

Recommendations for a Clinical Decision Support System for Work-Related Asthma in Primary Care Settings

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Objective: The aim of this study was to describe a recommended clinical decision support (CDS) approach for work-related asthma for incorporation in electronic health records (EHRs) for primary care health care providers. **Methods:** Subject matter experts convened by the American Thoracic Society reviewed available guidelines and published literature to develop specific recommendations. **Results:** It is important to recognize possible work-related asthma among persons with new-onset or worsening asthma. The work group recommends incorporating three simple questions about temporal relations between asthma symptoms and work in EHR systems and identified specific clinical conditions to trigger this intervention. Patients with positive responses to the three questions should have the asthma diagnosis documented and have further evaluation, education, and possible referral. **Conclusion:** An effective CDS system for improving recognition of work-related asthma may help reduce morbidity and mortality of asthma in adults.

OVERVIEW

This paper summarizes the efforts of a work group of subject matter experts (SMEs) convened by the American Thoracic Society (ATS) to develop recommendations about work-related asthma (WRA) for a clinical decision support (CDS) tool for inclusion in electronic health record (EHR) systems in the primary care setting. The National Institute for Occupational Safety and Health (NIOSH) contracted with ATS to convene these SMEs. Members of the work group identified by ATS were Drs Joe Gerald, Philip Harber (chair), Stella Hines, and Carrie Redlich. Margaret Filios and Dr Eileen Storey of NIOSH participated in providing context and ongoing connection to the larger NIOSH effort to demonstrate value and use of occupational information in EHRs. The full report is available at http://www.acoem.org/uploadedFiles/Public_Affairs/Policies_And_Position_Statements/Guidelines/Library_and_Reference_Material/NIOSH%20Final%20Reports.pdf.

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Funding to support this work was provided through CDC/NIOSH Contract 212-2014-M-59016 as part of NORA project #927ZLDN.

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

Two minor changes from the content of the technical document are included in this manuscript: Hospitalizations as well as emergency department visits may trigger the CDS. The range of relevant ICD-10 codes has been modified.

The authors report no conflicts of interest.

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DOI: 10.1097/JOM.0000000000001182

REASON FOR FOCUS ON EARLY RECOGNITION OF WORK-RELATED ASTHMA (WRA)

Asthma affects 18.7 million adults in the US (8.2% of the population).¹ WRA includes asthma caused by workplace exposures (termed occupational asthma, OA) or exacerbated by exposures in the workplace (termed work-exacerbated asthma or WEA).^{2,3} Workplace exposures are thought to contribute to 17% of new-onset adult asthma.⁴ Regardless of cause, an estimated 22% of adults with asthma suffer work-related exacerbations.³ Patients with WRA have more symptoms, use health care more, and experience more limitations in activities.^{5,6}

Work-relatedness of asthma often goes unrecognized.^{2,7-9} Of ever-employed adults with asthma, nearly half report that work played a role in its onset, and fewer than one in five of those have a diagnosis of WRA. Of adults with asthma, 9.1% are told their asthma is work-related, and 11.7% told their physician about their concern.¹⁰

The relatively short latency and availability of many exposure control methods make WRA an excellent candidate for linking prevention with clinical input. Initial clinical consideration of possible WRA is the critical first step in helping the patient and potentially protecting coworkers. Therefore, the work group elected to focus upon helping primary care clinicians recognize the *possibility* of WRA. The primary objective of the EHR-based CDS system is to improve recognition of WRA in primary care settings for working-age patients (18 years of age and older) with asthma. The recommendations seek to support clinician-patient discussion and further evaluation of possible WRA, rather than provide a complete diagnostic and management algorithm.

Process of Selection of Recommendation(s)

The work group reviewed existing recommendations of professional societies identified by the SMEs as relevant; these included the American College of Chest Physicians (ACCP) consensus statement on WRA,² the ATS official statement on WRA,³ the European Respiratory Society (ERS) taskforce guidelines for the management of WRA,¹¹ the American College of Occupational and Environmental Medicine (ACOEM) guideline,¹² the British Thoracic Society (BTS) standards of care for OA,^{13,14} and the related British Occupational Health Research Foundation (BOHRF) evidence reviews.¹⁵ The work group felt these provide important information but did not directly provide approaches for evaluating and managing WRA in many primary care settings. Therefore, the work group synthesized the existing statements with a limited literature review (discussed below) and its members' expertise to guide the development of recommendations.

