Making the **Case**

Pesticides are ubiquitous in our society. We use them in our homes, schools, workplaces and communities. Due to the widespread dissemination of pesticides and the potential for related illness and injury, especially among farmworkers and pesticide handlers, primary care providers should be prepared to recognize, manage, and prevent the pesticide-related health conditions affecting patients and communities.

When pesticide toxicity is discussed, most people usually think of an acute pesticide poisoning incident in an agricultural setting. However, pesticides are also of concern because of potential chronic health effects from long-term and cumulative exposures. In addition, pesticide exposure can occur in a number of settings outside agriculture, including urban environments, homes, and schools as well as through multiple routes. For example, diet is a major route of exposure of children (Etzel et al, 1999). A report published by the National Research Council concluded that prenatal and postnatal developmental toxic effects and the unique consumption patterns of children needed to be taken into account in establishing standards for pesticides on food (NRC, 1993). Rural populations not directly involved in farming also may be at risk for exposure to pesticides. Several objectives in *Healthy People 2010* aimed at improving human health relate to pesticides. These include reducing pesticides exposures indoors and outdoors, as well from dietary intake; monitoring exposures by measuring urine and blood samples; and increasing the number of jurisdictions that are monitoring for pesticide poisonings.

Patients and communities look to their primary care providers as important sources of information and guidance on suspected pesticide-related health conditions. These providers are not always able to respond effectively.

Primary care providers are on the frontline of health care and can play a key role in identifying and ameliorating potential pesticide poisonings and exposure. However, more needs to be done to ensure that health professionals are prepared for this role and that they know where to turn for assistance. This includes ensuring that providers can "problem solve" with patients who think an exposure has occurred, readily diagnose if appropriate, provide timely treatment for pesticide-related illnesses, provide prevention education, and, where appropriate, consult with local authorities. This Implementation Plan offers a way for health care professionals to be effectively prepared through their education and training, and to maintain this knowledge while in practice.

This Implementation Plan is based on the premise that addressing pesticide-related health conditions can be a part of routine primary care and does not require extensive expertise on the

part of the provider. This Initiative recognizes that primary care providers are faced with a number of competing public health concerns. The goal of the Initiative is to build on existing skills in toxicology, pharmacology, history-taking, and risk communication to provide tools that the busy practitioner can use when the need arises. Primary care providers working with high risk populations may need to attain a more detailed knowledge of pesticide-related health conditions.

More research is still needed on the health effects of pesticide exposures. Such research efforts should involve primary care providers. Research should focus on what conditions primary care providers see in their practices, specifically with regard to chronic exposures. As this Initiative evolves, it is recommended that epidemiologic research be developed using a registry of primary care offices to identify conditions requiring further research and documentation.

Following are a number of reasons, accompanied by supporting data, why pesticide-related health conditions are relevant to the practice of primary care today:

- Patient and community concerns
- Recent public pesticide issues
- Potential for acute exposures and health effects
- Potential for chronic exposures and health effects
- Clinical case examples
- Current provider training and education in environmental health.

Patient and Community Concerns

Patients and communities often ask for advice about a suspected pesticide exposure or ask the provider to investigate a potential health condition to see if it might be related to pesticides. Public concern about pesticides has been documented and often shows up in the questions asked by patients. By helping patients problem solve and evaluate risks from pesticides, primary care providers can help patients reduce risk to exposure and prevent future exposures. In addition, an alert clinician will also be able to identify a potential exposure when it occurs.

In some instances, providers serve populations that are more actively engaged with pesticides, such as the farmworker community. There are 3 to 4.5 million farmworkers in the United States and a million or more pesticide applicators who are often at greater risk for pesticide exposure because of mixing or applying pesticides or working in fields where pesticides are applied. A provider community that is more aware of the specific concerns of this population will be better prepared to effectively diagnose and treat health conditions, and prevent exposures.

The public has expressed concern about the risks of cancer, birth defects, reproductive effects, and other conditions from exposure to pesticides and other chemicals. For example, from a

FREQUENTLY ASKED QUESTIONS OF PRIMARY CARE PROVIDERS

Providers are often asked basic questions by their patients. Here is a sampling of pesticide-related questions and concerns that patients bring to their visits with providers:

(1) I received a report from my water utility that said the water contains 0.5 ppb of dibromochloropropane. What is this chemical, what does it mean for my health, and what should I do?

(2) I just read in the newspaper that schools in my state are spraying their buildings with toxic pesticides. I'm worried because my child has asthma and sometimes feels worse at school. Could it be the pesticides?

(3) I have a six-month-old child and the cat has fleas. Is it safe to have the exterminator in to flea-bomb the house? The exterminator says it's safe if we stay out for a few hours and open the windows afterwards.

(4) My husband and I are having trouble conceiving a child. We own a farm and he sprays pesticides. I want to know if the pesticides may be causing a problem.

(5) I get a headache and have difficulty concentrating at the office. I think it may be because the janitor sprays pesticides at night.

