on the occupational lung disease committee of the Commission des normes, de l'équité et de la santé et de la sécurité du travail.

Multimedia Appendix 1

Interview guide for workshop 1.
[PDF File (Adobe PDF File), 92 KB-Multimedia Appendix 1]

Multimedia Appendix 2

Interview guide for workshop 2.
[PDF File (Adobe PDF File), 95 KB-Multimedia Appendix 2]

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Multimedia Appendix 3

Questionnaire assessing providers' knowledge and awareness of work-related asthma.
[PDF File (Adobe PDF File), 68 KB-Multimedia Appendix 3]

Multimedia Appendix 4

Questionnaire for the Work-Related Asthma Screening Questionnaire–long version feedback.
[PDF File (Adobe PDF File), 81 KB-Multimedia Appendix 4]

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Abbreviations

ARU: Asthma Research Unit

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EMR: electronic medical record
KTA: knowledge-to-action
PAC: project advisory committee
WRA: work-related asthma
WRASQ(L): Work-related Asthma Screening Questionnaire–Long version

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Asthma Tools and Your EMR: Strategies that Work

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Disclosure of Potential Conflicts of Interest

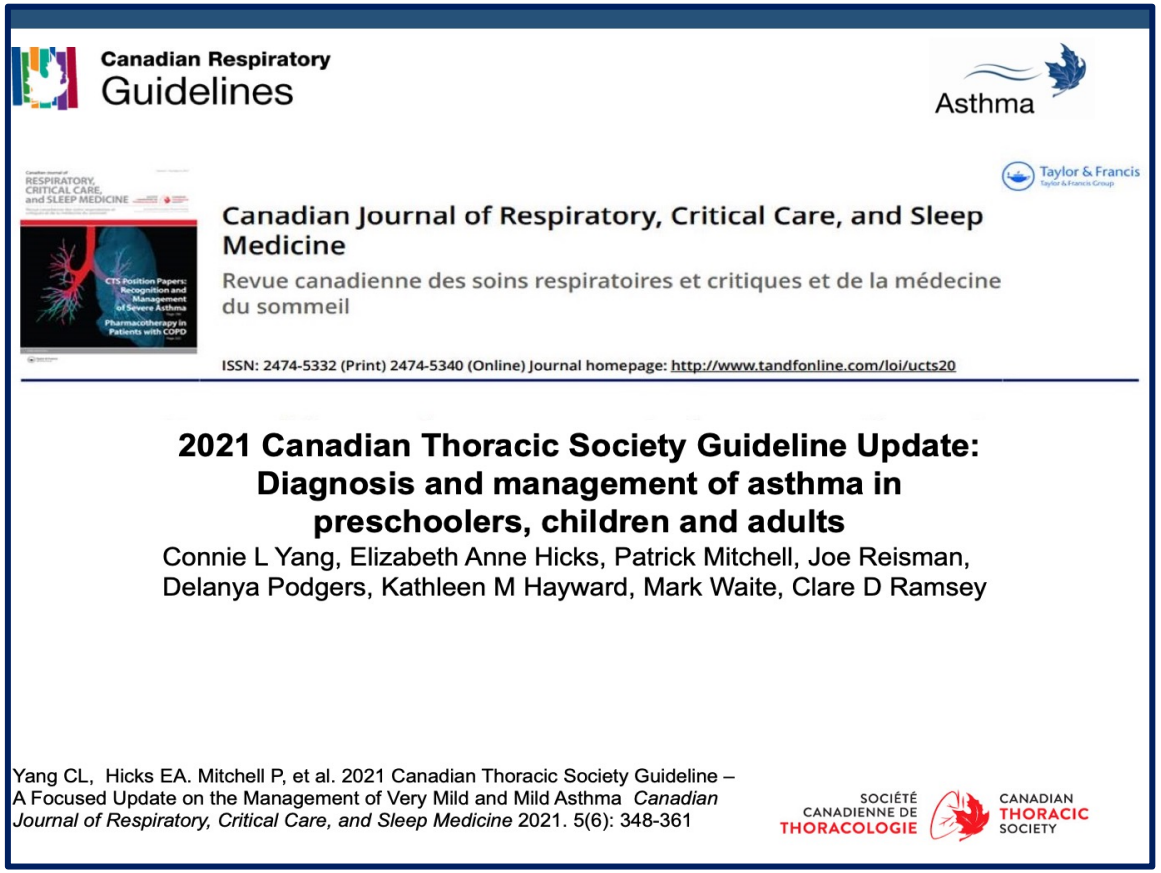
- **Potential for conflict(s) of interest:**
  - Diane Lougheed has received:
    - Honoraria from AstraZeneca for participation in the Precision Program Advisory Board
    - Grants paid directly to Queen's University for research from:
      - Canadian Institutes of Health Research (sub-grants from Ottawa Health Research Institute and University of Toronto)
      - Manitoba Workers' Compensation Board
      - Government of Ontario's Innovation Fund via The Southeastern Ontario Academic Medical Organization (SEAMO)
      - Queen's University
      - Astra Zeneca
      - GlaxoSmithKline
    - Affiliations:
      - Canadian Thoracic Society's Asthma Clinical Assembly - Member, and Past Chair of Steering Committee
      - Health Quality Ontario's Asthma in Adults and Asthma in Children Quality Standard Advisory Committee - Member
  - Max Moloney and Madison MacKinnon:
    - Nothing to disclose

Learning Objectives

- Understand the potential for electronic tools (eTools) in EMRs to support adherence with evidence-based asthma guidelines
- Recognize barriers to adoption of asthma eTools in primary care, including a validated work-related asthma questionnaire and performance indicators
- Identify strategies to support successful dissemination and implementation of asthma eTools that enable surveillance and benchmarking for quality improvement

OntarioMD
OntarioMD is a wholly owned subsidiary of the Ontario Medical Association.

Asthma Guidelines



Canadian Respiratory Guidelines

Asthma

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Revue canadienne des soins respiratoires et critiques et de la médecine du sommeil

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2021 Canadian Thoracic Society Guideline Update: Diagnosis and management of asthma in preschoolers, children and adults

Connie L Yang, Elizabeth Anne Hicks, Patrick Mitchell, Joe Reisman, Delanya Podgers, Kathleen M Hayward, Mark Waite, Clare D Ramsey

Yang CL, Hicks EA. Mitchell P, et al. 2021 Canadian Thoracic Society Guideline – A Focused Update on the Management of Very Mild and Mild Asthma *Canadian Journal of Respiratory, Critical Care, and Sleep Medicine* 2021. 5(6): 348-361

