

Review of Pesticide Education Materials for Health Care Providers Providing Care to Agricultural Workers

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ABSTRACT: *Context:* Pesticide exposure is an important environmental and occupational health risk for agricultural workers and their families, but health care providers receive little training in it. *Objective:* To evaluate the medical resources available to providers caring for patients, particularly farmworkers, exposed to pesticides and to recommend a selective bibliography for use in educating clinicians about pesticides and health care. These resources are divided into 3 domains: (1) the working knowledge, (2) the skill set, and (3) the references needed to care for these patients. *Methods:* We searched library databases dating back to 1995, as well as conference materials and Internet resources. Materials were included only if they were readily available through customary sources. Materials were randomly divided into 2 groups. Two authors wrote detailed reviews for each group. The remaining authors read each document and review, making changes that were agreed upon by the team. Review procedures were standardized to examine the contemporary relevance, quality, and overall strengths and weaknesses of the material relative to guidelines developed for each domain. These guidelines were developed from the authors' experience, national focus groups, and literature review. *Results:* While no 1 resource adequately addresses all needs, a number of resources were identified addressing the categories of working knowledge, skill set, and reference materials. Few of the reviewed materials address the cultural competence of providers treating farmworkers. Additional education resources are needed.

Pesticide exposure is recognized as an important health risk in the United States, as well as in other regions of the world.^{1,2} While virtually all persons can encounter pesticides through residential, lawn and garden, and food-borne pesticides, farmworkers are at particularly high risk because of the added risk of occupational exposure. Pesticides include "any substance or mixture of substances intended for

preventing, destroying, repelling, or mitigating any pest. Pests can be insects, mice and other animals, unwanted plants (weeds), fungi, or microorganisms like bacteria and viruses."³ Pesticides include insecticides, as well as herbicides, fungicides, rodenticides, nematocides, plant regulators, defoliants, desiccants, and disinfectants.

Health care providers receive little training in general environmental health issues, and they receive almost no training in the recognition and treatment of illness resulting from pesticide poisoning.^{1,4,5} While concern about health effects resulting from pesticide exposure has increased, those providers (rural and migrant clinicians) most likely to see these effects have not been trained to recognize them.^{1,6} Many cases of low-level pesticide exposure are not properly diagnosed. These undiagnosed cases include those for which patients do not seek treatment and those patients who seek treatment but whose illness is misdiagnosed.⁷ Efforts are under way to develop and provide educational programs addressing the health risks of pesticide exposure for all types of health care providers.^{1,2} The National Environmental Education and Training Foundation (NEETF) was chartered by Congress in 1990 to address this gap. NEETF designed

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a comprehensive approach to educating providers on environmental health and initiated a Pesticides Initiative. In partnership with the US Environmental Protection Agency (EPA), NEETF collaborates with the US Departments of Health and Human Services, Agriculture (FDA), and Labor (DOL) and with hundreds of clinicians, faculty, public health practitioners, and pesticide safety educators on this initiative to improve health care and advance environmental education.² The goal of this paper is to evaluate the resources health care providers who care for farmworkers and their families may find and employ in caring for patients exposed to pesticides. These resources are divided into 3 domains: (1) working knowledge, (2) skill set, and (3) references (Table 1).

There are numerous pesticide-exposure scenarios. For example, pesticide exposure can involve a single catastrophic event, as in instances when pesticides are spilled on a person or consumed (eaten or drunk). Pesticide exposure can involve single, multiple, or continuous events with sizable but not catastrophic levels of pesticides, as when (1) individuals who work with pesticides or apply them regularly to their homes do not take precautions such as wearing personal protective equipment, (2) persons enter fields or lawns to which pesticides have been applied before the end of the “restricted entry interval,” (3) individuals remain in a dwelling while pesticides are applied, or (4) there is drift onto homes from pesticides being applied to nearby fields. Finally, pesticide exposure can involve

single, multiple, or continuous events with low levels of pesticides, as in normal work around farms, being in homes contaminated from work clothes, or from single pesticide applications in homes.

