Using U.S. Poison Control Center Records to Identify Bystander Pesticide Exposures: A One-Year Surveillance of Four Southeastern States

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ABSTRACT. *The extent to which bystanders are exposed to pesticide applications is unknown. Systematic monitoring around spray areas is not routine. Quantifying exposures is extremely difficult. Persons inadvertently exposed to pesticides often do not know the chemical or quantity, and persons living near areas of frequent field spraying may receive multiple exposures. In the U.S., concerns about health consequences from these exposures may prompt calls to poison control centers. The goal of this study was to determine what surveillance poison control centers can provide on environmental pesticide exposures to bystanders. We searched the American Association of Poison Control Centers' 2001 electronic medical records for exposure reports involving persons from 129 agriculturally intensive counties in Kentucky, Tennessee, Louisiana, and Arkansas that implicated at least one of 54 generic classifications of agricultural chemicals. We abstracted 980 pesticide-related records. Narrative sections were reviewed to determine bystander status of the exposed person. Forty-six bystander exposures were identified from 32 events. Bystander ages ranged from 2 to 81 (median: 45; 16 females, 13 males). All pertinent information for bystander classification came from narrative sections of the record. 28% identified aircraft crop dusters as the pesticide source. The most implicated substance was malathion (30.4%), while 19.6% did not know the exposure substance. 73.9% of cases were symptomatic; 65.2% of the exposed persons were seen in or referred to a healthcare facility. No hospitalizations or deaths were reported. Although they may underestimate the true numbers, U.S. poison control center data can provide valuable information about bystander environmental pesticide exposures.*

Keywords. *Bystander pesticide exposures, Pesticides, Poison control centers, Surveillance.*

Pesticides are increasingly used in agriculture worldwide. Pesticides enable increased production of higher quality crops and the elimination of some diseases. Unfortunately, pesticides are toxic chemicals that are intended to cause harm or death to certain pests and may also be harmful to humans. Increasing evidence links adverse health effects to pesticides. Although chronic exposures are not easy to understand or study, pesticides have been associated with cancers (Zahm and Blair, 2001), skin and

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respiratory disorders (Perry and Layde, 1998; Merchant et al., 1989), neurological and reproductive adverse effects (Stallones and Beseler, 2002; Garry et al., 2002), and immune function impairments (Blakley et al., 1999). In 1999, the EPA estimated that 10,000 to 20,000 physician-diagnosed pesticide poisonings occur every year among agricultural workers alone (Stephenson, 2001).

The monitoring of pesticide-related illnesses is receiving more attention than in the past in order to increase the safety of pesticide use. In the U.S., surveillance of acute occupational poisonings has increased, thanks in part to the efforts of the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), and the U.S. EPA. NIOSH's Sentinel Event Notification System for Occupational Risk (SENSOR) program enables state health departments to develop and maintain occupational injury and illness surveillance. A NIOSH-lead collaboration with the U.S. EPA, and other governmental and non-governmental agencies, generated standardized variables and case definitions used in surveillance of pesticide-related illness. The development of the SPIDER database software allows aggregation of data across states. NIOSH has published guidelines to establish state pesticide illness reporting systems and has participated in countless other initiatives to protect farm workers (NIOSH, 2001; Calvert et al., 2004). OSHA develops workplace safety and health standards and oversees compliance.

The EPA's Office of Pesticide Programs (OPP) has the primary responsibility for regulating the use of pesticides to ensure human health and a safe environment. The OPP responds to health needs of agricultural workers by evaluating pesticides for registration, reviewing older pesticides for re-registration, approving the labeling that must accompany pesticides; by disseminating information on the recognition and management of pesticide poisonings; and by collaborating with various organizations to reduce pesticide risks. The OPP collaborated with the USDA and registrants to develop the AgDRIFT model to predict distances and directions of pesticide spray drift under various circumstances (AgDRIFT, 2003; U.S. EPA, 2002).

Standard regulations are recognized for active agricultural workers to time their re-entry into fields that have been treated with pesticides. However, persons who do not know that an area has been sprayed or what chemicals were used may become unintentionally exposed by premature re-entry into a treated area. Unintentional pesticide exposures can also be the result of ground or aerial spraying. Public health campaigns often spray insecticides to control insects that carry disease. Frequently, these sprayings are in areas that do not normally experience pesticide use and have the potential to expose large numbers of bystanders (Centers for Disease Control, 2003).