(6) I am a farmworker and was picking celery in the fields. Today I have a rash on my hands and arms. Is it from the chemicals?

list of 30 potentially hazardous activities, use of pesticides was perceived to rank in the top 10 most risky activities, higher in "riskiness" than surgery, electric power, swimming, large construction, x-rays, or bicycles (Slovic et al, 1980). In a 2000 survey of registered voters (n = 1,565), nearly all (90 percent) indicated that environmental factors like pollution, waste and chemicals are at least somewhat important contributors to diseases. More than half (53 percent) said these factors are very important in causing diseases (Health-Track, 2000). Voters linked the role of environmental factors in causing illnesses such as sinus and allergy problems, asthma in children, birth defects and cancer. Health care providers have an important role in helping their patients evaluate the relative risks from different types of environmental exposures, including pesticides. Health care providers need to be able to counsel patients about realistic risks, and avoid unwarranted trivialization or exaggeration of the risks.

In large measure, this Initiative is intended to help prepare the primary care provider with the information, skills, and resources to begin problem solving with patients. The questions in the shaded box above are only a sampling of the concerns presented to practitioners everyday. This Initiative will help primary care providers carry out their responsibilities to help patients evaluate the risks and determine whether further steps are required.

Recent Public Pesticide Issues

Misuse of Pesticides – Methyl Parathion — Case Studies of Misdiagnosis

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), EPA regulates an organophosphate insecticide called methyl parathion for use on specific crops. In the 1980s and 1990s, methyl parathion was widely used illegally in indoor environments by unlicensed applicators. One published report describes methyl parathion-related illness among seven siblings, two of whom died (CDC, 1984). Approximately two days before these children were correctly diagnosed, five of them were seen by their local physician and sent back to their contaminated home with a mistaken diagnosis of viral gastroenteritis. Since 1984, at least five different states have reported illegal use of methyl parathion inside homes and businesses. Some people exposed to methyl parathion in their homes experienced mild symptoms of organophosphate poisoning (e.g., nausea, headache, difficulty breathing, blurred vision) and some of them complained to their health care professionals. A report summarizing the 1995 investigations in Ohio (where at least 500 homes were treated illegally) found that 20 percent or more of respondents reported symptoms during the two weeks following methyl parathion application (NCEH, 1996). Unfortunately, corrective action was not enacted until 1994. More than 1,500 individuals were relocated from their homes. The estimated clean-up cost for these incidents was more than $90 million (*Environmental Health Perspectives*, 1997).

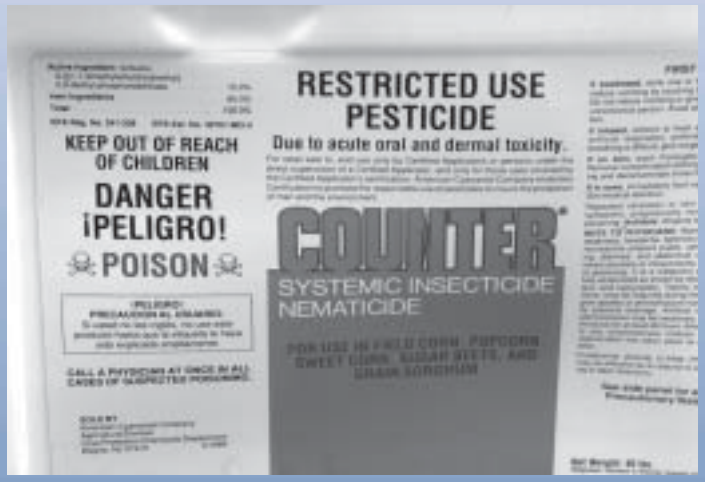
Misdiagnosis of organophosphate poisoning can be a severe problem. Zweiner and Ginsburg (1988) reviewed a case series of 37 infants and children poisoned by organophosphates and carbamates. Of 20 cases transferred to Children's Medical Center in Dallas, 16 (80 percent) had an incorrect transfer diagnosis ranging from encephalopathy and seizure disorder to pneumonia and pertussis.

Each of these cases of misdiagnosis or delayed diagnosis demonstrates the potential for acute exposures, public concern, and expenses related to the widespread use (and sometimes misuse) of pesticides in our country. The primary care provider can play a vital role in helping individuals deal with these exposures. Furthermore, alert providers aware of potential health conditions related to pesticide exposure can become a key link in limiting the spread of "pesticide epidemics" by identifying sentinel cases and bringing them to the attention of appropriate public health officials responsible for pesticide-related illness surveillance.

Control of Exotic Pests – Increase in Potential Pesticide Exposures to the Public

A growing number of exotic and public health pests are besieging the United States. Control of these pests increases the potential for pesticide exposure to large segments of the public. Aerial applications of insecticides over residential neighborhoods involving millions of people have been conducted in New Jersey for control of malaria-carrying mosquitoes, in New York City for control of mosquitoes carrying the West Nile virus, and in several Florida counties for control of the Mediterranean fruit fly (Medfly) (CDC, 2001). Surveillance conducted during the Florida