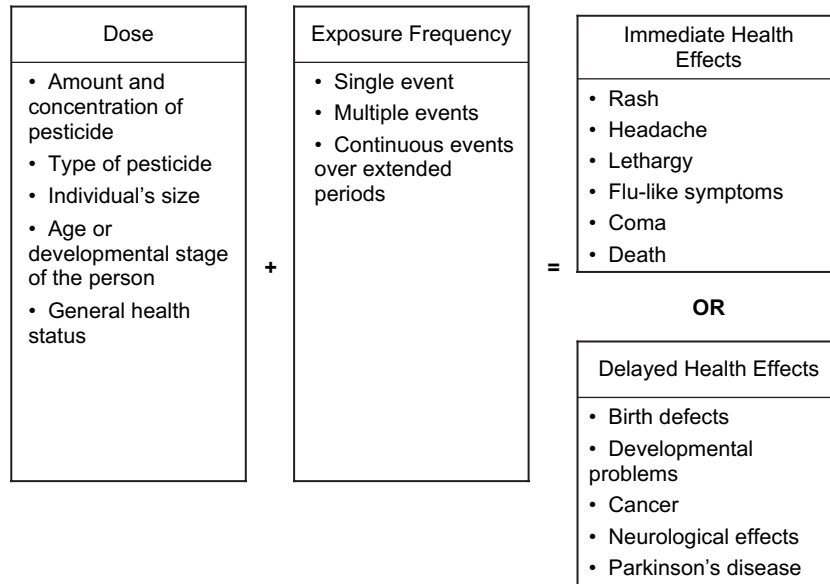
The health effects of pesticide exposure are a function of the dose and exposure frequency (Figure 1). Dose is the result of several factors, including the characteristics of the pesticide (type, concentration, and amount) and of the exposed individual (size, developmental stage, health status).¹ Exposure to pesticides can have immediate and delayed health effects. Depending on the dose and exposure frequency, the immediate health effects can range from rash, nausea, headache, dizziness, and lethargy, through coma and death.¹ Delayed health effects can include birth defects and reproductive problems, developmental problems, cancer, and neurological effects.^{1,8–15} Pesticides have become ubiquitous in American homes and public buildings, as well as in the food supply, and concern for adverse health effects continues to grow.^{16–19}

The problem of pesticide poisoning recognition and treatment is further exacerbated for agricultural workers and their families. Most agricultural workers are exposed to pesticides during their normal work activities.^{20–25} Agricultural workers and their family members are very likely to be exposed to agricultural and residential pesticides in their homes.^{26–30} Exposure to agricultural pesticides in agricultural worker homes results from residues on worker clothing coming into the home, as well as the proximity of homes to fields in

Table 1. Domains of Competence in Caring for Patients With Pesticide Exposure

Domain	Definition	Examples
Working knowledge	Information providers need to immediately care for exposed patients	Acute toxicity, general effects/epidemiology Differential diagnosis Pesticide classes (symptoms and treatment) Growing evidence of chronic effects Special populations Prevention (practices/policies that alter risk)
Skill set	Skills needed to immediately care for exposed patients	How and when to obtain an occupational and environmental exposure history How to read a pesticide label How to handle a contaminated patient How to prevent others from contamination
Reference	Where information can be found while caring for exposed patients	EPA Manual manual “Recognition and Management of Pesticide Poisonings” EXTOXNET American Academy of Family Physicians’ AG-MED www.neetf.org Cooperative Extension Service Textbooks

Model of the Relationship of Dose and Exposure Frequency to Health Effects.



which pesticides are applied. The dwellings in which many agricultural workers live are substandard and prone to insect and rodent infestation. Exposure to residential pesticides results from residents' efforts to control these pests.

Our formal in-depth interviews with clinicians providing care to migrant and seasonal farmworkers in North Carolina indicate that they believe they need more education to recognize and treat the health effects of pesticide exposure. Other investigators also document this need.^{1,6} Many of these health care providers have little or no agricultural experience to help them understand their patients' exposure. They work in community and migrant clinics or county health departments with limited resources. Many agricultural workers are Spanish-speaking immigrants who are mobile and not familiar with the American health care system, making it difficult to provide care. There also can be a high turnover among providers who serve this population, and experiential knowledge takes time to develop. It is important that easily accessible pesticide recognition and treatment educational programs and reference materials be provided to health care providers serving the agricultural worker community. While existing resources (eg, textbooks, poison control centers) provide support, they often do not address the social and cultural circumstances particular to farmworkers, such as language and health.³¹⁻³⁴ These existing

resources often cannot provide the information needed by the clinician treating agricultural workers in a timely manner, for example, a poison control center cannot help when a farmworker does not know the pesticide to which he or she was exposed, and most do not,³¹ and the clinician does not know the local crops and the types of pesticides applied to those crops in a specific season.

