An Epidemic of Pesticide Poisoning in Nicaragua: Implications for Prevention in Developing Countries

ABSTRACT

Objectives. The purpose of this study was to demonstrate the usefulness of the Northwestern Nicaraguan Ministry of Health surveillance system for detecting pesticide poisonings.

Methods. Cases were reported to the regional department of epidemiology through daily telephone reports and through monthly consolidated reports from each of the 18 health centers of the National Health Service. Reporting forms were also distributed to the four area hospitals.

Results. During June and July 1987, an epidemic of 548 pesticide poisonings was detected in northwestern Nicaragua. Seventy-seven percent of the poisonings were caused by carbofuran or methamidophos. Of the work-related cases (91% of reported poisonings), more than 80% occurred among maize farmers and on small to medium land holdings (fewer than 140 hectares). Nineteen percent of the work-related cases involved children under 16 years of age.

Conclusions. Unsafe working conditions such as manual application of pesticides and the use of backpack sprayers, the introduction of a hazardous powdered formulation of carbofuran highly restricted in the developed world, and agricultural subsidies that encouraged the use of hazardous pesticides all contributed to the epidemic. (*Am J Public Health.* 1993;83:1559–1562)

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Introduction

Pesticide poisoning is a major public health problem in the Third World. Recent worldwide estimates suggest that each year, there are 3 million severe, acute pesticide poisonings and 220 000 deaths.[1] Most of the poisonings and 99% of the deaths are believed to occur in developing countries, although the Third World accounts for only 25% of total worldwide pesticide consumption.[2] Although food-borne outbreaks of severe poisoning, which often result in hospitalization, are reported commonly in the Third World,[3] there are remarkably few well-documented examples of epidemics of worker poisoning. Unfortunately, most available data in Latin America reflect hospital-based (severe) poisonings, because there seldom exists the capability to organize surveillance systems outside hospitals.

In the early 1980s, Nicaragua implemented a series of social reforms, including redistribution of agricultural land to small farmers, and universal health coverage was provided through the new unified National Health Service, which emphasized primary care services and preventive public health.[4] Surveillance systems for preventable diseases were established, including a regional pesticide poisoning registry for the 632 000 people living in the principal agricultural area on the northern Pacific Coastal plain.[5] Reporting forms were distributed to the four hospitals and the 18 health centers of the National Health Service, which was the exclusive source of medical care for most of the rural population in this region. The reporting of pesticide poisonings increased immediately (see Figure 1).

The usefulness of the system was demonstrated in an epidemic of poisonings in June and July 1987 (see Figure 2). Two peaks in frequency of poisoning occurred in two distinct seasons: June and July, corresponding to the planting of food crops (especially maize), and September through December, corresponding to the cultivation of cotton. However, the number of poisonings involving food crops increased disproportionately in 1987. Information collected through the surveillance system made it possible to identify and characterize the epidemic.

Methods

Cases were reported to the regional department of epidemiology through daily telephone reports and through monthly consolidated reports of all reportable diseases from each health center of the National Health Service. Name, age, location where poisoning occurred, reporting center, and (sometimes) job title and pesticide used were available through these reports. These reports were used to direct the regional ministry's outbreak control unit, which conducted investigations and on-site worker training in safe use of pesticides and screened workers for cholinesterase depression (a test for subclinical overexposure to toxic organophosphate insecticides). The regional department of epidemiology also provided follow-up cholinesterase tests for overexposed or poisoned workers referred by the health centers. Treating clinicians were almost exclusively physicians who had been trained in the diagnosis and treatment of acute poisoning in a course run by

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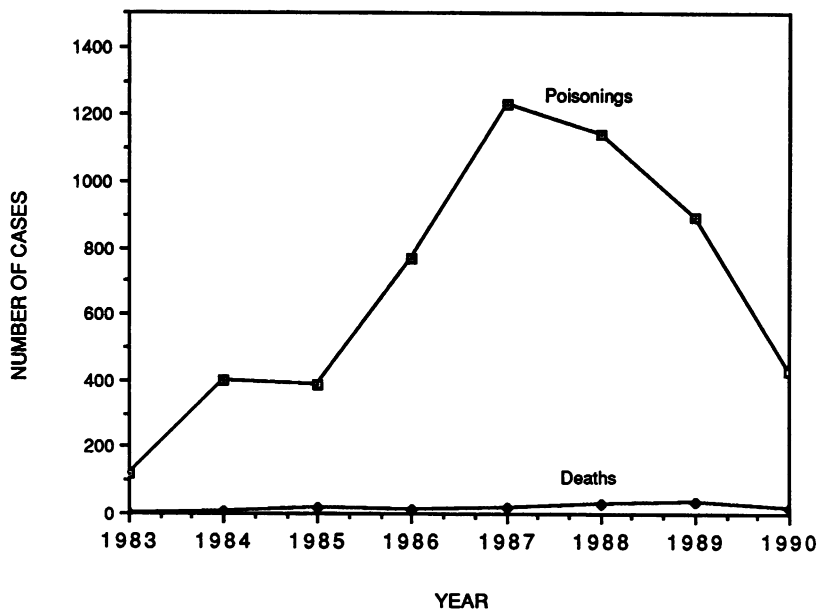

FIGURE 1—Pesticide poisonings and deaths reported to the Nicaraguan Ministry of Health Region II registry, 1983 through 1990.