Medfly Eradication Program identified 123 individuals with illness potentially related to pesticides used in the program (CDC, 1999b). In 1999, when pesticides were used against mosquitoes in New York during the outbreak of West Nile Virus, Poison Control Centers received approximately 3,500 inquiries concerning sprayings. Approximately 250 of these inquiries involved unconfirmed complaints of adverse health effects, nearly all of which were classified as "minor effects" (e.g., patients exhibited some symptoms as a result of exposure, but they were minimally bothersome). Other cases were classified as "not followed, minimal clinical effects possible," e.g., patient was not followed because, in the clinical judgment, the exposure was likely to result in only minimal toxicity of a trivial nature (Matthew P. Mauer, 2001). Continued use of pesticides against emerging public health and agricultural threats is likely to lead to increased health concerns and reports to health care providers of illness. During surveillance to detect human illness (e.g. West Nile virus) and pesticide spraying campaigns to control exotic pests, health care providers are called upon to provide sound preventive advice, and to recognize, manage, and report pesticide-related and/or insect borne viral illnesses (CDC, 2001). Careful documentation and reporting of suspected cases are needed to protect those who may be unusually susceptible.



"Even though I know it is very important to diagnose and treat this problem, we have to start by preventing the problem in the very first place. That is when we are going to start seeing some changes in the long run."

— Gerardo de Cosio, MD
US-Mexico Border Health Association

Potential for Acute Exposures and Health Effects

Health care providers may be faced with patients who have experienced acute pesticide poisonings. A pesticide poisoning is considered acute when the onset of symptoms occur shortly after the time of pesticide exposure. Acute pesticide poisonings can differ in their degree of severity.

While providers may not see very many acutely poisoned patients, they should possess a basic understanding of signs and symptoms, and an ability to diagnose so that appropriate management can be instituted. Oftentimes it is the primary care provider who identifies possible sentinel cases that signify the presence of previously unrecognized pesticide hazards in the community. By notifying the proper authorities of real or potential poisonings, health care providers can play a critical role in pesticide-related illness surveillance.

The EPA manual *Recognition and Management of Pesticide Poisonings* provides health professionals with information on the health hazards of pesticides currently in use. It deals primarily with acute effects and provides consensus recommendations for management of poisonings and injuries caused by current pesticides (US EPA, 1999a).

Health Care Providers Poisoned While Providing Treatment

From 1982 through 1998, malathion, an organophosphate with relatively low toxicity, was associated with 467 cases in California, where it was considered primarily responsible for reported symptoms (mostly minor and often related to the odor). One surprising finding was that 31 (7 percent) of these cases were emergency or medical personnel responding to nine cases of ingestion (Blondell et al, 2000). In 2000, eleven more police officers, firefighters, and paramedics sought medical care for symptoms such as burning eyes and throat irritation after their exposure to a suicide case who ingested and doused himself with malathion (Das, 2000). In another incident, several clinic staff became ill within one year of this incident while treating 24 vineyard workers exposed to drift from chlorpyrifos and propargite (Das, 2000). Three additional reports came from Georgia, where emergency department staff became ill while caring for patients contaminated with organophosphate insecticides (Geller et al, 2001). These reports illustrate the personal stake that all health care providers—particularly first responders—have to understand the risks of pesticide exposure.

Agricultural Exposures

Agriculture accounts for 76 percent of the conventional pesticides used annually (approximately 944 million pounds, not including disinfectants, wood preservatives, or water treatment chemicals) (US EPA, 1999b). Pesticide handlers and agricultural workers appear to be at greatest risk for acute pesticide poisoning. Based on states with required reporting of pesticide-related health concerns, EPA estimates there are approximately 250-500 physician-diagnosed cases per 100,000 agricultural workers (including pesticide handlers) (Blondell, 1997). Migrant and seasonal farmworkers are especially at high risk since they often work and live in areas where pesticide exposures can be significant.

Non-Agricultural Exposures

Urban and suburban uses of pesticides can be as high as in some agricultural areas. A 1990 EPA survey estimated that 84 percent of American households used pesticides, most commonly insecticides (Whitmore et al, 1992). Each year, homeowners on average use 5-10 pounds of pesticide per acre on their lawns and gardens, many times the concentration applied by farmers to corn and soybean fields (Robinson et al, 1994). They also use pesticides in the form of disinfectants, including pine oil cleaners, bathroom cleaning products, and cleaning materials for swimming pools. Occupational exposures occur in many, not always obvious, workplace settings, including structural pest control, construction work, work in nurseries, greenhouses and landscaping, the application of fumigants and sprays in ships' holds, aircraft and other transport settings, and in the use of engineering and air-conditioning biocides.

Table 3 below lists numerous occupations that increase the chance for pesticide exposure, as well as some occupational and non-occupational sources that present an opportunity for pesticide exposure.