The goal of this paper is to evaluate the resources health care providers may find and employ in caring for patients, particularly farmworkers, exposed to pesticides. These resources are divided into 3 domains consistent with deliberations of the National Strategies for Health Care Providers: Pesticides Initiative.² These are: (1) the working knowledge providers need to immediately care for patients exposed to agricultural pesticides, (2) the skill set they need while caring for these patients, and (3) the references they should be able to access when caring for patients exposed to pesticides (Table 1). Based on a systematic review of appropriate materials, the resources for each of these areas are critically evaluated, and the best materials are identified.

Methods

To develop a selective bibliography of health care provider educational resources relevant to farmworkers and pesticides, we searched library

databases, reviewed materials and reference lists from conferences, and reviewed the reference lists of articles and continuing medical education (CME) offerings. The search was aimed at locating materials that fit the 3 domains of interest: working knowledge, skill set, and reference materials. We limited our search to the period since 1995 to include only contemporary materials. This review did not include textbooks, nor did we review regional references provided by each state's Cooperative Extension Service, as this review is to appraise those additional resources that give specific information on medical care for pesticide exposures. Three databases were searched (Medline/PubMed, Agricola, and ERIC [Educational Resources Information Center]) with the key words "pesticide toxicity and recognition," "pesticides and treatment," "pesticides and prevention," and "farm workers and Pesticides." Clinical Internet resources (MDConsult and UpToDate) were also searched with the same key words.

The search process produced 39 relevant items published since 1995 that we were able to obtain and review. Some items reviewed are noteworthy yet proved difficult to obtain, and they are not highlighted in this review. Materials were first divided into 3 domains of competence as defined in Table 1. Overlap existed in these materials, and some resources were evaluated in multiple domains.

For each domain, we formulated review guidelines based on our previous experience, national focus group discussions,² and literature review. These guidelines were agreed upon by collaborative opinion among the research group. These guidelines provided a template with which to judge the completeness and quality of the educational materials reviewed. These guidelines are presented in Results with the resulting bibliography separated into domains.

Collected materials were randomly divided into 2 groups. One of the authors (AEH) wrote detailed reviews of materials in 1 group, and another author (JE) wrote detailed reviews in the other group. For the longer documents, both of these 2 authors wrote detailed reviews. All the authors then read each document and the reviews, made additions to the reviews, and suggested changes to the reviews that were agreed upon by the team.

Review and annotation procedures were standardized so that all materials were reviewed in the same way. Reviewers used a standard set of criteria and a standard form to record reference information and their evaluation of the item. Information included title, category of material, source, author, publisher, cost, language of presentation, length, target audience, focus, summary of focus, and content. Review criteria included contemporary relevance, quality of the

material, orientation to the learner, and an overall evaluation of strengths and weaknesses. The objective of the review process was to provide an accurate description of health care provider educational materials related to farmworkers and pesticides and to evaluate the quality, completeness, and appropriateness of materials for health care providers in relation to the guidelines for each domain.

Results

Guidelines for Working Knowledge. The working knowledge of health care providers should include the general effects of acute pesticide toxicity. For those providers who face undifferentiated illness and care for agricultural communities, pesticide exposure should be included in their differential diagnoses. Additionally, the agricultural worker's symptoms may not be solely attributable to pesticide exposure; in the appropriate patient, the differential diagnosis should not only include acute pesticide toxicity (organophosphate or carbamate) but also heat-related illness, crop-specific toxicity such as green tobacco sickness, in addition to the provider's usual differential diagnosis for a nonagricultural worker.^{35,36} Working knowledge should also include the major pesticide classes, their symptoms, and treatment. Beyond acute exposure, health care providers should be aware of the growing body of evidence connecting chronic and low- and high-level exposure with delayed effects such as cancer, neurologic disease, and reproductive health problems. Providers should be aware of special populations, particularly children and elderly, and their unique sensitivities to pesticides. Finally, those serving the agricultural worker community should be aware of preventive measures to reduce pesticide exposure. These include personal protective equipment, delayed entry into fields after application, industrial hygiene (hand washing), and decreasing contact via closing windows if a home is near a field, removing work clothes and shoes prior to entering one's home, and showering as soon as possible after work.³⁷ These guidelines were used to review the resources that contribute to working knowledge.