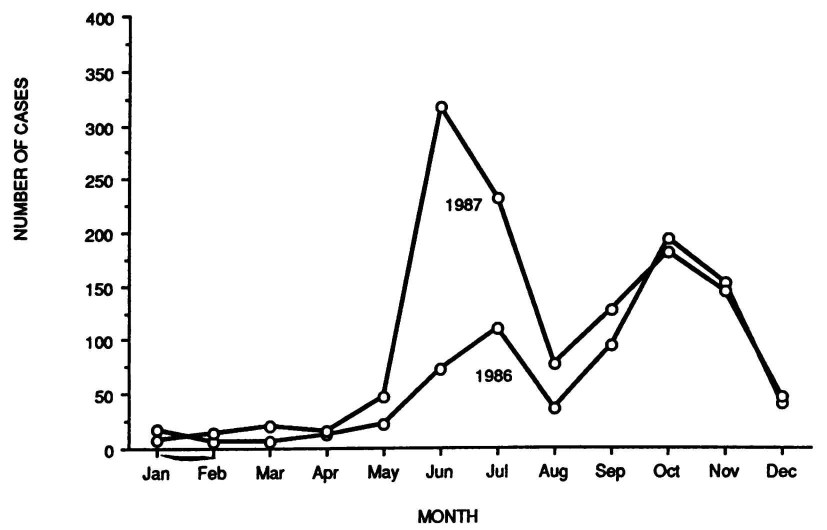

FIGURE 2—Monthly reports of pesticide poisonings reported to the Nicaraguan Ministry of Health Region II registry, 1986 through 1987.

TABLE 1—Principal Pesticides Responsible for Occupational Poisonings: June–July 1986 and June–July 1987

Pesticide	Total Cases, % 1986 (n = 181)	Total Cases, % 1987 (n = 351)	Change in No. of Reported Poisonings, 1986–1987	Proportionate Morbidity Ratio Based on 1986 Standard (95% Confidence Interval)[14]
Carbofuran	26	46	+131	173 (159, 186)
Methamidophos	39	31	+39	80 (73, 88)
Chlorpyrifos	13	6	−5	40 (32, 51)
Methyl parathion	. . .	2	. . .	. . . . . .

Note. Reports with missing data are not included.

the Ministry of Health. A summary of descriptive statistics from the registry was distributed quarterly to each clinic in the region. Field observations of pesticide applications were made during the period of the epidemic.

Results

The epidemic of June and July 1987 was not the result of improved reporting, because the increase was confined to this 2-month period (Figure 2). Of the 548 cases reported (316 in June and 232 in July), 91% (368/404) were occupational, 8% involved other accidents, and 1% were suicide attempts. (Of the 548 responses to the question regarding type of poisoning (occupational or otherwise), 144 (26%) were left blank by the reporting health workers. In general, missing data were not included in the calculations presented.) The description of the epidemic is restricted to occupational poisonings. Of the four deaths, three were suicides and one was a nonoccupational accident. Three of the four deaths were caused by the insecticide methamidophos.

Of the occupationally exposed patients for whom sex was reported, 96% (353 of 368) were male. The mean age was 27 years, and 19% (71 of 366) of the patients were less than 16 years old, the minimum legally permissible age for working with pesticides in Nicaragua.[6] Forty-one percent (166 of 404) of occupational poisonings were relatively more severe occurrences reported from hospitals. Eighty-six percent (301 of 351) of the cases for which crop was indicated involved maize. Eighty-two percent (276 of 338) of the poisonings for which size of farm was identified occurred among workers on small and medium-sized farms (fewer than 140 hectares). Only 10% (35 of 338) and 8% (27 of 338) occurred among workers on large private farms and state farms (greater than 140 hectares), respectively.

The insecticides responsible for the epidemic were cholinesterase inhibitors. More than half of the poisonings involved a carbamate insecticide, and almost half involved an organophosphate. Two specific insecticides were most often implicated (see Table 1). Almost half of the poisonings involved the carbamate insecticide carbofuran (sold under the trade name Furadan), which at the time was imported from Mexico, and one third resulted from the organophosphate methamidophos, a peripheral neurotoxin[7] (sold in Nicaragua as Monitor, Filitox, Tamaron, and MTD). The increase in carbofuran poisonings from 1986 to 1987 accounted for the majority of the overall increase (in occupational poisonings for which the responsible pesticide was reported by the health worker). Thirty percent of the carbofuran poisonings for which the type of formulation was indicated reportedly involved powder, a formulation that is severely restricted in most of the developed world because of the easy absorbance by the respiratory tract. Most of the remainder of the absolute increase was accounted for by methamidophos, although the proportion of all poisonings caused by methamidophos decreased. Of note is that the number of poisonings involving chlorpyrifos decreased.