Studies using geographic information systems to compare historical crop maps with known populated areas suggest that residents of agriculturally intensive areas are potentially at risk for pesticide exposures because of their proximity to crop fields, even if they are not the users of the chemicals. Pesticide drift has been measured up to approximately 900 m from spraying applications (Ward et al., 2000). Wind conditions, both speed and direction, can determine the amount of pesticide application that reaches target or non-target areas (Richards et al., 2001). Although people still refer to aerial applicators as "crop dusters," currently pesticides formulated as powders or dusts are usually applied as wettable powders (Dowling and Seiber, 2002). In addition to the increased hazard from drift, dusting proved less productive than water emulsion spray in delivering the active ingredient to the target area. Pesticide drift can occur when spray droplets, usually less than 100 μm in diameter, resist deposition and remain suspended in the atmosphere. There may also be vapor loss from spray droplets. Water is often used as the carrier solvent for the pesticide. When the water evaporates, the droplets become smaller until a suspended particle results (Dowling and Seiber, 2002). To what extent bystanders in non-targeted areas are unintentionally exposed to pesticides is not known.

Surveillance of non-occupational pesticide exposures is challenging. Non-production areas adjacent to agricultural areas are not routinely tracked for pesticide exposures. Unlike most occupational exposures, bystanders are seldom aware of the chemical involved or its health consequences. Information is lacking on a comprehensive picture of the factors influencing toxicity: the chemical involved, the dose received, the route of exposure, and the characteristics of the exposed person: sex, age, and individual susceptibilities. There is no mandatory national surveillance system in place to monitor non-occupational pesticide exposures (Calvert et al., 2001). It is difficult to know how to assess the burden that bystanders bear pertaining to pesticide poisonings. In order to prepare a proper exposure assessment, basic surveillance information is needed.

In the absence of a national active system to provide an accurate picture of non-occupational pesticide-related exposures, passive surveillance systems need to be used. Participating poison control centers across the U.S. employ toxicological resources to routinely collect data on poisoning exposures and report a national summary of these data. Anonymous reporting encourages utilization of the poison control centers' services (Litovitz et al., 1993).

Study Objectives

The Mississippi River Delta region of the U.S. is an agriculturally intensive area. Although pesticides have been identified as an environmental problem, little is known about non-occupational pesticide exposures occurring in the region or their impact on the health of the residents. The Delta region does not have an active, systematic surveillance system for pesticide exposures. However, poison control centers do provide poisoning information for this area. This study is an analysis of one year of data from a four-state (129 counties) test run of a larger study investigating pesticide exposures within the eight-state Mississippi River Delta Region. The larger study will use data available from all 290 Mississippi River Delta Authority counties in eight states for 2001 and 2002 and is being coordinated by the Southeast Center for Agricultural Health and Injury Prevention, located in Lexington, Kentucky, in partnership with the Southwest Center for Agricultural Health in Tyler, Texas, and poison control centers in Arkansas, Alabama, Illinois, Kentucky, Louisiana, Mississippi, Missouri, and Tennessee. Poison control center data have been successfully used to look at occupational pesticide exposures in other areas (Calvert et al., 2001; Bresnitz et al., 1999; Ferguson et al., 1991; Olson et al., 1991; Blanc et al., 1989). Our goal for this smaller study was to assess the feasibility of using poison control center data for surveillance of bystander pesticide exposures.

Data Collection

Poisoning exposure reports completed by specialists at poison control centers serving Kentucky, Tennessee, Alabama, and Louisiana provided data for this retrospective study. Calls to the poison control centers originated from both health care institutions and lay individuals. Documentation of calls received during 2001 from all four centers are recorded on the American Association of Poison Control Center's (AAPCC) Toxic Exposure Surveillance System (TESS) report forms utilizing computerized Toxicall software.

Case Identification

Case identification occurred in two phases. During the first phase, poison control center staff searched the poison center's computer database, which contained reports from the 2001 calendar year to generate a list of reports that implicated at least one of 54 predetermined generic agricultural-related chemical categories identified in the TESS database. This included codes for the categories of fertilizers, fungicides, fumigants, herbicides, rodenticides, and insecticides. Records implicating these toxic agents were abstracted. Printed copies of each AAPCC report, including the narrative notes prepared by poison control specialists at the time of the exposure calls, were obtained by the study investigators. We evaluated each narrative section of the medical record to ascertain if it met our bystander case criteria: a potential environmental pesticide exposure occurring to a person who was not personally using, or having control over the use of, that pesticide. Included were reports attributing the chemical exposure to possible pesticide drift, direct spray exposures, releases during transport, or discharges from manufacturing plants.