Working Knowledge Bibliography. An article by Sanborn et al entitled, "Identifying and Managing Adverse Environmental Health Effects: 4. Pesticides," is the top resource in this category.³⁸ The 8-page article is concise and includes mnemonics to facilitate retention (ie, SLUD, MUDDLES) (Table 2). The article is clinically oriented, yet also has the breadth to address,

Table2. Mnemonics for Diagnosing Organophosphate Poisoning and for Obtaining an Exposure History

Mnemonic	Definition
SLUD*	Salivation Lacrimation Urination Defecation
MUDDLES*	Miosis Urination Diarrhea Diaphoresis Lacrimation Excitation of central nervous system Salivation
WHACST†	What do you do in your job? How do you do your job? Are you concerned about any exposures? Coworkers or others exposed? Satisfied with your job?
CH ₂ OPD ₂ *	Community Home Hobbies Occupation Personal habits Drugs Diet

Sources: *Sanborn M, Cole D, Abelsohn A, Weir E. Identifying and managing adverse environmental health effects: 4. Pesticides. CMAJ. 2002;166(11):1431-1436.

†"Where Do You Play? A Boy and His Rash" Workbook. Association for Occupational and Environmental Clinics. Available at: <http://www.aoec.org/resources.htm>. Accessed July 11, 2005.

in a practical way, acute management, chronic effects, special populations, and prevention. Some information is specific to Canada, but this does not limit its wider applicability. The article by Simpson and Schuman, "Recognition and Management of Acute Pesticide Poisoning," is also valuable.³⁹ This review article does not have the breadth as that of the article by Sanborn et al³⁸ as it does not address chronic effects, special populations, or prevention. However, it is the best working knowledge resource for its stated purpose of recognizing and managing acute pesticide poisoning. It is succinct and practical in its coverage of decontamination principles. An effective table lists the recognition and management of the most common pesticide poisonings. A third resource (developed by the authors of this article) is an online CME course, "Pesticide Exposure and Treatment Education for Health Care Providers," sponsored by Wake Forest University Health Sciences and the Northwest Area Health Education Center.³⁵ It is intended to offer

information in a concise, user-friendly format. Available for free or for CME credit, it specifically addresses differential diagnoses when a sick farmworker presents from the field. A final resource is "Pesticides and Human Health," published by Physicians for Social Responsibility.⁴⁰ This resource is too lengthy to be categorized solely as working knowledge; therefore, it falls somewhere between working knowledge and reference. At 60 pages, the packet has a great amount of text, but covers prevention, terminology, and acute and chronic effects, with the addition of epidemiologic support. Although the booklet uses realistic cases to introduce the variety of health effects, these cases are never "answered," which highlights the clinical challenges involved.

Guidelines for Skill Set. Beyond the knowledge base, there is a skill set needed by health care providers to better serve the agricultural community. These skills include how and when to obtain an occupational and environmental exposure history,^{1,38} how to read a pesticide label,⁴¹ how to handle a contaminated patient (intentional or unintentional poisoning), and how to protect others from contamination, whether clinic personnel or other workers.³⁵

Skill Set Bibliography. The EPA manual "Recognition and Management of Pesticide Poisonings" is an excellent place to start to learn how to obtain an occupational and exposure history.¹ There is a concise, functional chapter on obtaining an occupational and exposure history. Other resources refer to this information or reprint it verbatim.^{40,41} Its strengths include being easily navigated, easily accessible, and routinely updated. The manual details instructions for obtaining a history starting with screening questions, offers a detailed questionnaire, and addresses special populations such as agricultural workers and children. The article by Sanborn et al is also a valuable resource in obtaining a history.³⁸ The unique offering of this article is the CH₂OPD₂ mnemonic to obtain an exposure history (Table 2). Sanborn et al also wrote a case-based pesticide module on environmental health.⁴² Although the module cases are not limited to farmworkers, they provide several opportunities to apply this mnemonic. The Outreach Program for Health Care Professionals is another exposure history resource.⁴³ It is available on the Internet and includes a downloadable file on "Developing a Pesticide Exposure History." Although it is easily accessible, it is thorough and not easily memorized. It offers separate questionnaires for occupational versus nonoccupational pesticide exposure. A final occupational and exposure history resource is the

training module, "Where Do You Play? A Boy and His Rash" Workbook.⁴⁴ An easy-to-remember mnemonic (WHACS) is offered to facilitate the process of screening for exposures in a busy rural clinic (Table 2). These screening questions can be followed up with more detailed exposure and occupational questions as needed.