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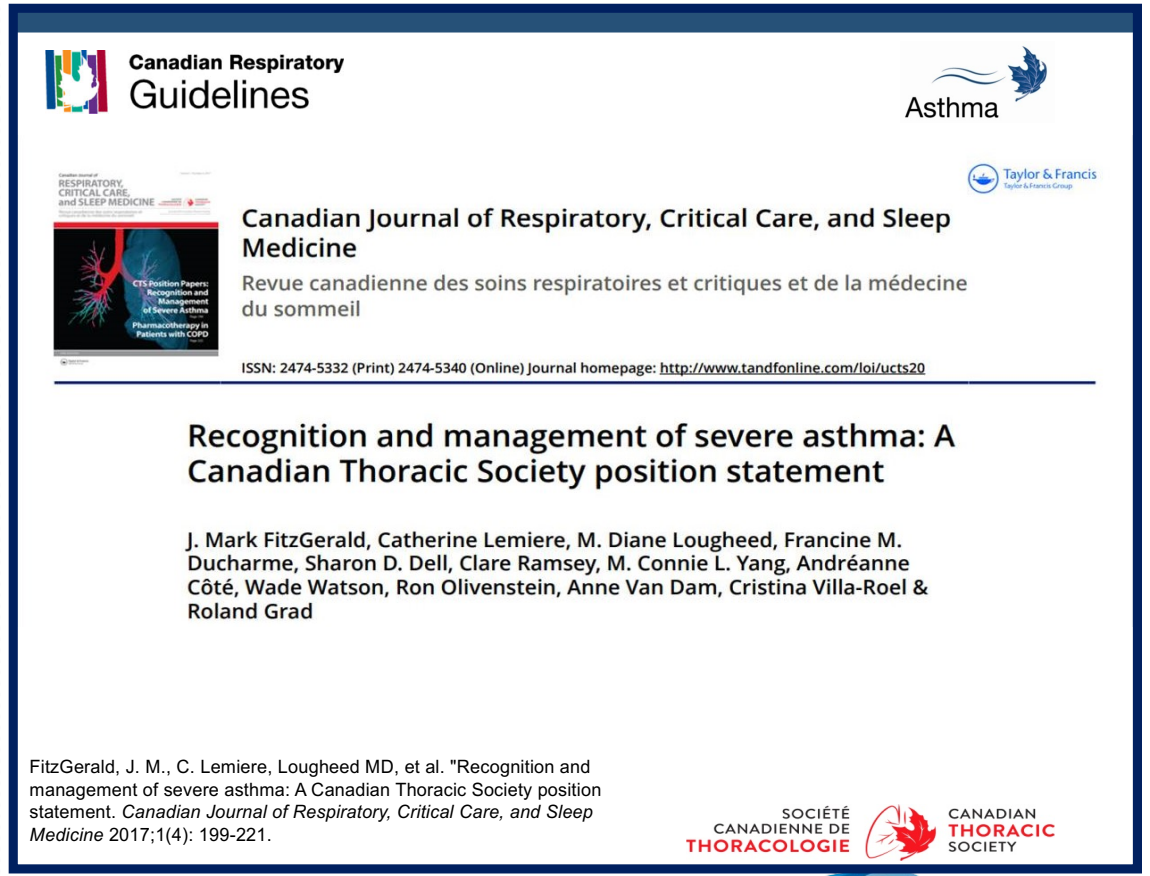

Canadian Respiratory Guidelines

Asthma

Taylor & Francis

Canadian Journal of Respiratory, Critical Care, and Sleep Medicine

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Recognition and management of severe asthma: A Canadian Thoracic Society position statement

J. Mark FitzGerald, Catherine Lemiere, M. Diane Lougheed, Francine M. Ducharme, Sharon D. Dell, Clare Ramsey, M. Connie L. Yang, Andréanne Côté, Wade Watson, Ron Olivenstein, Anne Van Dam, Cristina Villa-Roel & Roland Grad

FitzGerald, J. M., C. Lemiere, Lougheed MD, et al. "Recognition and management of severe asthma: A Canadian Thoracic Society position statement. *Canadian Journal of Respiratory, Critical Care, and Sleep Medicine* 2017;1(4): 199-221.

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Asthma Guidelines: Key Evidence-based Recommendations

- Diagnosis of asthma is based on a compatible clinical history and objective evidence of reversible airflow obstruction.
- Assess asthma control and the risk of exacerbation
- Provide asthma self-management education including a written action plan
- Identify triggers and discuss environmental control
- Prescribe appropriate pharmacologic treatment to achieve and maintain control and minimize exacerbations.

Yang et al. Can J Respir Crit Care Med 2021; 5(6): 348-361

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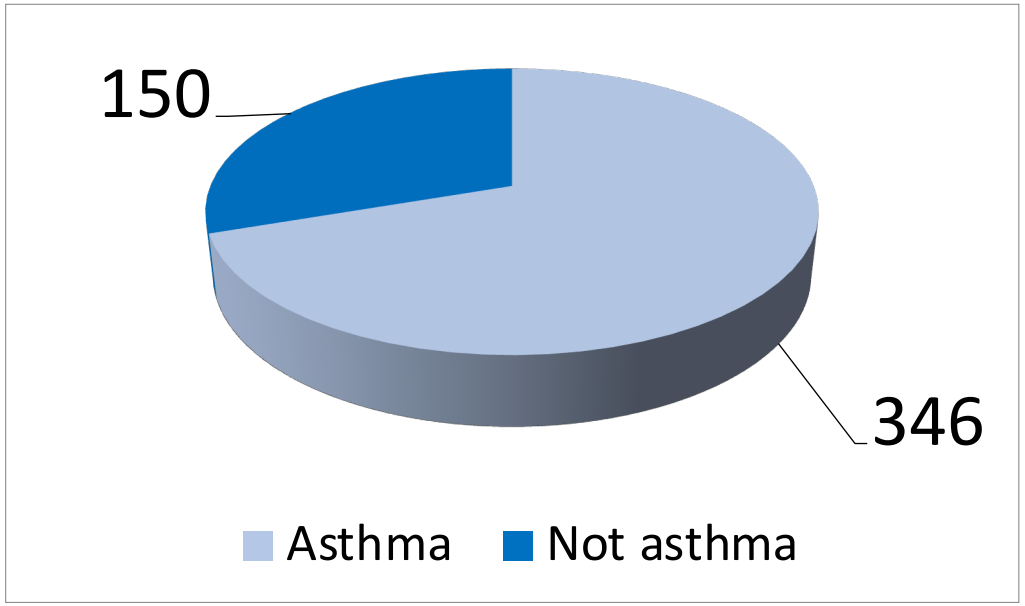
Overdiagnosis of Asthma in Canada

- 540 individuals recruited with self-reported doctor-diagnosed current asthma
- Up to 4 visits to PFT labs to look for evidence of asthma on spirometry or methacholine challenge tests