Table 3: Occupational and Non-Occupational Sources of Pesticide Exposure

NONOCCUPATIONAL	OCCUPATIONAL	
Accident or Intentional ingestion/suicide attempt	Agricultural application	Marina workers
Food residues	Agronomists	Medical personnel
Hazardous waste sites	Building maintenance work	Mixing and loading pesticides
Industrial spills	Crop duster maintenance	Park workers
Residues from treated structures (houses, schools, office buildings)	Emergency responders	Pesticide applicators
Residues on treated lawns and landscapes	Entomologists	Plant pathologists
Termite control	Farm work	Research chemistry
Water residues	Firefighters	Sewer work
	Flaggers	Storage/warehouse work
	Forestry workers	Structural application
	Formulating end product	Transportation
	Greenhouse, nursery, mushroom house work	Transporting pesticides
	Hazardous waste workers	Treating contaminated workers
	Landscapers	Vector control workers
	Livestock dippers and veterinarians	Wood treatment workers
	Manufacturing active ingredient	Work on highway or railroad rights of way

Source: McConnell R. Chapter 37: Pesticides and Related Compounds. In: Rosenstock L, Cullen MR, eds. *Textbook of Clinical Occupational and Environmental Medicine.* Philadelphia, PA: W.B. Saunders Company; 1994.

A substantial number of people in the US are at risk of acute pesticide poisoning from non-agricultural uses. One of the major sources of data on acute pesticide poisoning is the Toxic Exposure Surveillance System (TESS) maintained by the American Association of Poison Control Centers (AAPCC). Data collected from Poison Control Centers showed that in 1996, over 40,000 adults were sufficiently exposed to various types of pesticides to warrant a call to their local Poison Control Center. These calls were from individuals who had a concern about overexposure and were not requests for information. It is estimated that as many as 60 percent of these individuals developed symptoms of pesticide poisoning. These figures are thought to represent less than 30 percent of the incident cases of acute pesticide-related illness in the US (Litovitz et al, 1997; Chafee-Bahamon et al, 1983; Harchelroad et al, 1990; Veltri et al, 1987).

Pesticide exposures among children also warrant concern. Children may be more susceptible than adults to environmental health risks because of their physiology and behavior. They can be more heavily exposed to environmental toxins than adults because children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults. They

also play close to the ground and they put objects in their mouths. They may be more susceptible to toxins because their neurological, immunological, digestive, and other bodily systems are still developing, and they may be less able than adults to metabolize and excrete the pollutants (Landrigan, 1997).

In the agricultural setting, children may be exposed to pesticides in a number of ways; through prenatal exposure, from being in the fields where their parents work, contact with pesticide residues on parents' clothing, living in migrant camps next to camps being treated and working in the fields themselves (US Congress, Office of Technology Assessment, 1990). A report by the General Accounting Office (GAO, 2000) found that improvements were needed to ensure the safety of farmworkers' children.

In addition to the agricultural settings, children may be exposed to pesticides in urban and suburban settings, e.g. in their houses, yards, day care settings and schools. In 1996, Poison Control Centers were notified about approximately 80,000 children (age 0-19) being exposed to common household pesticides in the United States. It is estimated that one quarter of those children developed symptoms of pesticide poisoning. In a study of unintentional exposures to pesticides (excluding disinfectants), EPA found that 78,500 such exposures were reported annually to Poison Control Centers in 1985-92, with 92 percent of them occurring at residences (AAPCC, 1994). Children ages five and younger accounted for 63 percent of the

Table 4: Pesticides Most Often Implicated in Symptomatic Illnesses, 1998*

Rank	Pesticide or Pesticide Class	Child < 6 years	Adults and 6–19 yrs.	Total*
1	Pyrethrins/pyrethroids	947	3369	4333
2	Organophoshate insecticides	429	2865	3307
3	Hypochlorite disinfectants	963	1425	2394
4	Other insecticides	601	1551	2167
5	Herbicides	314	1748	2078
6	Pine oil disinfectants	1182	844	2029
7	Insect repellents	959	748	1712
8	Phenol disinfectants	591	391	987
9	Carbamate insecticides	165	762	932
10	Other disinfectants	323	460	785
	All other pesticides	456	1237	1750
	TOTAL	6930	15,400	22,474

* Includes only unintentional illnesses. Intentional (e.g., suicide attempts) cases excluded.
** Column totals include 144 cases of unknown age.
Note: Poison Control Center Specialists categorized 86 percent of these cases as minor medical outcome, and 31 percent of the total were seen in a health care facility.
Source: American Association of Poison Control Centers, Toxic Exposure Surveillance System, 1998 data.

cases. Additionally, GAO documented over 2,300 reported pesticides poisonings in schools between 1993 and 1996 (GAO, 1999).

The majority of pesticide poisonings (85 percent of symptomatic cases reported to Poison Control Centers) have a minor outcome (often treatable at home), 14 percent have a moderate outcome (typically requiring treatment in a health care facility) and 1 percent experience a major or fatal outcome (Litovitz et al, 1997). In 1992-98, there were an estimated 24,000 emergency department visits annually resulting from pesticide exposure, of which 61 percent of the cases involved children younger than five years (McCaig, 2000; McCaig and Burt, 1999). These figures are likely under-estimates and may represent only a fraction of the incident cases of acute pesticide-related illness among children.

Studies by Chafee-Bahamon et al. (1983), Harchelroad et al. (1990), and Veltri et al. (1981) found that Poison Control Centers captured between 24 percent and 33 percent of all poisoning cases seen in hospitals as inpatients and/or outpatients. Since this does not include cases seen by health care providers who are not in a hospital setting, it is likely that the actual number of pesticide cases seen annually is several times the figures reported in the table 4 (previous page) or around 100,000 per year.