Considerations Guiding the Approach

The recommended CDS should leverage the unique capabilities of embedding within an EHR rather than being a generic set of recommendations. As asthma is frequent among primary care patients, defining triggering conditions to select those patients most likely to benefit is important to encourage clinician follow-up.

The work group considered whether to make recommendations about specific agents such as toluene diisocyanate (TDI) or

TABLE 1. Factors Considered by the Work Group for Choosing Approach

Primary care focus: settings and practice
Feasibility in primary care setting
Potential utility of an intervention
Likelihood of successful embedding within an EHR system
Scope of recommendations: initial recognition versus diagnostic/management algorithm
Strength of evidence
Targeting patients likely to receive greatest benefit
Generic versus causative agent specific recommendations
Work-related asthma (both occupational asthma and work-exacerbated asthma)

irritants, but favored a more general approach. Although an approach focused upon initial suspicion was selected, the group felt that providing list of common WRA exposure agents/conditions as well as resources targeted to health care providers and patients would help early recognition and management of WRA. Table 1 summarizes factors guiding the approach of the work group. In addition, the general category of WRA should be addressed rather than focusing on either of the subtypes (WEA or OA), particularly because they are often difficult to differentiate at the initial presentation.

EVALUATING THE EVIDENCE/STRENGTH OF THE RECOMMENDATIONS

The work group decided to select recommendations based on the most recent available statements on WRA from the major professional organizations. Throughout the development process, these statements were supplemented with additional literature searches and the expert opinion of the work group. Expert judgment rather than a priori inclusion/exclusion criteria was utilized (eg, a specific search and evaluation was done for OA questionnaires). The literature search and assessment of individual articles were done iteratively throughout the recommendation development process.

Guidelines and statements from the ACCP,² American College of Occupational and Environmental Medicine (ACOEM),¹² ERS,^{11,16} ATS,³ BOHRF, and BTS Standards of Care^{13–15} were reviewed. The ACCP and ATS documents used a consensus approach. The BOHRF and ERS documents used the Scottish Intercollegiate Guidelines Network (SIGN), Royal College of General Practitioners (RCGP), and/or Grading of Recommendations Assessment, Development, and Evaluation (GRADE) systems to evaluate the quality of the evidence and the strength of the recommendations. There was general agreement in these statements, given mainly smaller cohort studies rather than randomized controlled trials, that the quality of the literature is low to moderate. Of note, the recommendations regarding the diagnosis and management of WRA in these different documents were remarkably similar, despite the limited quality of the evidence and different rating systems, as noted in a recent quality appraisal of these WRA documents.¹⁷ The ERS Statement, using the GRADE system, rated the strength of almost all recommendations as strong, given that the benefits outweighed risks.¹¹ The recommendations are described in detail in the section, “Recommended Intervention.”

For recommendation 1a (Administer three screening questions for WRA), relevant questionnaires from prior statements and guidelines, published literature, and comments from professional colleagues were reviewed to identify questions to screen for WRA in a primary care setting.^{2,11,18–21} Validation of these questionnaires for WRA has been limited and all were too lengthy for use in their entirety in a primary care setting. A shorter WRA screening questionnaire that was evaluated in a primary care asthma program

was considered most applicable to current needs.^{18,22} Three questions addressing the temporal relationship of symptoms to work, questions common to most WRA questionnaires, were chosen from this 14-item questionnaire, as all 14 questions were considered too lengthy.

Recommendation 1b (Evaluate diagnosis of asthma) is based on the existing WRA reports, which define asthma as reversible airflow obstruction.^{2,11,13,15} These reports all highlight the importance of attempting to document asthma when WRA is being considered, rather than relying on a firmly established clinical diagnosis, as is common in a primary care setting. The spirometry criteria used are also consistent with ATS and ERS guidelines and the Global Initiative for Asthma (GINA).^{23,24}

Recommendation 1c (Provide WRA tools to clinician and patient) is also based on the previously WRA documents cited in the earlier section,^{2,3,11,13,14} which all stress the importance of obtaining a thorough focused work and exposure history and referral to clinicians with specialized expertise in WRA.