Not Asthma: 31 %

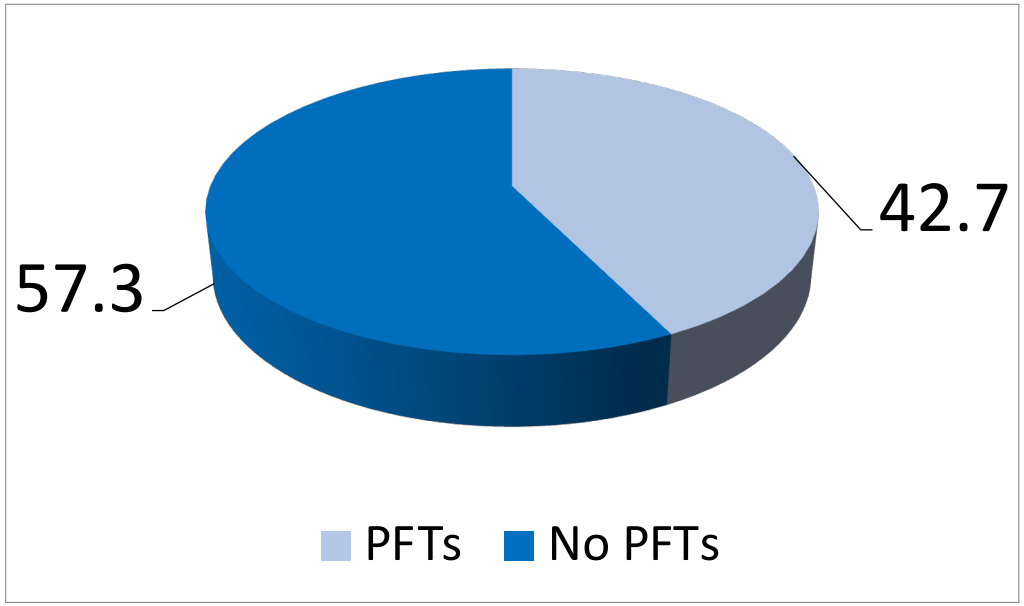


S. Aaron et al. *CMAJ* 2008;179(11):1121-31

Underutilization of Spirometry

- Retrospective cohort study
- 465,866 Ontarians ≥ 7 years old with newly diagnosed asthma
- Health administrative data to identify receipt of PFTs 1 year before and 2.5 years after diagnosis

No PFTs: 57.3%



Gershon et al. *Chest 2012; 141(5): 1190-1196*

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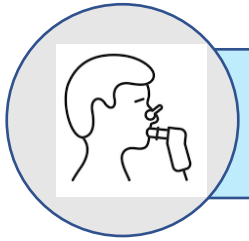
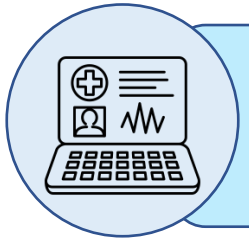
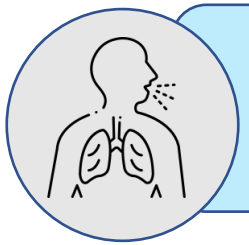
Key Asthma Care Gaps



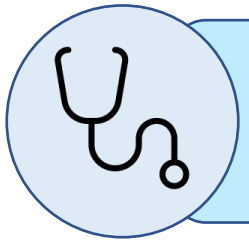
Underutilization of objective measures of lung function (e.g., spirometry, PFTs)



Need for standardized documentation of diagnosis status in Electronic Medical Records (EMRs)



Challenges in assessing uncontrolled asthma and reasons for poor control



Identifying individuals with severe asthma who would benefit from a specialist assessment

McIvor et al. 2007 *Can Fam Physician*; Aaron et al. 2008 *CMAJ*; Gershon et al. 2012 *Chest*; Moloney et al. 2022 *Eur Resp J*

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Choosing Wisely Canada™

Choosing Wisely Respiratory Medicine

CANADIAN THORACIC SOCIETY

2017

- Don’t initiate medications for asthma (e.g. inhalers, leukotriene receptor antagonists, or other) in patients ≥ 6 years old who have not had **confirmation of reversible airflow limitation with spirometry**, and in its absence, a positive methacholine or exercise challenge test, or sufficient peak expiratory flow variability

2022

- Don't continue medications for asthma (e.g., inhalers, leukotriene receptor antagonists, or other) in individuals who have not had a clear **clinical benefit or confirmation of reversible airflow limitation with spirometry** or peak flow testing, when non-diagnostic, a positive methacholine or exercise challenge test, provided timely access to testing allows it.

Gupta et al. *Can J Respir Crit Care Sleep Med* 2017; 1(2): 54-61;
https://choosingwiselycanada.org/recommendation/respiratory-medicine/

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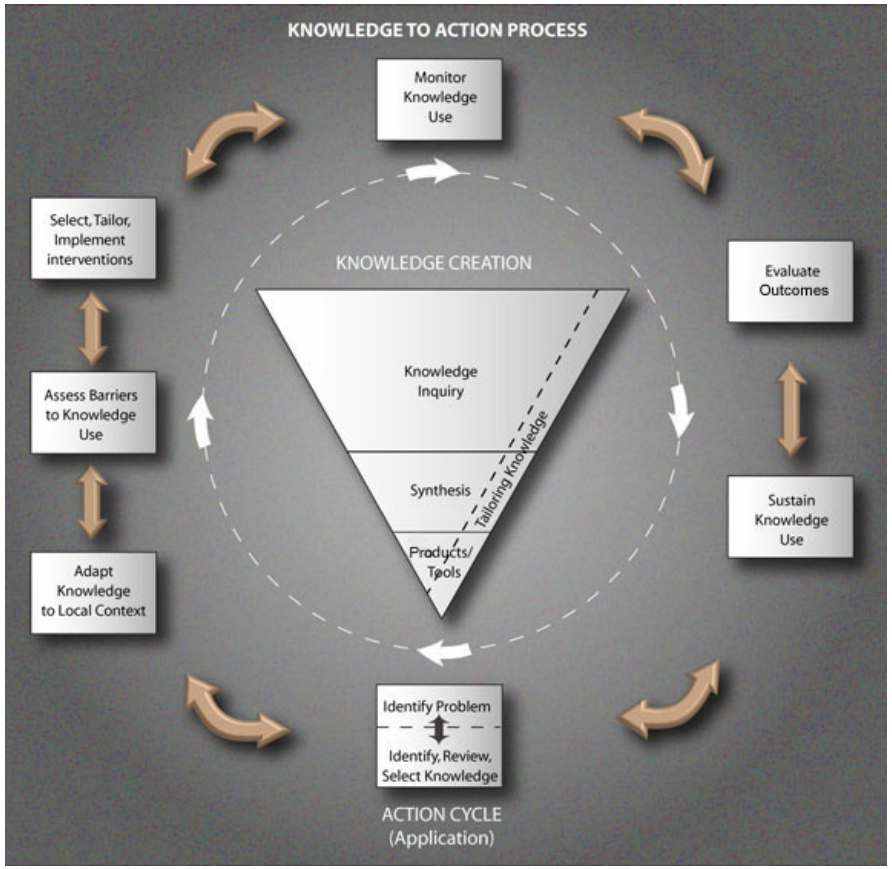
Knowledge Translation

"…dynamic and iterative process that includes **synthesis, dissemination, exchange** and **ethically-sound application of knowledge** to improve the health of Canadians, provide **more effective health services and products** and strengthen the health care system." (Graham, 2010)



http://www.cihr-irsc.gc.ca/e/29418.html

Asthma KT: Are EMRs a Solution?

- Despite guidelines …. care gaps remain!
- Performance measurement, benchmarking and continuous quality improvement are national health system priorities
  - practical systems which support chronic disease management are not routinely available.
- Electronic medical records (EMRs) are increasingly prevalent
  - novel opportunity to integrate guidelines into practice

Potential Benefits of Electronic Health Records and Standardized Data Elements

Improved quality of care	Adherence with best practice Patient safety
Improve[illegible]	[illegible]ent information [illegible]nd time trends [illegible]mated referrals)
Outcomes monitoring	Patient/program evaluation or practice audit Performance measurement and benchmarking Surveillance and registries

Standardized respiratory data elements are crucial!

Boulet et al. Can Respir J 2012; 19: 117-26.