Pesticides Most Often Associated with Pesticide-Related Health Conditions

Organophosphate and pyrethroid insecticides are the categories of pesticides most often implicated in acute pesticide-related illnesses reported to Poison Control Centers. Table 4 on the previous page ranks the class of pesticides most often linked to symptoms in patients, based on data from TESS. This table includes only unintentional exposures to single pesticide products.

Potential for Chronic Exposures and Health Effects

Patients and others in the community may come to providers with concerns about the chronic health effects of both short- and long-term exposure to pesticides. There is a growing body of scientific literature detailing these effects. For example, in a 1999 CDC study (National Health and Nutrition Examination Survey, NHANES), levels of metabolites of organophosphate pesticides were measured in urine from a subsample of NHANES participants six through 59 years of age who were selected to be representative of the US population. Whether the levels of metabolites reported in the study are a cause for concern is not yet known. The urine metabolite data can provide health care providers with a reference range so that they can determine whether people have been exposed to higher levels of organophosphate pesticides than those experienced in the general population (NCEH 2001). A well-informed health care provider who possesses a basic understanding of the latest scientific evidence is better prepared to talk with and counsel patients who are concerned about pesticide exposures and the risk of future adverse health effects.

Risk communication is also a critical aspect of the therapeutic encounter, and requires active listening to identify patients' concerns and fears. It requires appropriate risk assessment,

including an assessment of the pesticide involved, the actual source and route of exposure, whether absorption occurred (and, if so, how much), and an honest appraisal of the state of knowledge about long-term outcomes. Clinicians face the daunting challenge of providing appropriate reassurance where needed, while being careful not to dismiss a patient's concerns without investigating them. Under certain circumstances, the most effective course of action may be to refer the patient to an occupational/environmental specialist, and the list of resources for that referral should be readily available in every clinical practice. On the other hand, the primary care clinician may wish to provide this information directly, and information sources are available to help.

Cancer Studies

With regard to the relationship between chronic pesticide exposure and cancer, EPA has received and reviewed the required studies for predicting cancer effects for numerous active ingredients. Over 60 of these active ingredients have been classified as probable human carcinogens by EPA or the International Agency for Research on Cancer. Although most of these pesticides are no longer on the market or have had their uses severely restricted, their potential to cause cancer in persons previously exposed is still a concern. A review by the National Cancer Institute (NCI) lists 15 pesticides for which there is evidence of cancer in human epidemiologic studies (Zahm et al, 1997). A large prospective study of commercial pesticide applicators and their spouses is underway in Iowa and North Carolina, funded jointly by NCI, EPA and the National Institute of Environmental Health Sciences, to try to determine which pesticides may pose a risk of cancer in humans (Alavanja et al, 1996). This study began enrolling subjects in 1994-1997 and includes 57,000 applicators and 32,000 spouses. Analyses of the possible associations of pesticides with prostate, breast, non-Hodgkin's lymphoma, colon and lung cancer are planned within the next three years. Many other disease endpoints will also be studied, including asthma, neurologic symptoms, Parkinson's disease, visual dysfunction, adverse reproductive effects, and respiratory diseases (see http://www.aghealth.org/analyses.html for updates).

Non-Hodgkin's lymphoma has been associated with frequent use of herbicides (e.g., 2,4-D) and is associated with farming (Hoar et al, 1986; Wigle et al, 1990, Zahm et al, 1990). As a result of the widespread concern, the Lymphoma Foundation of America prepared a research summary, "Do Pesticides Cause Lymphoma?" (Osburn 2001), which reports abstracts from 79 studies and 35 letters/commentaries concerning pesticides and lymphoma. The report did not conclude pesticides were a cause of lymphoma but noted "there is some evidence that links pesticides with non-Hodgkin's lymphoma"; therefore, "it makes sense for us to reduce our exposure to pesticides." In the face of mounting concern from the public, physicians need to know where to go to obtain objective information about pesticides and their potential for carcinogenicity.

Studies on Central Nervous System Effects

Many insecticides and fumigants are designed specifically to target the nervous system of the pest they are intended to control (referred to as neurotoxins). There is increasing human evidence in the form of case reports and epidemiologic studies that suggests that humans

may experience chronic neurologic or neurobehavioral effects following high levels of exposure to certain types of pesticides (Keifer and Mahurin, 1997). Several reports have also found chronic neurological sequelae (reduced neurobehavioral function) after acute organophosphate poisoning (Savage et al, 1988; Rosenstock et al, 1991; Steenland et al, 1994; Stephans et al, 1995). EPA has concluded that some subset of organophosphate-poisoned subjects probably experience persistent neurobehavioral effects as a result of their exposure. In November 1999, the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (1999) of the Department of Health in the United Kingdom concluded:

> The balance of evidence supports the view that neuropsychological abnormalities can occur as a long-term complication of acute organophosphate poisoning, particularly if the poisoning is severe. Such abnormalities have been most evident in neuropsychological tests involving sustained attention and speeded flexible cognitive processing ("mental agility").

