Hospital-based Survey of Pesticide Poisoning in Japan, 1998–2002

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Data concerning clinical cases of pesticide poisoning from 1998 to 2002 from the hospitals affiliated with the Japanese Association of Rural Medicine were analyzed. 346 cases of poisoning by agricultural chemicals were reported from 65 hospitals. Suicides accounted for 70% of pesticide poisoning cases, followed by accidental exposures during spraying work (16%) and accidental ingestion (8%). The majority of cases were acute or subacute systemic poisonings (90%), followed by acute dermatitis (5%) and chemical burns (3%). Organophosphate insecticide was the most frequent inducer of clinical cases (36%), followed by bipyridylium herbicide (20%) and carbamate insecticide (6%). The death rate from poisoning by the herbicide paraquat was more than 70% of clinical cases, even though it is a low-concentration product, whereas those from the alternative herbicides, glufosinate and glyphosate, were less than 10%. *Key words*: pesticide poisoning; pesticide disorders; hospital-based survey; Japan; paraquat.

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In Japan, the use of pesticides has increased since World War II reducing agricultural labor but increasing productivity. However, it has also caused poisonings and other pesticide-related disorders, which in itself has been a grave issue for rural medicine.

Japanese farmers currently use an estimated 400,000 tons of pesticides per year,[1] and the number of deaths caused by pesticides is about 1,000 persons per year[2] in the early 2000s.

In 1966, the Japanese Association of Rural Medicine established the Pesticide Poisoning Research Group, under the leadership of Dr. Toshikazu Wakatsuki, to work out a strategy for the prevention of pesticide poisoning. The group prepared a survey questionnaire on pesticide poisoning and conducted a nationwide survey from 1967 to 1989,[3] collecting data on more than 3,000 cases. The survey provided valuable information for the prevention, diagnosis, and treatment of pesticide poisoning.

In the early 1990s, it was decided to revise the survey questionnaire and the Pesticide Poisoning Research Group was reorganized, with Dr. Toshio Matsushita serving as chief, in 1994. The research group revised the questionnaire in 1996, and the Japanese Association of Rural Medicine resumed its nationwide survey, which continues to this day.

In this paper, we report the recent trends of pesticide poisoning and other pesticide-induced disorders in Japan as reflected in our hospital-based case survey.

METHODS

Data concerning clinical cases with pesticide-induced toxicity were collected from approximately 100 hospitals affiliated with the Japanese Association of Rural Medicine. The hospitals are located across Japan, from Hokkaido to Kagoshima Prefecture.

The questionnaire used for our survey was the one revised in 1996,[4] which elicits numerous data of the clinical cases recorded by the physicians, including characteristics of the patients, diagnosis categories, signs and symptoms, circumstances of exposure, conditions of spraying, uses of protective gear, factors of exposure, clinical episodes, and sequelae.

The total numbers of affected inpatients and outpatients per year were reported from every hospital. The numbers of deaths and the total numbers of inpatients and outpatients seen at the surveyed hospitals were compared with corresponding national statistics from 1998–2001.[2,5]

This report summarizes the trends in pesticide-related disorders in Japan from 1998 to 2002.

RESULTS AND DISCUSSION

Estimation of the Scale of the Survey

Although we could not collect information about subclinical cases of pesticide-related poisonings or other disorders, it is appropriate to estimate the scale of our survey.

The Ministry of Health, Labor and Welfare[2] releases Vital Statistics every year, collecting the numbers of

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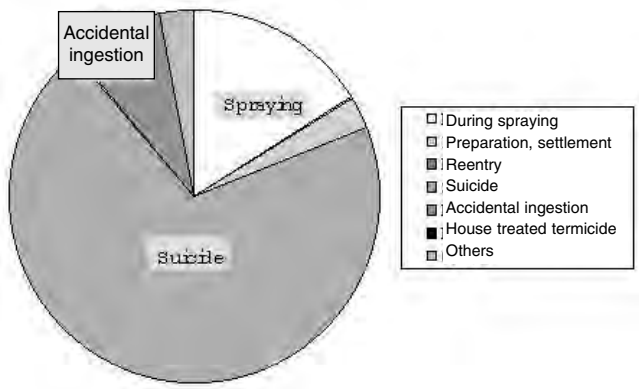


Figure 1—Circumstances of pesticide exposures of the cases collected by the survey, 1998–2002.

death cases in Japan. Those caused by pesticides ranged from 860 to 1,070 persons per year in 1998– 2001. In the same years, the numbers of pesticide-related death cases collected by our survey ranged from 16 to 20 per year. The ratios of these versus national statistics were calculated as 1.6% to 2.1% in the four years, respectively.

In addition, the Ministry of Health, Labor and Welfare[5] releases statistics from all hospitals in Japan every year. The total numbers of outpatients and inpatients in all hospitals in Japan ranged from 646×10^6 to 657×10^6 persons per year and from 508×10^6 to 513×10^6 person-days per year in 1998–2001, respectively. In the same years, the sums of the totals of outpatients and inpatients in the surveyed hospitals ranged from 14.6×10^6 to 17.7×10^6 persons per year and from 7.6×10^6 to 10.2×10^6 person-days per year, respectively. The ratios of these versus national statistics were calculated to be from 2.2% to 2.7% and from 1.5% to 2.0% in the four years, respectively.

From these data, we roughly estimated that this hospital-based survey covered 1.5–2.5% of the clinical cases caused by pesticides in Japan. Although the scale of our survey is small, the trends of pesticide-induced disorders in Japan in recent years may be deduced from the 346 cases collected in our survey from 1998–2002.