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Asthma Data Standards and eTools

Data Standards

Primary Care Asthma Performance Indicators (PC-API©, e-API)

PRESTINE Asthma EMR elements

Point of Care Tools

Care Maps

(AMOMS, Provider Asthma Assessment Form)

Questionnaires (eAQLQs, WRASQ(L)®)

Portals (*AsthmaLife*®)

Decision Support Tools

eAMS

Severe Asthma Algorithm

To et al. *Int J Qual Health* Care 2010: 22(6) 476-485;
Gupta et al. *Eur Respir J* 2019; 53(4): 1802241;
Taite et al. *HealthCare Quarterly* 2020;23(2):67-74;
Lougheed et al. *Can J Respir Crit Care Med* 2021; 5(6): 391-399

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Study Aims

- To determine how best to
  - integrate electronic asthma tools (eTools) into primary care EMRs
  - measure and provide feedback on performance within an EMR
  - design and scale an asthma surveillance system that supports quality improvement
- To propose dissemination and implementation strategies for asthma eTools

Moloney et al. *JMIR Form Res* 2023; 21(7): e42767

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OntarioMD Peer Leader Workshops

Workshop #1: Asthma Indicators	
Duration	2 hours
Participants	• 6 physicians • 1 nurse practitioner
Goals	1. Understand what an asthma surveillance system is and how to scale a system across Canada 2. Learn how to provide feedback in an EMR that is easy for clinicians to use 3. Determine health care provider preferences for asthma indicators
Data Collection	• Asthma indicator survey

Workshop #2: eTools	
Duration	2 hours
Participants	• 5 physicians • 1 nurse practitioner • 1 patient
Goals	1. Understand how EMR tools can support best practice in clinic 2. Determine which eTools to integrate into an EMR or dashboard environment
Data Collection	• eTool survey

Moloney et al. *JMIR Form Res* 2023; 21(7): e42767

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OntarioMD Peer Leaders Workshop

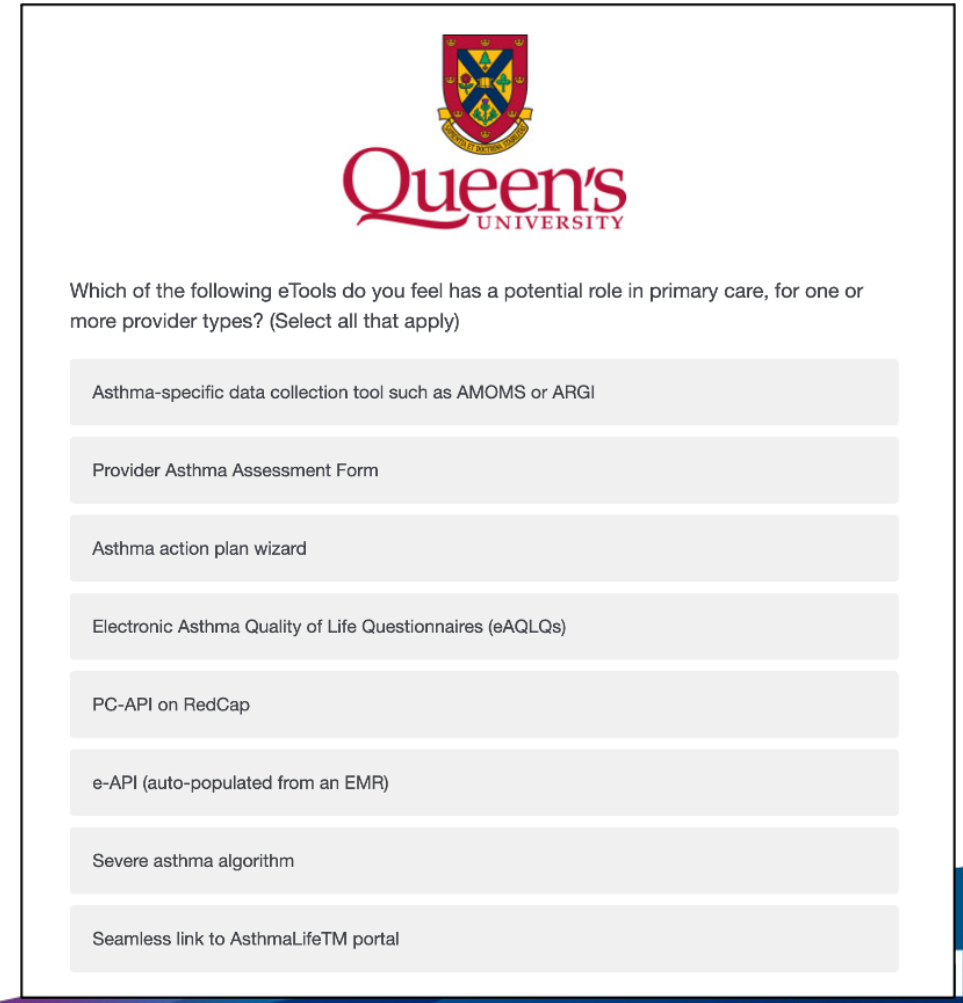
Asthma Indicator Survey

- 24 indicators
- Rated characteristics including:
  - Clarity, feasibility, relevance, overall
- Preference between PC-API© or HQO

Asthma eTool Survey

- 8 eTools
- Rated characteristics including:
  - Benefits, potential users, barriers

Moloney et al. *JMIR Form Res* 2023; 21(7): e42767



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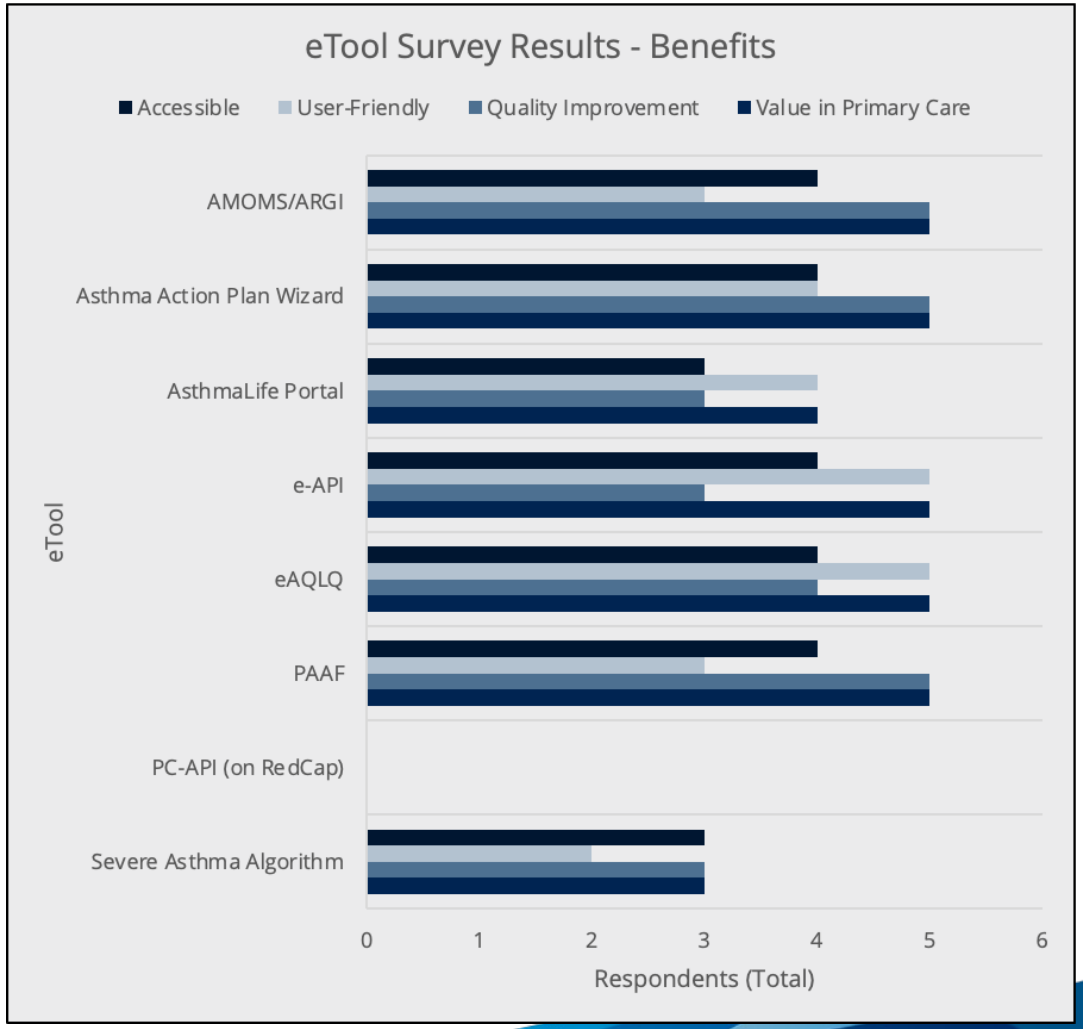
Workshop Quantitative Results