This report did not find evidence that exposure absent poisoning was a risk factor for neurotoxicity and noted the need for high quality research to better determine the extent and type of risks that might be associated with long-term and cumulative exposures.

Studies on Reproductive Effects

Many pesticides have been identified as developmental or reproductive toxicants. "There is increasing evidence for reproductive effects associated with exposure of males to occupational agents. Some of the best known examples are reductions in fertility and sperm counts in men who were occupationally exposed to dibromochloropropane" (Sever et al, 1997). Dibromochloropropane (DBCP), a nematocide that was banned by EPA in 1979, produced azospermia and oligospermia among exposed workers (Whorton et al, 1979). Sever et al (1997) concluded "there is increasing evidence for reproductive and developmental effects of both maternal and paternal pesticide exposures. Areas of particular concern include infertility and time to pregnancy, spontaneous abortion, neural tube defects, and limb reduction defects." A study based on the US Collaborative Perinatal Project (Longnecker et al, 2001) strongly suggests that DDT use increases preterm births, which is a significant indicator of infant mortality. The concentration of DDE, a metabolite of the pesticide DDT, was measured in the mothers' serum samples stored during pregnancy (n = 2,380) for children born between 1959 and 1966. Of these women's births, 361 were born preterm, and 221 were small for gestational age. Mothers of these affected infants had higher levels of DDE in their blood, indicating higher DDT exposure.

Asthma and Pesticides

In 1998, asthma affected an estimated 17,299,000 persons in the United States and cost an estimated $12.7 billion for medical care (CDC, 1998a; Weiss et al, 2001). Self-reported prevalence of asthma increased 75 percent from 1980 to 1994 (CDC, 1998b). From 1975 to 1993-95, office visits for asthma doubled to over 10 million per year. Around the 1994 time period there were 1.8 million emergency room visits, 466,000 hospitalizations, and over 5,000 deaths.

Pests, such as dust mites, cockroaches, and mice, are thought to be important triggers and, perhaps, initiators of asthma (Huss, 2001; Phipatanakul et al, 2000a; Phipatanakul et al, 2000b). Prevalence of these pests may partially explain the increased risk for asthma and asthma-related deaths among blacks and especially among the urban poor. The use of pesticides, therefore, could be an important tool in a comprehensive asthma management program. At the same time, some pesticides may pose additional risks to those with asthma (Wagner, 1994; Wagner, 2000; Wax et al, 1994); in fact, deaths due to asthma have been reported to be associated with exposure to pesticides (Wagner, 2000; Wax et al, 1994). In January 2000, a product designed to control dust mites had to be pulled off the market because of hundreds of reports of adverse reactions among users including, primarily, asthma and respiratory reactions.

An Institute of Medicine report (IOM, 2000) concluded that although there is evidence suggesting that high level exposures to some pesticides may elicit persistent asthma, there is inadequate or insufficient evidence whether or not an association exists between pesticide exposures at the levels typically encountered in nonoccupational or residential settings and the development or exacerbation of asthma. The report suggested that proper use of pesticides as part of an exposure control program may yield benefits for asthmatics through elimination of or reduction of allergen sources.

Studies on Other Health Effects/Specific Populations

Hypotheses related to pesticide effects on respiratory, cardiovascular, endocrine, and other body systems have also been suggested and are currently being studied. The impact of pesticides on child development is also a growing area of research and investigation.

While studies have indicated associations between pesticide exposures and chronic health effects, there still remains insufficient evidence to document a causal relationship between frequently used pesticides and long-term health effects, except in a few cases such as arsenic-associated cancer, male infertility due to exposure to dibromochloropropane, and neurologic sequelae following severe poisonings with neurotoxic pesticides. Health care providers need an awareness of the current state of knowledge on pesticides to assist patients and others in the community who are concerned about long-term health effects.

The concern about potential future adverse effects of non-acutely toxic pesticide exposures represents a special challenge to health care providers. The nature of scientific inquiry yields associations between pesticide exposures and health effects long before causal relationships can be reasonably concluded. These associations and the publicity they generate can be enough to raise concerns among patients and the community. Providers should be sensitive to the level of concern and the need to provide reassurance, as well as the possibility that a referral to an occupational and environmental medicine specialist may be indicated.

Evaluation of patient concerns about toxic exposures can be complicated by time constraints and the need to engage assistance from non-clinical disciplines. For example, site visits and

industrial hygiene consultations are expensive and not generally part of a private patient's insurance coverage. Again, primary care providers need to recognize when these specialties are needed and know how to obtain an appropriate referral.

Clinical Case Examples: *The Challenge of Diagnosing Pesticide Exposures*

For many pesticides, the short-term and many of the long-term health effects associated with exposure can easily be mistaken for other agents or health conditions. Determining if a patient has been exposed to pesticides will improve a professional's ability to make the correct diagnosis. To make a timely and accurate diagnosis, primary care providers need to be familiar with the settings in which a pesticide exposure may occur, the symptoms associated with these exposures, and the appropriate diagnostic methods.