Used sequentially, the three components of the recommendation are each important. The first is a sensitive tool for encouraging both the patient and health care provider to consider the possibility of WRA. The second component should enhance specificity, which is important in view of the potential adverse impact of a WRA diagnosis upon employment and income. The third component provides the health care provider with tools to assist the intervention.

The work group used both expert judgment and identified publications to assess the balance between likely benefits and risks such as potential health risks and consequences such as impact on employment status. Anticipated risks for all components of the recommendation were considered minimal, and the potential benefits of identifying WRA were considered substantial, including improving health outcomes, leading to improved exposure controls, and encouraging appropriate job modification or alternate work.^{2,6,11}

RECOMMENDED INTERVENTION

Overall Clinical Objective

The primary objective is to improve recognition and management of WRA in primary care settings for patients with asthma who are likely to be of working age (≥ 18 years old).

RECOMMENDATIONS

The work group recommends a systematic approach to identifying WRA in primary care settings. The recommendation contains several components, which would be triggered in a sequential fashion, as summarized below and in Table 2:

Recommendation #1a: Administer 3 WRA screening questions to all working age (≥ 18 years old) patients with new-onset or worsening asthma

IF: Reason for visit is:

- Asthma (ICD-9 493; ICD-10: J45) that began within the last 2 years
 - OR
 - Patient had one or more emergency department (ED) or acute clinic visits or hospitalizations for asthma during the past 2 years
- THEN** ask:

- (1) Do/did your asthma symptoms start at your current/recent workplace?
- (2) Do/did your asthma symptoms worsen at work?
- (3) Are asthma symptoms different (eg, better) on days off work and/or holidays?

Recommendation #1b: Evaluate diagnosis of asthma

TABLE 2. Recommended Sequential Approach to Improve Recognition and Management of Work-Related Asthma in Primary Care Settings

Recommendation 1a

IF

Reason for visit = Asthma (ICD-9 493; ICD-10: J45) that began within the last 2 years

OR

Patient had one or more emergency department or acute clinic/hospital visits for asthma over the past 2 years

THEN:

Ask:

- 1) Do/did your asthma symptoms start at your current/recent workplace?
- 2) Do/did your asthma symptoms worsen at work?
- 3) Are asthma symptoms different (eg, better) on days off work and/or holidays?

Recommendation 1b

IF

Patient responds positively to any of the three screening questions

THEN:

Clarify the diagnosis of asthma with acceptable and repeatable spirometry testing that meets ATS guidelines for quality

Recommendation 1c

IF

Patient responds “yes” to any of the three screening questions

AND

Patient has asthma

THEN:

Provide WRA tools to the clinician and patient

AND:

Document the discussion regarding the patient’s work and respiratory symptoms in EHR

ATS, American Thoracic Society; EHR, electronic health record; WRA, work-related asthma.

IF: Patient responds positively to any of the three screening questions

THEN: Clarify the diagnosis of asthma with acceptable and repeatable spirometry testing that meets ATS guidelines for quality.²⁵

Spirometry showing airflow obstruction based upon the ratio of the forced expiratory volume in 1 second (FEV₁) to the forced vital capacity (FVC), or FEV₁/FVC below the lower limit of normal (LLN) and a significant response to bronchodilator (defined as improvement in either FEV₁ or FVC by 200 mL and a 12% improvement over baseline) supports a diagnosis of asthma and provides documentation of asthma.

Recommendation #1c: Provide WRA tools to clinician and patient, and encourage discussion

IF: Patient responds positively to any of the three screening questions **AND** patient has asthma

THEN: Provide WRA tools to the clinician and patient

AND Document in EHR the discussion regarding the patient’s work and respiratory symptoms

The WRA information tools should include three components:

(1) Checklist of selected high-risk exposure²²:

- Adhesives/glues
- Agricultural agents (eg, grain)
- Animal/fish materials
- Biologic agents, enzymes
- Molds, viruses
- Chemicals
- Cleaning agents
- Cold air
- Dust
- Dyes

- Food agents (eg, flour)
- Fumes (eg, exhaust)
- Insects/insect materials
- Isocyanates
- Natural rubber products
- Pharmaceuticals
- Plants/plant materials
- Metal working fluids
- Metals
- Smoke
- Textile fibers
- Wood dust

- (2) Educational materials for providers and patients, including information on diagnosis and management of WRA: Education materials are from the ATS, Occupational Safety and Health Administration (OSHA), and the medical literature.^{26–29}
- (3) Referral resources: Information on local clinicians with specialized knowledge of occupational respiratory disorders (including referral instructions and forms), and additional local resources such as county/state health departments and affiliates of the American Lung Association.