Survey	Results
Asthma Indicator Survey	• Highest rated indicators 1. Smoking cessation support 2. Emergency department visits 3. Monitoring by objective measures • Preference for PC-API© indicators (7/9)
eTool Survey	• Highest rated eTools demonstrated: ◦ Asthma Action Plan Wizard ◦ Electronic Asthma Quality of Life Questionnaire (eAQLQ) • Greatest barriers in developing new eTool: ◦ Time ◦ Too specialized



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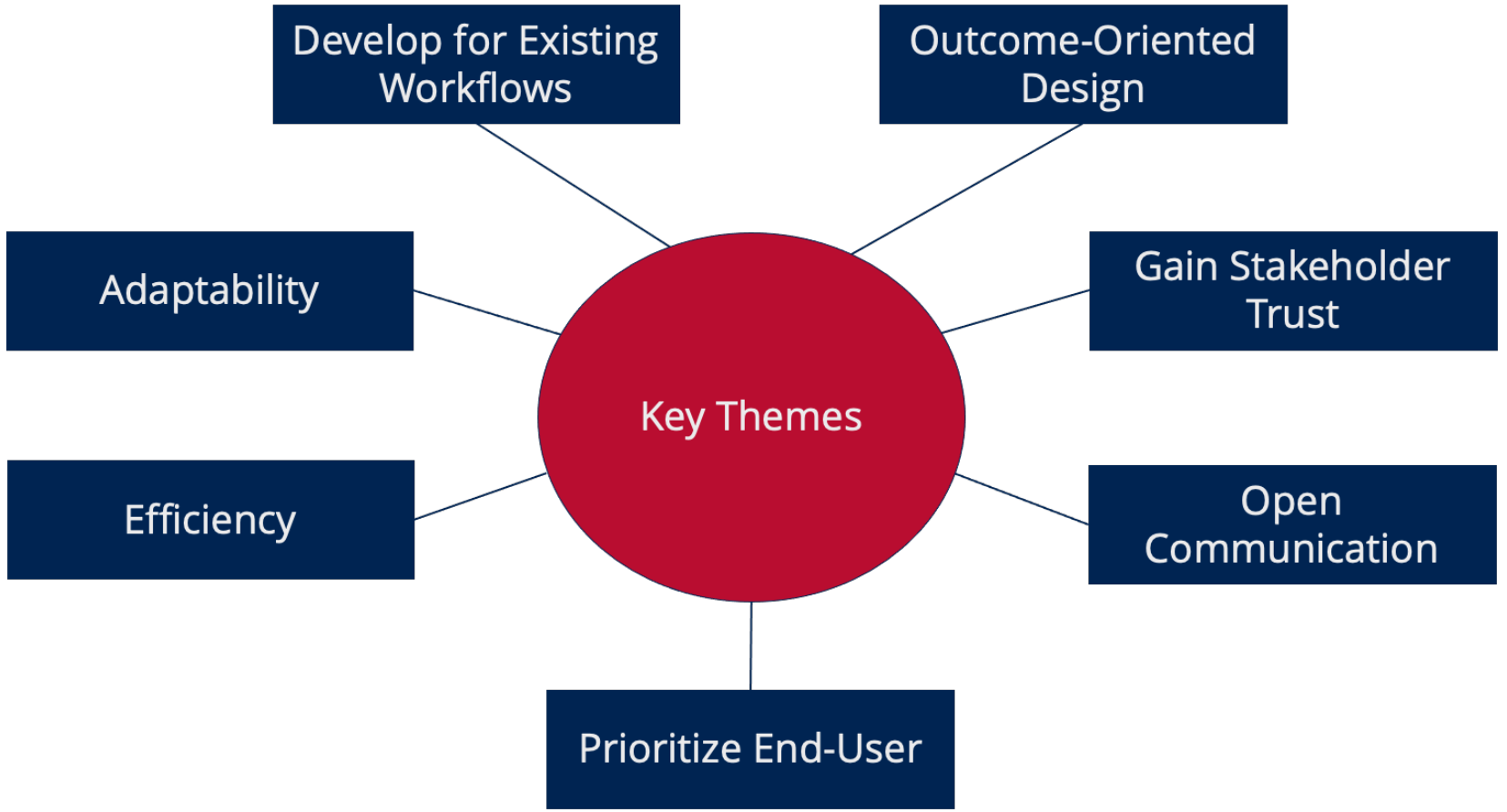
Workshop Qualitative Results