Case Study 1 – Chronic Health Conditions

At the Environmental and Occupational Health Sciences Institute (EOHSI) at the University of Medicine and Dentistry of New Jersey, two farmers were referred to the occupational medicine clinic for problems associated with the use of pesticides. Initially, the concern was the possibility of drug interaction and pesticide use. Both farmers had worked in a large lima bean operation, and used organophosphate compounds extensively from early in the season until the harvest. The initial evaluation, along with an industrial hygienist's evaluation of the farm, led the health scientists and physicians to conclude that both men had experienced long-term exposure to a series of organophosphate compounds. A rigorous evaluation led to the use of personal protective equipment, installation of an on-site shower, and a laundry for pesticide-contaminated clothing. Over a period of 12 months, considerable improvement was noticed. Both men felt better and no longer reported symptoms of blurred vision, lack of concentration, headaches, etc.

A coordinated effort of the Cooperative Extension faculty, as well as the clinical faculty at EOHSI, led to the diagnosis and a very positive preventive outcome. An earlier evaluation by the local physician did not connect pesticide exposure to the health problems; in fact, the farmers were told that there were no real problems and they should just continue what they were doing. The wife of one of the farmers pursued the problem aggressively for four years, first going to the Extension Service and then to the specialists at the university.

Case Study 2 – Aldicarb Exposure

The following case study, reported in the Morbidity and Mortality Weekly Report (CDC, 1999a), describes a foodborne outbreak of aldicarb poisoning that occurred when improperly stored and labeled aldicarb was mistakenly used in food preparation.

On July 19, 1998, 20 employees attended a company lunch prepared from homemade foods. Shortly after eating, several persons developed neurologic and gastrointestinal symptoms. Ten visited a hospital emergency department, and two were hospitalized. On July 20, a hospital

infection-control nurse reported the incident to the Louisiana Office of Public Health, which then investigated the outbreak. The lunch consisted of pork roast, boiled rice, cabbage salad, biscuits, and soft drinks. Only the cabbage salad was associated with illness. Of the 16 persons who ate the cabbage salad, 14 became ill (attack rate: 88 percent); the four persons who had not eaten the cabbage salad did not develop symptoms.

The employee who prepared the cabbage salad reported mixing precut, prepackaged cabbage in a bowl with vinegar and ground black pepper. The black pepper came from a can labeled "black pepper" that he had found 6 weeks before the lunch in the truck of a deceased relative. This black pepper had not been used by the employee for food preparation before the company lunch. The contents of the black pepper container were tested for organophosphate and carbamate pesticides. Testing showed the granules in the pepper container as 13.7 percent aldicarb. A six gram portion of cabbage salad contained 272.6 parts per million of aldicarb, a level which can produce illness in humans. The deceased owner of the pepper can had been a crawfish farmer, and it is believed that he used aldicarb on bait to prevent destruction of his crawfish nets, ponds, and levees by wild dogs and raccoons.

Cholinesterase-inhibiting pesticides (i.e., organophosphates and carbamates), which are widely used in agriculture and urban pest control, can cause illness if they contaminate food or drinking water. Aldicarb, a regulated carbamate pesticide, is highly toxic. Health care providers and public health officials should keep in mind that food poisoning might result from pesticide or other chemical contamination as well as from infectious organisms.

Case Study 3 – Organophosphate Exposure

A couple in their sixties entered their vacation condominium in Hawaii and were immediately aware of a strong odor. Three days later they discovered that the odor emanated from a leaking five-gallon can of liquid Metasystox-R-2, an organophosphate insecticide which was being stored in a room adjoining the condominium. The chemical container had leaked and saturated the floorboards and the adjoining wall, as well as leaking under the condominium.

The Poison Control Center advised them to see a doctor, which they did, complaining of continuing and increasingly severe headaches, blurred vision, and shortness of breath (i.e., symptoms compatible with organophosphate intoxication). Pulmonary function tests were performed and unexpectedly revealed mild obstructive pulmonary disease that improved following bronchodilator use. No other testing was performed. The physician treated the couple for a mild reactive airway disease and told them to return for further care only if symptoms persisted. When they inquired about the need to investigate continuing or residual effects from exposure to the pesticide, the physician did not know how to answer.

When symptoms persisted, the couple called the National Pesticide Information Center (NPIC) and were advised to return immediately to the physician and request a cholinesterase enzyme assay analysis. The results for the male were minimally above the lower normal range (i.e.,

consistent with either an acute or resolving intoxication). NPIC advised the couple to vacate the condominium and contact the Hawaii Department of Agriculture, which helped identify a commercial laboratory that confirmed the contamination, and provided clean up. The couple's symptoms resolved approximately two weeks later.

Case Study 4 — Arsenic Exposures

A clinician examined a rural family of eight with a number of signs and symptoms. Family members had conjunctivitis, bronchitis, pneumonia, sensory hyperthesia of the arms and legs, muscle cramps, dermatitis over the arms, legs and soles of the feet, nosebleeds, ear infections, blackouts and seizures, gastrointestinal disturbances, and severe alopecia. Symptoms became most severe during the winter months and tended to remit in summer (Peters et al, 1983). These conditions were initially attributed to stress, poor diet, hypochondria, and even child abuse. Only when a toxicologist heard about the case from the news media and performed appropriate laboratory tests on environmental samples was the source of the problem identified, three years later. The problem was found to be burning copper-chrome-arsenic treated wood (outdoor grade plywood) in the family's wood stove.