Sufficient resources are available for learning to read a pesticide and material safety data sheet (MSDS) label, and little variety exists. The National Pesticide Information Center is web based and maintained by Oregon State University and the EPA.⁴⁵ Although it is geared toward the educated lay person, links for the health care provider are included. Links to various MSDS are offered, and 1 section reviews the basic approach to reading a pesticide label. Beyond this text format, an interactive label offers pop-up windows to explain the area highlighted by the reader. A second resource for reading a label is the "Where Do You Play? A Boy and His Rash"⁴⁴ Workbook mentioned above. This resource offers an introduction to the MSDS with a concise list of reference phone numbers. Additionally, this CD-ROM compares the MSDS with the pesticide label and even highlights the sections of the labels important to physicians. Sanborn's pesticide module⁴² is valuable in that 1 case demonstrates how the MSDS is necessary to treatment.

Decontamination principles comprise the final skill set. The EPA manual¹ is the recommended starting point as this information is thorough, concise, and functional. Simpson and Schuman's³⁹ article also contributes to knowledge of decontamination principles. This article covers the same information as the EPA manual; additionally, it mentions respiratory protection for the health care worker. This information is even more user friendly, in that it is more condensed than the EPA manual and uses a table to list methods and dosages for gastrointestinal decontamination. The "Pesticide Exposure and Treatment Education for Health Care Providers" online CME³⁵ is noteworthy in the category of skill sets. In a case-based format, decontamination techniques are discussed throughout, in addition to practicing the exposure history and reading a pesticide label and the MSDS. The practicality is enhanced by the realistic farmworker cases.

Guidelines for References. Health care providers serving rural and agricultural communities need to know the resources they can access when caring for a patient whom they suspect is presenting with a pesticide-related illness. These resources must be up to date and easily accessible via telephone, Internet, or text. These resources can include more details about symptomatology, diagnosis, and treatment course.

They should provide further information, including brand and chemical names of pesticides in addition to regional crop information.

References Bibliography. Textbooks (such as *Goldfrank's Toxicologic Emergencies* or *Keifer's Human Health Effects of Pesticides*) or regional references from each state's Cooperative Extension Service play a vital role as reference material. They are not, however, included in this review because of assumed standardization and the scope of material available. In our review, EPA manual "Recognition and Management of Pesticide Poisonings" is the top reference.¹ The manual is thorough, has highlights in the columns, and lists management steps, making it user friendly and a quick reference. It begins with general principles of management and decontamination, followed by specifics of each class of pesticide, including chemical and brand names. EXTOXNET⁴⁶ is a noteworthy reference as it is online and thorough. The Web site is not user friendly, and the search engine takes some practice to successfully navigate. "Pesticides and Human Health" by Physicians for Social Responsibility is a valuable reference.⁴⁰ The publication is well organized, readable, current, and allows for quick reference by placing topic headings in the left-hand margin of each page. The handbook details the effects of chronic and acute pesticide exposure on the various body systems. Recognition and management of acute pesticide exposure is covered. Each section begins with a clinically relevant case scenario and often includes farmworker examples. The American Academy of Family Physicians' AG-MED⁴⁷ is also a recommended reference to have available. Although it covers the breadth of agromedicine, the manual addresses the toxicity, symptoms, and treatment for the major classes of pesticides. The information is presented in an outline format. Since the manual addresses agromedicine, it mentions green tobacco sickness, agricultural dermatoses, and heat-related illness, which are in the differential diagnosis of some pesticide exposures. This publication does not carry management down to the minutest detail; however, it is an excellent desk reference for the provider. It also provides a cross-reference by presenting complaint and primary organ system involved. The NEETF Web site² should be mentioned as a noteworthy onlinereference. Although it is designed as an educational initiative, the Web site has a resource library that provides excellent links to the "standard references," including EXTOXNET, government agencies, academic institutions, and extension services. Finally, Sudakin's article demonstrates the

use of web-based resources for health care providers using a case scenario of farmworkers who develop dizziness, headache, vomiting, and tremulousness after working in a citrus grove. He uses Internet resources to assist with hazard assessment, exposure assessment, clinical assessment, surveillance, and protection.⁴⁸

Discussion

Although this paper reviews resources in print that are available nationwide, providers should be reminded to familiarize themselves with agricultural practices in the region in which they work. Visiting farms and businesses before a poisoning incident occurs can help the provider understand the events more quickly. To learn about the most common pesticides used in their regions, the providers can contact the area poison control center, a Cooperative Extension educator, or university faculty who may assist with pesticide safety training.