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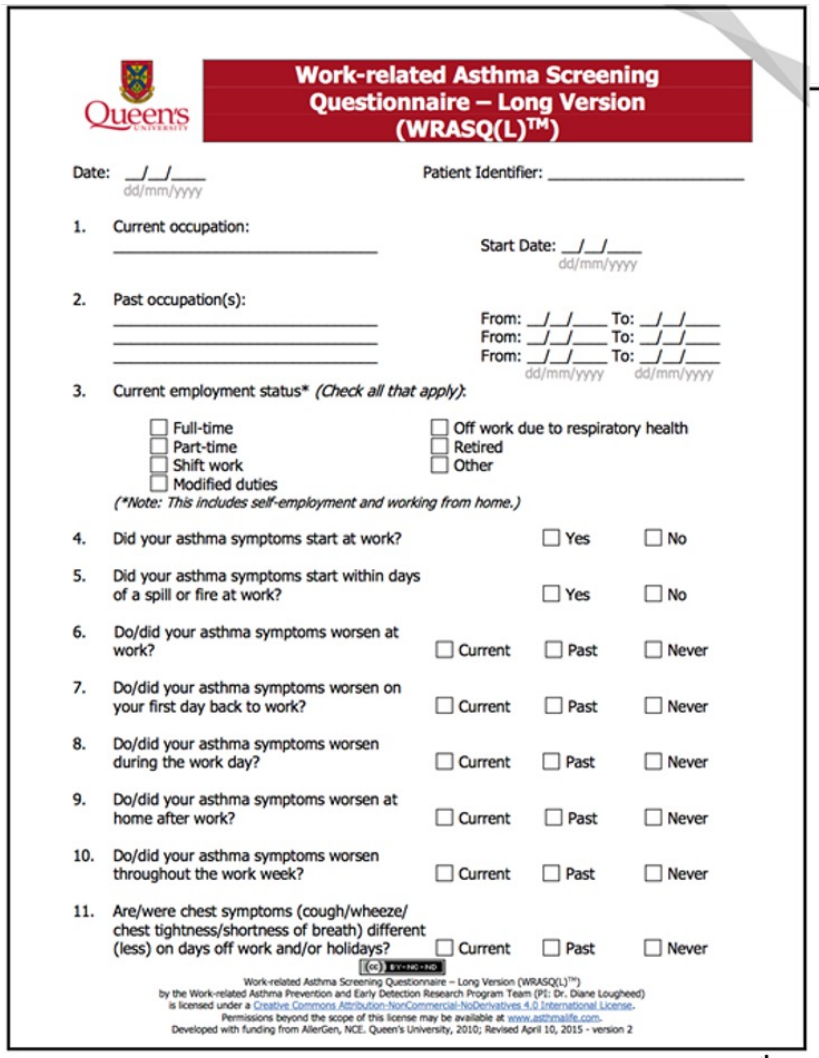
Case Study: Developing Strategies for Implementation of the WRASQ(L)™



Queen's University

Work-related Asthma Screening Questionnaire – Long Version (WRASQ(L)™)

Date: __/__/____ dd/mm/yyyy Patient Identifier: _____

1. Current occupation: _____ Start Date: __/__/____ dd/mm/yyyy
2. Past occupation(s):
   _____ From: __/__/____ To: __/__/____
   _____ From: __/__/____ To: __/__/____
   _____ From: __/__/____ To: __/__/____
   dd/mm/yyyy dd/mm/yyyy
3. Current employment status* *(Check all that apply)*:
   - ☐ Full-time
   - ☐ Part-time
   - ☐ Shift work
   - ☐ Modified duties
   - ☐ Off work due to respiratory health
   - ☐ Retired
   - ☐ Other

   *(*Note: This includes self-employment and working from home.)*
4. Did your asthma symptoms start at work? ☐ Yes ☐ No
5. Did your asthma symptoms start within days of a spill or fire at work? ☐ Yes ☐ No
6. Do/did your asthma symptoms worsen at work? ☐ Current ☐ Past ☐ Never
7. Do/did your asthma symptoms worsen on your first day back to work? ☐ Current ☐ Past ☐ Never
8. Do/did your asthma symptoms worsen during the work day? ☐ Current ☐ Past ☐ Never
9. Do/did your asthma symptoms worsen at home after work? ☐ Current ☐ Past ☐ Never
10. Do/did your asthma symptoms worsen throughout the work week? ☐ Current ☐ Past ☐ Never
11. Are/were chest symptoms (cough/wheeze/ chest tightness/shortness of breath) different (less) on days off work and/or holidays? ☐ Current ☐ Past ☐ Never

Work-related Asthma Screening Questionnaire – Long Version (WRASQ(L)™)
by the Work-related Asthma Prevention and Early Detection Research Program Team (PI: Dr. Diane Lougheed)
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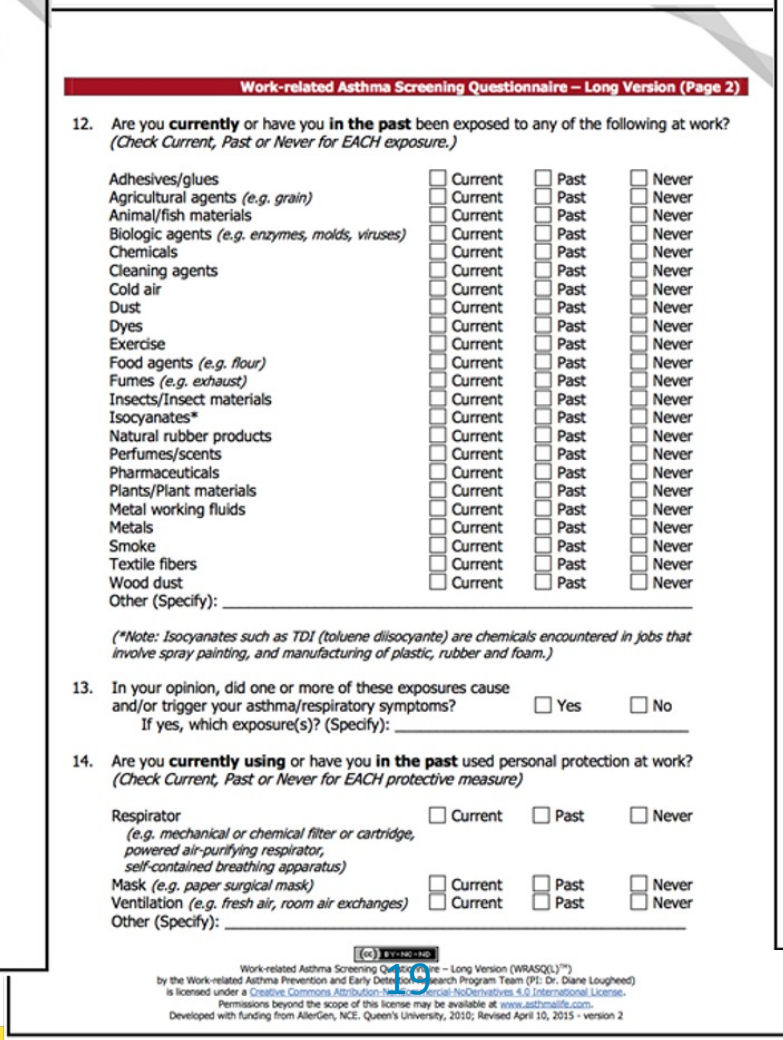
Developed with funding from AllerGen, NCE. Queen's University, 2010; Revised April 10, 2015 - version 2



Work-related Asthma Screening Questionnaire – Long Version (Page 2)

12. Are you **currently** or have you **in the past** been exposed to any of the following at work? *(Check Current, Past or Never for EACH exposure.)*

Adhesives/glues	☐ Current	☐ Past	☐ Never
Agricultural agents *(e.g. grain)*	☐ Current	☐ Past	☐ Never
Animal/fish materials	☐ Current	☐ Past	☐ Never
Biologic agents *(e.g. enzymes, molds, viruses)*	☐ Current	☐ Past	☐ Never
Chemicals	☐ Current	☐ Past	☐ Never
Cleaning agents	☐ Current	☐ Past	☐ Never
Cold air	☐ Current	☐ Past	☐ Never
Dust	☐ Current	☐ Past	☐ Never
Dyes	☐ Current	☐ Past	☐ Never
Exercise	☐ Current	☐ Past	☐ Never
Food agents *(e.g. flour)*	☐ Current	☐ Past	☐ Never
Fumes *(e.g. exhaust)*	☐ Current	☐ Past	☐ Never
Insects/Insect materials	☐ Current	☐ Past	☐ Never
Isocyanates*	☐ Current	☐ Past	☐ Never
Natural rubber products	☐ Current	☐ Past	☐ Never
Perfumes/scents	☐ Current	☐ Past	☐ Never
Pharmaceuticals	☐ Current	☐ Past	☐ Never
Plants/Plant materials	☐ Current	☐ Past	☐ Never
Metal working fluids	☐ Current	☐ Past	☐ Never
Metals	☐ Current	☐ Past	☐ Never
Smoke	☐ Current	☐ Past	☐ Never
Textile fibers	☐ Current	☐ Past	☐ Never
Wood dust	☐ Current	☐ Past	☐ Never
Other (Specify): _____			