Results

Poison center staff identified 980 pesticide-related records to be reviewed. Of these records, 46 bystander exposures were identified from 32 events. Of reports that contained information on gender, 13 males and 16 females were identified. The exposed persons' ages ranged from 2 to 81 with the median age being 45. Almost two-thirds (65.2%) of potentially exposed persons were referred to or were seen in a health care facility; eight calls originated from a health care professional. No hospitalizations or deaths were reported. Symptoms were reported for 73.9% of the exposure cases. Table 1 lists the symptoms reported. Both dermal and inhalation routes of exposure were implied in 62.5% of the cases, 28.1% of the cases indicated exposure from inhalation only, and 9.4% were the result of only dermal exposure.

In the current study, malathion, an organophosphate insecticide, was the substance implicated most often (n = 14, 30.4%). Figure 1 shows the categories of implicated substances specified in the poison control center reports. There was no way to verify that the substance identified by the caller was accurate. Although two cases listed unknown

Table 1. Pesticide exposure symptoms reported by bystanders.

Symptom Reported	Number of Individuals Reporting Symptom	Percentage of Total Cases
Dermal irritation	8	17.4
Nausea	7	15.2
Headache	7	15.2
Neurological	5	10.9
Dizziness	4	8.7
Diarrhea	4	8.7
Irritated throat	4	8.7
Respiratory complaints/short of breath	3	6.5
Coughing	3	6.5
Vomiting	3	6.5
Eye irritation	2	4.3
Lips stinging or feel thick	2	4.3
Bad taste in mouth	2	4.3
Nasal stuffiness	1	2.1
Salivation	1	2.1

herbicides as the source of exposure, four cases implicated Prowl (pendimethalin) and one listed Round-up (glyphosate) as the substance of exposure. Of the 25 insecticides identified, 17 were organophosphates (14 malathion, one methyl parathion, one acephate, and one dicrotophos). Insecticides named also included three pyrethrins, two carbamates, and three botanicals (nicotine). Anhydrous ammonia was implicated in three cases. While figure 1 shows that seven cases did not offer even a generic category for the involved exposure substance, 19.6% (*n* = 14) of the 46 persons exposed did not know the substance involved even though they put it into a general category of fertilizer, insecticide, etc.

Discussion

Reliance exclusively on poison control center data may underestimate the true number of bystander environmental pesticide exposures that occur (Litovitz et al., 1993). Since pesticide exposure reporting is not mandatory, and because many cases are left to self-management or professional visits without poison control center notification, underreporting is almost certain. Language barriers, lack of telephones, or lack of knowledge on how to access poison control center information could lead to underutilization of poison control center services, which gives rise to an undercounting of the actual number of bystander pesticide exposures. Medical confirmation is not available on all exposures reported. However, data procured in this study show the potential for poison control surveillance of bystander pesticide exposures. Almost five percent (4.6%) of the cases implicating one of the study's 54 agriculturally related chemicals involved exposures of bystanders.

Although four case reports mentioned pesticide odor, odor is not a reliable indicator for the amount of pesticide active ingredient. Herbicide active ingredients are usually odorless, the odor being from manufacturing impurities or additives in commercial formulations. Because of the lack of quantitative data on pesticide exposures, symptoms must be used as a proxy for the hazard involved. Symptoms from acute pesticide poisonings are well documented in the literature and range from dizziness, nausea, and

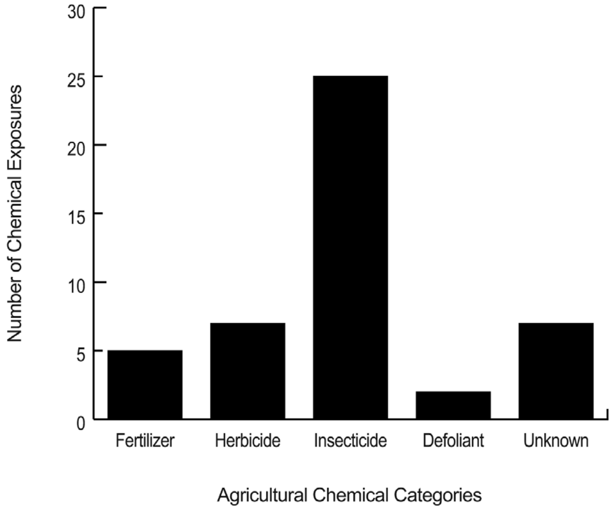

Figure 1. Categories of agricultural chemicals implicated in bystander exposure cases.