These case studies point to the preventable human suffering that can be associated with delayed or missed diagnoses of pesticide poisoning. Since the use and presence of pesticides are ubiquitous, there is a strong argument for sensitizing all primary care providers to develop a high index of suspicion, diagnostic acumen, and awareness of available resources, to respond promptly to patients whose presentations may represent pesticide poisoning. While it is anticipated that providers working with high-risk populations — such as in agricultural areas, emergency departments, and pediatrics — will be most sensitive to this proposition, these cases show the potential for such severe health consequences that all primary care providers are advised to be vigilant.

Current Provider Training and Education in Environmental Health

Health care providers are the primary audience for this Plan because the public looks to them for guidance on health concerns. While some progress has been made in introducing environmental health issues into curricula at medical and nursing schools, most health providers still do not have adequate knowledge and tools to address patient and community concerns. Key studies by recognized medical institutions and committees convened by federal agencies and national scientific bodies have addressed this concern:

- In 1985, only 50% of medical schools addressed occupational and environmental health in their curricula, with an average of only four hours being taught over four years. By 1992, 66% percent of medical schools required an average of about six hours of study in occupational and environmental health over four years (Schenk et al, 1996). (See box on next page).

TRAINING OF PRIMARY CARE PROVIDERS

A 1994 survey of environmental medicine content in US medical schools found that:

- Ninety US medical schools (76 percent) reported requiring environmental medicine content in the curriculum. Only two schools (2 percent) had a dedicated course. Eighty-nine schools (75 percent) indicated that environmental medicine was taught as part of a required course. Forty-six schools (39 percent) offered it as an elective course.
- Fifty schools (42 percent) reported no instruction in taking an exposure history.
- Among schools with required environmental medicine instruction, the average time in the curriculum was seven hours over the four years of medical education. An average of three hours of environmental medicine instruction was provided in pre-clinical courses and four hours in clinical courses.
- Eighty-one schools (68 percent) reported some faculty with environmental and occupational medicine expertise, most often in departments of internal medicine (42 percent), community/preventive medicine or public health (37 percent), and family medicine (28 percent).
- Nineteen schools indicated innovative or unusual approaches to teaching environmental medicine, including small group case discussions, community-based clerkships, and site visits. These schools reported an average of five faculty members with occupational/environmental medicine expertise, compared with an average of four faculty members for all other schools.

Note: Of the 126 schools surveyed, 119 (94 percent) responded.
Source: Schenk et al, 1996.

- In 1988, an Institute of Medicine (IOM) committee on the role of the primary care physician in occupational and environmental medicine recommended that all primary care physicians be able to identify possible occupational or environmentally induced conditions and make appropriate referrals (IOM, 1988).
- In December 1994, the American Medical Association adopted a resolution urging Congress, government agencies, and private organizations to support improved strategies for the assessment and prevention of pesticide risks (AMA, 1994).
- Specific recommendations to change medical/nursing education and practice were made by two IOM committees on medicine and nursing, in 1994 and 1995, respectively. In 1995, the Institute of Medicine produced two landmark reports — *Environmental Medicine: Integrating a Missing Element into Medical Education* (Pope and Rall, 1995) and *Nursing,*

Health and the Environment (Pope et al, 1995) — that called for more effective environmental health education and training of medical and nursing professionals.

- In *Toward Environmental Justice, Research, Education, and Health Policy Needs* (IOM, 1999) an IOM committee on environmental justice recommended enhancing health professionals' knowledge of environmental health as well as environmental justice issues.

Health care providers can be extremely effective in addressing pesticide exposures and other environmental health conditions in the lives of their patients and in their communities. However, they do not need to become experts in order to fill an important and crucial role. Some of the important knowledge and skills that they should possess include:

- Recognizing possible signs and symptoms of pesticide exposure
- Taking a brief and relevant environmental and occupational history
- Diagnosing possible associated health conditions, including those of sensitive populations such as children and the elderly
- Calling upon an appropriate specialist or expert to assist them
- Having ready access to a recommended referral list of resources and contacts
- Providing basic preventive guidance for patients
- Recognizing when to report exposure incidents to the proper health authorities
- Possessing a basic awareness of environments in which patients live, work, and play
- Identifying possible sentinel cases
- Participating in surveillance systems.

Training of Primary Care Providers

This Initiative emphasizes the provider's ability to recognize a potential pesticide exposure, to communicate effectively, and to access and work with pesticide/environmental health experts and resources. In an educational setting, this may mean working with an occupational and environmental medicine specialist to design and integrate a pesticides module into a toxicology course for medical students. In a practice setting, this may involve incorporating an occupational and environmental history into primary care practice and referring patients to appropriate experts in the event of a suspected poisoning. User-friendly teaching materials exist for faculty to use, along with user-friendly guides and curriculum maps indicating where pesticide topics could be inserted into the curriculum.

The issue of pesticide-related health conditions is one that requires the participation of health care providers. The rationale given in this section serves as the underpinning of the three-pronged strategy in this Implementation Plan.