*(*Note: Isocyanates such as TDI (toluene diisocyante) are chemicals encountered in jobs that involve spray painting, and manufacturing of plastic, rubber and foam.)*

13. In your opinion, did one or more of these exposures cause and/or trigger your asthma/respiratory symptoms? ☐ Yes ☐ No
    If yes, which exposure(s)? (Specify): _____
14. Are you **currently using** or have you **in the past** used personal protection at work? *(Check Current, Past or Never for EACH protective measure)*

Respirator *(e.g. mechanical or chemical filter or cartridge, powered air-purifying respirator, self-contained breathing apparatus)*	☐ Current	☐ Past	☐ Never
Mask *(e.g. paper surgical mask)*	☐ Current	☐ Past	☐ Never
Ventilation *(e.g. fresh air, room air exchanges)*	☐ Current	☐ Past	☐ Never
Other (Specify): _____			

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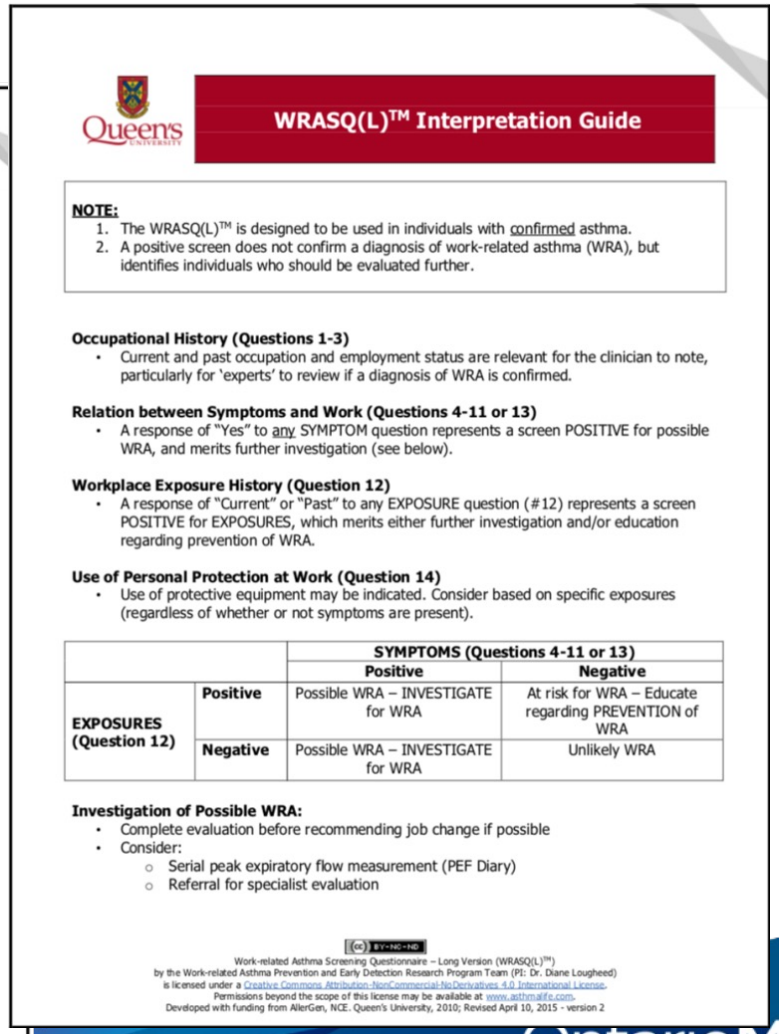

Queen's University

WRASQ(L)™ Interpretation Guide

NOTE:
1. The WRASQ(L)™ is designed to be used in individuals with confirmed asthma.
2. A positive screen does not confirm a diagnosis of work-related asthma (WRA), but identifies individuals who should be evaluated further.

Occupational History (Questions 1-3)
- Current and past occupation and employment status are relevant for the clinician to note, particularly for 'experts' to review if a diagnosis of WRA is confirmed.

Relation between Symptoms and Work (Questions 4-11 or 13)
- A response of "Yes" to any SYMPTOM question represents a screen POSITIVE for possible WRA, and merits further investigation (see below).

Workplace Exposure History (Question 12)
- A response of "Current" or "Past" to any EXPOSURE question (#12) represents a screen POSITIVE for EXPOSURES, which merits either further investigation and/or education regarding prevention of WRA.

Use of Personal Protection at Work (Question 14)
- Use of protective equipment may be indicated. Consider based on specific exposures (regardless of whether or not symptoms are present).

		SYMPTOMS (Questions 4-11 or 13)	
		Positive	**Negative**
EXPOSURES (Question 12)	**Positive**	Possible WRA – INVESTIGATE for WRA	At risk for WRA – Educate regarding PREVENTION of WRA
	Negative	Possible WRA – INVESTIGATE for WRA	Unlikely WRA

Investigation of Possible WRA:
- Complete evaluation before recommending job change if possible
- Consider:
  - Serial peak expiratory flow measurement (PEF Diary)
  - Referral for specialist evaluation

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Methods

Project Advisory Committee	Ontario MD Workshops	Questionnaires
Invited Relevant stakeholders	Two semi-structured workshops	Pre-workshop: WRA awareness and management
1 hour meeting 3x per study period	Presentation of eTools	Post-workshop: WRASQ(L)™ feedback
	Thematic Qualitative Analysis	