CASE EXAMPLE

Mr Jones is 35-year-old man with a complaint of cough and wheeze over the past 6 months who comes to his primary care clinician for evaluation. In the past month, with worsening symptoms, he missed work for two “sick days” for breathing problems. He went to a local ED last week where the diagnosis was asthma. He received a “breathing treatment” and was given a prescription for albuterol. He is a nonsmoker with no prior history of asthma. He denies recent fever, weight loss, or sputum production.

Pertinent findings on his physical examination included expiratory wheeze on forced expiration; there were no rales or

crackles. The primary care clinician records a diagnosis of asthma, a new diagnosis for this patient. A questionnaire is sent to Mr Jones electronically via his provider's EHR portal to complete. He indicates a positive response to asthma symptoms worsening at work and asthma symptoms different (ie, better) on days off work and/or holidays. This triggers an alert to the clinician, who orders spirometry with bronchodilator. A notification about the scheduled test is sent to Mr Jones. The testing is performed and shows mild airflow obstruction with a positive bronchodilator response, supporting the diagnosis of asthma.

The CDS a) notifies the patient (and the health care provider) to make an appointment for an extended visit to review his occupational history, b) sends the patient and provider a list of exposures that can cause WRA, educational information on the diagnosis of WRA, and c) provides the primary care provider with information on local clinicians with specialized knowledge of occupational respiratory disorders and referral instructions and forms.

Mr Jones returns for his longer appointment. He identifies "adhesives" on the WRA agent list. He and his primary care clinician review his spirometry results, and discuss his job and associated respiratory symptoms. His asthmatic symptoms started about 2 months after he started his new job, worsen at work, and improve on weekends. He denies ever having asthma or prior pulmonary function testing. A coworker has also been diagnosed with asthma.

Mr Jones' primary care clinician documents the discussion regarding Mr Jones' work history and respiratory symptoms in his electronic medical record including: dates of employment/job changes/job title, the timing of onset of his asthma symptoms, temporal associations of his symptoms with work/away from work, and any other asthma triggers.

His primary care clinician makes a diagnosis of asthma and suspects the asthma may be work-related based on his patient's clinical presentation, work-related symptoms, spirometry results, and occupational history, including identification of exposure to "adhesives" at work, a substance on WRA agent list. He refers Mr Jones to a local occupational pulmonary specialist for further evaluation and management and also prescribes standard asthma treatment (inhaled steroids, bronchodilator), based on National Asthma Education and Prevention Program (NAEPP) guidelines. The clinician discusses with Mr Jones his goals and whether temporary removal or restriction from exposure is advisable and feasible while waiting for the consult.

While the CDS application stops here, ideally the referral would result in the following:

Mr Jones next sees the occupational pulmonary specialist (Dr X), who learns that Mr Jones worked for the same company, an aircraft engine manufacturer, for the past 10 years. About 8 months ago, he switched to a new job at the same manufacturer, which involves preparing engine parts for assembly. This work involves inspecting the parts for defects, cleaning them with an air-gun, and spraying an adhesive to contact surfaces before final assembly. He wears gloves but no other protective gear when he applies the adhesives. Dr X performs additional evaluation, including review of safety data sheets (SDS) that Mr Jones obtained from his workplace and peak flow recordings at and away from work. The SDS for the spray adhesive documents that MDI (methylene diphenyl diisocyanate), a known potent sensitizer that can cause OA, is one of the main components of the adhesive.

On the basis of this additional information, Dr X diagnoses Mr Jones with WRA (specifically, new-onset sensitizer OA), and makes recommendations regarding exposure reduction/elimination, and medical follow-up. Dr X also instructs Mr Jones to inquire about workers' compensation.

Working collaboratively with the employer, Mr Jones initially was provided protective clothing and an appropriate respirator, and local ventilation was improved. However, Mr Jones's work-associated asthmatic symptoms persisted. The employer was unable to switch to an alternative adhesive that did not contain MDI. Subsequently, the employer decided to fully enclose and automate the adhesive application process so that Mr Jones and his coworkers could avoid exposure to the adhesive.