Resources are found in a variety of places. Informational sources include journals, publications by advocacy groups, conference materials, CME materials, state agencies, and federal government agencies. These resources are often accessed through the Internet and require careful review to determine the intended audience and the source's reliability and validity. An exhaustive list of resources does not exist, nor does a critical review. The naive health care provider may not be able to differentiate among the varied materials. This challenge is in addition to the minimal amount of time environmental health, pesticide exposure, and the requisite skills are given in medical and provider education.

Our review shows that no 1 resource adequately addresses the working knowledge, skill set, and reference material categories. The numerous resources are either intended to be reference or designed to be concise and functional. The working knowledge resources may address acute toxicity, chronic toxicity, differential diagnoses, special populations, skills, prevention, or some combination of the above, but not all these topics.

Our review found the EPA's¹ manual to be a top resource. This manual is the gold standard reference for the skills required and as a reference in the heat of the moment for those providers with a pesticide-exposure case. It is thorough, concise, user friendly, includes brand and trade names, and guides the health care provider in diagnosis and management of pesticide exposure. NEETF² is also a noteworthy reference as it is online, easily accessible, routinely updated, and the

resource library connects the reader to a cadre of reliable references. The article by Sanborn et al³⁸ is valuable in its clinical orientation. In 8 pages, it offers mnemonics for diagnosis and for obtaining an exposure history that facilitate a provider's working knowledge. Although concise, it has the breadth to address prevention, acute management, chronic effects, and special populations. Simpson and Schuman³⁹ efficiently review decontamination principles and acute toxicity management. Valuable resources exist in each state's Cooperative Extension Service regarding regional crop and pesticide information. Health care providers should become familiar with these as they will be specific to regional agriculture.

Cultural competence is not considered in the reviewed materials. Almost 85% of farmworkers are Hispanic,⁴⁹ and the health beliefs of these workers are not considered in any of the materials, with the exception of the online CME, "Pesticide Exposure and Treatment Education for Health Care Providers."⁴⁸ Cultural issues are important to prevention and treatment. For example, Baer and Penzell found that farmworkers in Florida do not distinguish between the symptoms of pesticide poisoning and the folk illness "susto."³² Susto is thought to be caused by severe fright and can include any number of vague symptoms, including decreased appetite, personality change, and inability to concentrate. Quandt et al found that farmworkers in North Carolina (primarily Mexican) believed that chemicals and their residues could be detected through the senses; if they could not be felt, smelled, or tasted, they were not there.³³ In addition, they believed that the skin acts as an effective barrier to chemical absorption, with most chemicals entering the body through the lungs and mouth. Taking such health beliefs into account may be necessary to effectively educate and prevent exposure in farmworkers.

Conclusions and Recommendations

The need for continuing education exists for providers caring for agricultural workers, as shown by NEETF's educational commission, accumulating evidence regarding chronic effects of pesticide exposure, and the changing workforce. Primarily, we propose that education relating to environmental health and pesticides should be increased in the health care providers' coursework and clinical curriculum.² Secondly, we propose that CME that encompasses working knowledge and skill sets, with details on accessible references should be developed and made readily available. While this

CME can be offered in several formats, an online format is preferred. The online format would be accessible to all providers and would ensure wider distribution for a scattered population. Providers of health care in rural America are additionally challenged by location, access, coverage, time, and finances. Online, this CME could be offered and maintained by an Area Health Education Center. An ideal CME would include case illustrations. It would address the areas needed to manage a patient presenting with a known exposure or with an undifferentiated illness potentially related to pesticide exposure. The learning objectives would include differential diagnosis, acute management, secondary prevention of exposure among other workers/health care providers, primary prevention in a culturally sensitive manner, and a review of the complex epidemiologic studies relating to chronic effects of pesticides, as well as provide references every provider would be able to access quickly. While attempts have been made to develop CME materials,^{35,36,42,43} none of these includes all the ideal features.

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