Discussion

The epidemic demonstrates the viability of a clinic-based comprehensive surveillance system in the Third World and the value of this system in detecting, measuring, and, ultimately, alleviating outbreaks of pesticide poisoning. Contrary to the common conception that clinic-based surveillance is difficult in the Third World, the surveillance system functioned effectively because participating clinicians perceived the benefits that the clinics received from reporting: an outbreak control unit that responded to clinicians' requests, a training course designed to upgrade clinical skills in the treatment of pesticide poisoning, a referral center for follow-up of poisoned workers, and periodic feedback on patterns of pesticide poisoning in the region. The system could be implemented because rural access to health care was almost universal under Nicaragua's National Health Service.

Surveillance is a powerful tool for demonstrating the public health impact of pesticides in a way that impresses the public. Based on a crude estimate that two thirds of poisonings are not reported, 3602 cases of medically treated poisoning may have occurred in this region in 1987 (or 5.9/1000, based on 1234 reported cases for the year and a total population of 632 000). (A survey of 633 agricultural workers identified 24 who reported that they had been treated for poisoning.[8] Only 8 of these cases were actually reported to the surveillance system.) Further review of data on childhood poisoning in this region revealed an alarming increase in the proportion (as well as in the absolute number) of reported poisonings among children, from 12.7% of all poisonings in 1984 to 17.1% in 1987 (χ^2 = 3.24, for slope; P = .072).[9] During the mid-1980s, young men who traditionally applied pesticides were away at war. Because pesticide application is not a job that requires extensive physical strength and because of the shortage of adult labor, children were used in this activity.

Health authorities declared a regional health emergency 3 weeks into the epidemic, a media campaign was begun to advise workers in less hazardous handling of carbofuran, and outbreak control and preventive education were expanded through the clinic network. Proposals emerged to substitute less hazardous imports for more hazardous ones, and there has been no repetition of the dumping of carbofuran powder on the Nicaraguan market.

However, the long-term impact of the epidemic in reducing pesticide poisoning in Nicaragua, as well as the ability of the health sector, by itself, to reduce poisoning in the Third World in general, is questionable. The reason is that the health sector can offer little more to workers than health education and the promotion of personal protective equipment as a solution to the problem of endemic pesticide poisoning, a solution actively promoted by the pesticide industry.[10] The reasons for pesticide poisoning in the Third World (and for this epidemic) often include economic factors outside of the control of the health care system. For example, health effects are seldom considered anywhere in the Third World in developing policy on pesticide subsidies, although subsidies that encourage pesticide use are common.[11] During 1987, pesticides were supplied almost free of charge to most Nicaraguan farmers through favorable exchange rates and negative real interest rates.[12,13] As a result of subsidies, farmers increased the number of applications in maize, the crop involved in most of the poisonings, from 4.2 to 6.3 per season. In addition, in 1987, the price at which maize could be sold was deregulated by the government from its previously fixed price. Production of maize increased in the region from 12.1 million kg to 49.1 million kg between 1986 and 1987 (unpublished data, Ministry of Agricultural Development and Agrarian Reform 1988), and demand increased for highly toxic carbofuran and methamidophos for control of maize pests. The weight of imported carbofuran active ingredients increased by more than 50% from 1986 to 1987. In addition, importation of chlorpyrifos ceased, in part because chlorpyrifos was more expensive than either methamidophos or carbofuran. Since there was a shortage of chlorpyrifos, which is considerably less acutely toxic than carbofuran, workers substituted carbofuran for chlorpyrifos.

Working conditions typical of the developing world contributed to the epidemic. In the developed world, carbofuran granules are applied by tractor, entailing little exposure to the applicator. In Nicaragua, carbofuran was mixed with urea, which facilitated dermal absorption, and applied by hand. As noted above, carbofuran also was available in a powder formulation in 1987. In the developed world, acutely toxic liquid pesticides such as methamidophos are applied by planes or tractor-drawn boom sprayers. Among small farmers in the developing world, they are applied by backpack sprayers, and leakage is common. Most occupational pesticide poisonings in this region occur during backpack application. In addition, most farmers received no training in the hazards of pesticides because there were essentially no agricultural extension services such as those in developed countries, and protective rubber gloves and respirators, had they been available, cannot be worn by farmers working in the tropical sun in a humid climate where ambient temperatures reach 40°C. Finally, like most Third World countries, Nicaragua still does not require that imported pesticides be registered in the country of origin, and pesticides banned or restricted in the country of origin are used widely.

This epidemic suggests that the importation of acutely toxic pesticides, pesticide subsidies, and the overuse of pesticides under primitive working conditions are major causes of poisoning in developing countries. The number of poisonings decreased only slightly in 1988, the year after the well-publicized epidemic (see Figure 1). A further decline in 1990 probably resulted from markedly reduced subsidies for pesticides purchased by small farmers (although it may reflect greater underreporting as a result of decreased funding for health). Although surveillance is necessary to focus attention on the problem of pesticide poisoning, recent experience in reducing pesticide use suggests that policies promoting nonchemical alternatives to pest control may be the most appropriate solution to the problem of poisoning in Nicaragua and elsewhere in the Third World.[15] □

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