MacKinnon et al. *JMIR Form Res* 2022; 6(9);e37503

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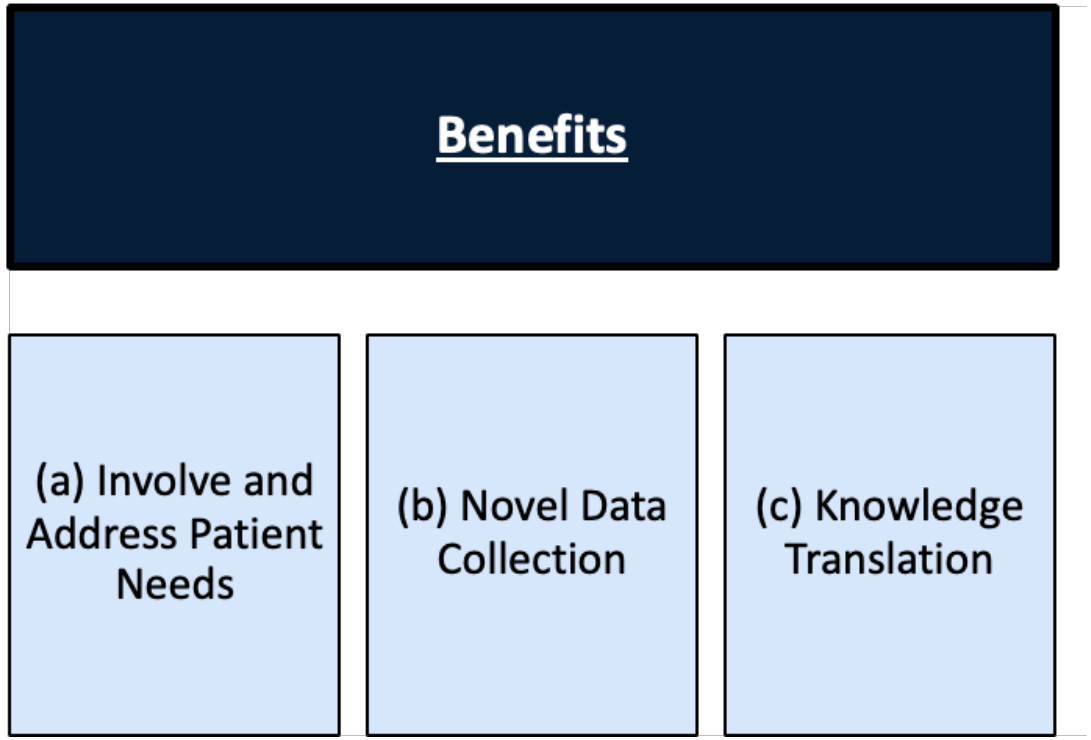
WORKSHOP RESULTS: Barriers & Enablers to Implementation



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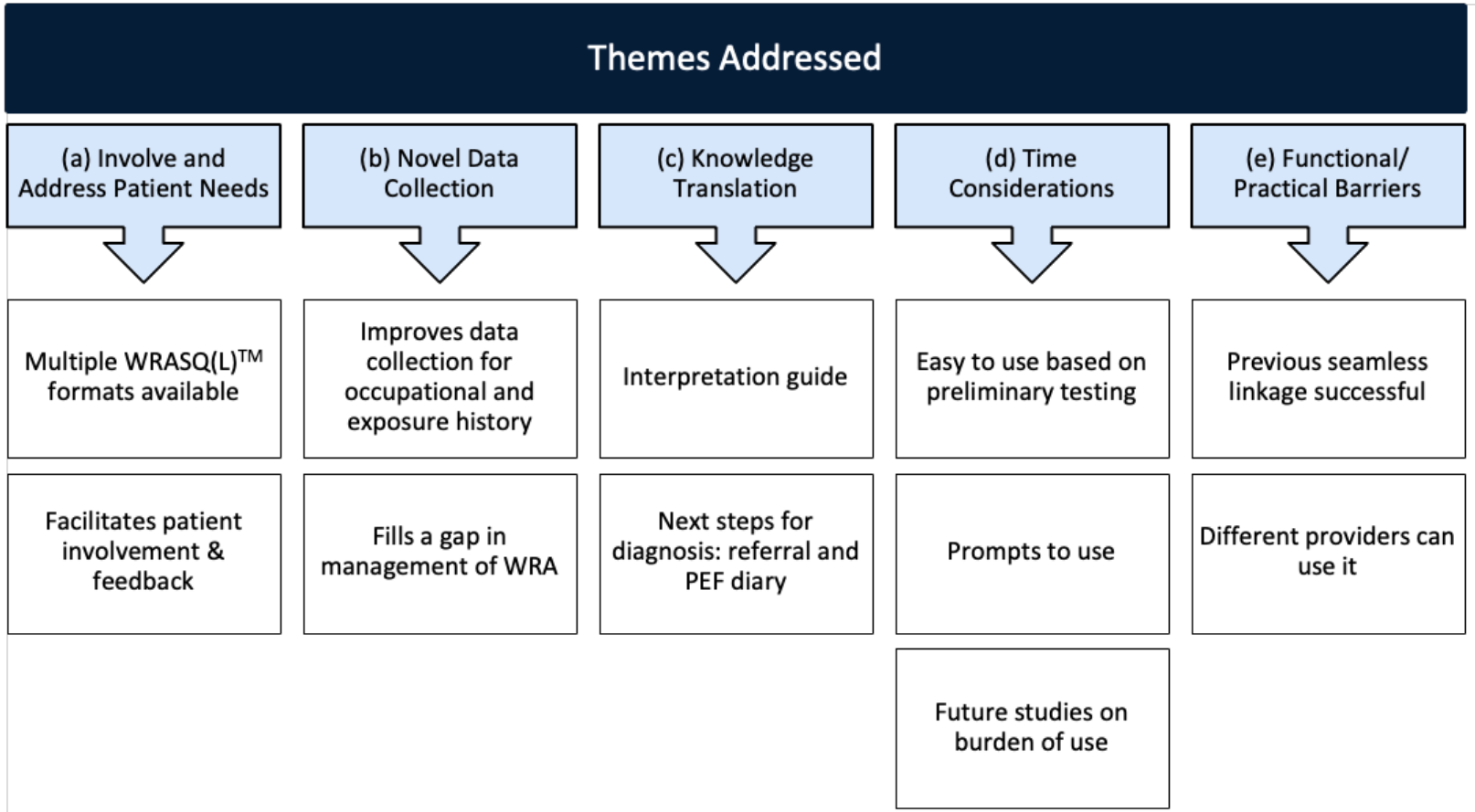
Linking workshop results to strategies for Implementation



MacKinnon et al. *JMIR Form Res* 2022; 6(9);e37503

PROJECT ADVISORY COMMITTEE: Knowledge Translation Strategies

Dissemination Strategies	Implementation Strategies

• Develop educational material
  • WSIB Champions Program
  • LHF eModule for providers on WRA
• Link to websites/eToolkits
  • LHF's "current educational strategies" for providers
  • CTS toolkit
• Translate to other languages
• Leverage existing healthcare and research networks:
  • CREs: CNRC, PCAP
  • CTS Asthma Clinical Assembly
  • ATS and ERS WRA Taskforces
  • CREOD
• Conference presentations
• Peer-reviewed publication
	• Integrate into EMRs
	  • OntarioMD's Dashboard
	  • Collaborate with EMR vendors, MOL and MOH
	• Design multifaceted interventions
	  • prompts and reminders
	  • performance indicators
	  • audit and feedback
	• Target non-traditional settings
	  • workplaces
	  • pharmacies
	• Implement in research settings as well as clinical

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Patient Impact from Implementation Strategies

Direct	Indirect

• Increase awareness
• Screen for suspected WRA
• Education
  • Exposures
  • Prevention
  • Symptom-workplace management
• Improve health outcomes
	• Inform providers for better management
	• Inform employers
	• Fill gaps in knowledge translation strategies

MacKinnon et al. *JMIR Form Res* 2022; 6(9);e37503

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Summary

- eTools in EMRS have tremendous potential to support adherence with evidence-based (asthma) guidelines, for asthma and other chronic diseases
- Barriers to eTool adoption include time considerations, functional barriers and human limitations
- Strategies for successful integration and adoption of asthma eTools that support surveillance and benchmarking for quality improvement include:
    - Targeting barriers early on in implementation process
    - Stakeholder and patient involvement
    - Emphasizing knowledge translation to address key care gaps
    - Use of validated asthma indicators and data standards

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  - Genevieve Digby, MD, MSc
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