Mr Jones continues to work for the same aircraft manufacturer. His primary care clinician and occupational pulmonary specialist collaborate to manage his asthma, which has improved, with less frequent use of his albuterol inhaler. He applied for workers' compensation given his diagnosis of WRA. Discussion continues as to whether ongoing potential exposure to even small amounts of MDI poses a risk for persistent asthma or worsening asthma over time despite treatment.

CHOICES MADE: BENEFITS, RISKS, AND LIMITATIONS

The primary objective is to develop CDS tools to improve the recognition and management of WRA in primary care settings for working age patients with asthma. Review of both standard and grey literature such as governmental reports indicated that there were no publicly available CDS tools for WRA. Although there are CDS tools for asthma and COPD in primary care,³⁰ these were not directly applicable for the occupationally related conditions. The work group therefore needed to develop a recommendation to identify patients with WRA. Three sequential components were identified. The work group concluded that the potential benefit of the recommended approach is likely to significantly exceed potential adverse effects and that implementation is feasible in primary health care settings.

The questionnaire (Recommendation 1a) is simple and similar to one used in a published trial.^{18,22} It imposes little burden upon the patient or the clinician and is unlikely in itself to impose significant risk. However, use of a simple screening questionnaire will likely not identify all cases of possible WRA.

Clarifying the diagnosis of asthma (Recommendation 1b) is likely to provide several benefits to patient care. This will help limit use of medications with potential adverse effects to those likely to benefit. Objectively documenting that asthma is present will help clarify the patient's diagnosis, which can impact a patient's job as well as health. The recommended test, spirometry, is safe and has only rare complications. However, the recommended approach may not identify all patients with WRA; it may not identify those whose spirometry is currently normal, possibly because they have left the workplace and/or are taking asthma medications. This approach will also not identify patients with work-related rhinitis or other respiratory conditions.

Facilitating patient-clinician discussion about possible WRA (Recommendation 1c) not only has substantial potential benefits but also potential risks. Diagnosing WRA can lead to appropriate exposure control, job modification, and/or compensation. Early recognition of WRA and exposure reduction improves health outcomes.^{2,16,31} Identification of a sentinel case may also lead to workplace protections for other workers, preventing other cases of WRA.

Potential risks include over- or underdiagnosis of WRA. For example, some asthma patients may have normal spirometry if tested on a single occasion. Patients may be subject to income or job loss if WRA is diagnosed, which can be mitigated by accurate diagnosis and exposure reduction. Costs related to clinician and patient time for obtaining the occupational history will be incurred.

The CDS recommendations have several limitations. The three recommended intervention components have not been

rigorously evaluated in a randomized controlled trial. However, they are based on recommendations from the major professional organizations, and most of the components have been used in actual patient care settings. The work group feels that the benefits are likely to outweigh potential adverse effects.

For optimal performance, the CDS must be effectively embedded in the EHR for real-time performance. The system should identify target patients, generate the questions, collect the responses, and where appropriate, provide both patient and clinician the instruction to further assess WRA without delays. Furthermore, patient selection requires linkage between the clinic EHR and other data sources such as pulmonary function laboratory and/or other clinics. Spirometry may be unavailable for some patients.

Utilization requires commitment of both patient and clinician to discussing work exposures. Some patients may be unable to provide accurate work information.

Suspecting WRA is only the first step in actually benefiting the worker. The diagnosis must be confirmed or ruled out. If confirmed, the problem must be appropriately managed, considering both the clinical and the workplace aspects. Finally, issues of workplace change and accommodation must be addressed. Primary health care providers may have insufficient time, interest, or knowledge to properly handle the case to the extent of actually benefiting the worker. This may lead to ignoring prompts, overdiagnosis, or underdiagnosis.

The diagnosis and management of WRA can be challenging, even when a pulmonary or occupational medicine physician with particular occupational lung specialty evaluates a patient. The availability of referral expertise varies substantially by geographic location and health care system.

ACKNOWLEDGMENT

The authors gratefully acknowledge the assistance of Chris Hughes of the ATS and Joe Gerald, MD, PhD, of the University of Arizona.

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