increased mucus production to respiratory failure, coma, and death. The symptoms reported in this study, as shown in table 1, are consistent with reported acute pesticide exposure-related symptoms (Petrie et al., 2003). Severity of symptoms can be utilized as an indication of the exposure dose. In this study, dermal complaints ranged from sunburn-like redness to whole-body rashes to blistering skin; headaches ranged from mild to migraine; and neurological impairments ranged from malaise, disorientation, and confusion to slurred speech, constricted pupils, and visual impairments. Primarily based on presenting symptoms, the majority (65.2%) of exposure cases were either referred to or seen by a professional in a health care facility.

Certain populations are very susceptible to the hazards that pesticide exposures present. There is a very wide age-range of people identified as bystanders in this study. The bystander exposure cases included children, the elderly, and possibly persons with chronic illnesses or weakened immune systems. Persons living in the same agricultural location as their predecessors may have effects from accumulated exposures. All of these special populations may experience greater adverse effects from unintentional pesticide exposures than those that customarily work with pesticides (Ames, 2002). Poison control center data can provide information on pesticide exposures to persons of ages not included in the usual scope of occupational pesticide exposure surveillance.

These data may also provide the impetus for investigations into why pesticides are being applied to non-target areas or why non-target areas experience pesticide drift:

- Signs posting pesticide application times could have prevented at least five of the exposures cited, three of which occurred when a parent took his children for a ride through a pecan orchard that was being sprayed at the time. Two cases involved persons living adjacent to golf courses. Notification of spraying schedules, along with identification of the chemicals used, would benefit nearby residents.
- Communication to inform area residents of public health mosquito abatement spraying and education about the chemicals used could possibly have prevented three exposures.
- Exposures to anhydrous ammonia were attributed to a leaking tank at a fertilizer store and from a break in a fertilizer plant pipeline. These situations could indicate a need to create a buffer zone around such facilities.
- Three exposures to herbicides occurred during product transport. In one instance, a truck carrying a leaking drum of herbicide released fumes to passengers in the vehicle behind it. In another exposure event, an overturned truck released fumes from the herbicide it was hauling. Investigation could determine whether the policies for transporting chemicals were being followed or if more stringent policies are needed.

Unfortunately, the poison control specialists' notes did not give enough detail to derive prevention strategies for exposures attributed to aerial spraying, although two cases gave enough information to suggest that additional regulations or additional applicator training might be needed. If exposures occurred from authorized spraying, then current pesticide use practices or aerial regulations might need to be reassessed. Feedback on the circumstances of the pesticide exposures should be given to the extension agents who train pesticide applicators, and to the Departments of Agriculture that test and license them.

To obtain a true measure of the impact that pesticides have on human health requires good measurement of exposure, the resulting symptoms, and any harmful consequences. Many chronic diseases have long latency periods that necessitate the forethought to keep records of exposures in order to relate current illness to past chemical contact. While the threat of a bioterrorism attack involving aerial spraying is slight, studies have demonstrated that poison control centers have the capability to detect temporal clusters of toxic events. Besides striving to reduce pesticide exposures, the added incentive to provide information on unusual events in a timely fashion is imperative, with non-occupational events receiving a higher priority than ever before (Pavlin et al., 2003). Poison control centers can provide this type of timely data.

This study has shown that using the full record available from poison center surveillance can be beneficial in acquiring valuable information about unintentional pesticide exposures to bystanders. The cases involved events from ground and aerial sprayings, inadvertent re-entry into treated areas, and exposure from public health spraying campaigns. Persons exposed by being adjacent to both crop fields and golf courses were discovered, as well as exposures on a highway from a leaking herbicide drum on a moving vehicle.

The narrative sections of poison control center records are underutilized by both poison control center staff and researchers. Although the main focus of the poison control centers is the medical management of acute poisonings, poison control specialists should be encouraged to add as much detail about the circumstances of the exposure event as possible. Currently, national summary data reported by the AAPCC do not include information from the narrative sections of the poison control centers' records. Researchers should direct efforts to creating a method to routinely access the information in the narrative sections. These narrative notes reveal important facts about the specific circumstances surrounding pesticide exposures to bystanders, and sentinel events could thereby be identified. This study suggests that U.S. poison control centers may be an important surveillance source for bystander pesticide exposures and may provide valuable information to improve management practices for the use of pesticides.

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