Trends of All Cases Reported

The 65 hospitals in the study reported a total of 346 cases of poisonings or other disorders caused by pesticides.

By gender, poisoning cases among males reached 60%, and those among females were 39%. By age group, the highest incidence occurred in the age group 60–69 (22%), followed by 50–59 years (20%) and 70–79 years (16%). This trend seems to be explainable by the aging of the population across Japan in several recent decades—especially, among farmers.

Suicides accounted for 70% of the pesticide poisoning cases, followed by accidental exposures during spraying work (16%) and by accidental ingestion (8%) (Figure 1).

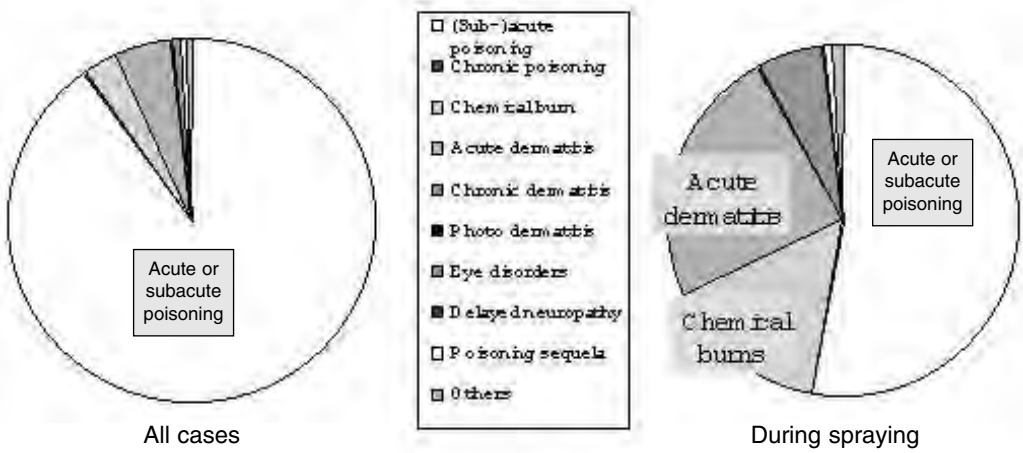
The majority of cases were acute or subacute systemic poisonings (90%), followed by acute dermatitis (5%) and chemical burns (3%) as shown in the left graph of Figure 2.

Among the pesticides involved, organophosphate insecticide was the most frequent inducer of clinical cases (36%), followed by bipyridylium herbicide (20%) and carbamate insecticide (6%), as shown in the left graph of Figure 3. This trend seems to mirror pesticide sales in Japan, with the notable exception of the bipyridylium herbicide paraquat.

Examination of the outcomes showed that 69% of the clinical cases recovered, whereas 25% died, as shown in the left graph of Figure 4. Problems relating to the paraquat products, which are the main cause of deaths, are discussed below.

Cases Caused by Exposures during Spraying, Preparation, Settlement, or Reentry

The clinical cases caused by exposures during spraying, preparation, settlement, or reentry are important for



All cases

During spraying preparation, settlement, or reentry

Figure 2—Diagnostes of cases of pesticide-related disorders in the survey, 1998–2002.

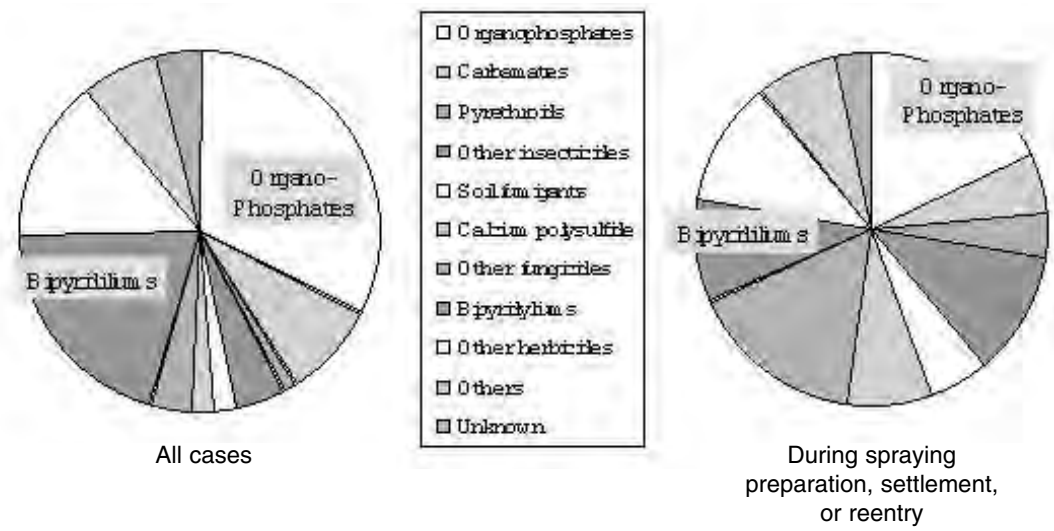


Figure 3—Categories of pesticides causing toxic effects in cases in the survey, 1998–2002.

agricultural preventive medicine. For convenience, the condition "during spraying, preparation, settlement, or reentry" is here referred to as "during spraying, among others," to analyze cases resulting from these pesticide exposures.

We collected 65 cases resulting from exposures during spraying, among others, from 1998 to 2002.

By type of clinical manifestation, the majority of these cases were acute or subacute systemic poisonings (53%), followed by acute dermatitis (24%), chemical burns (15%), and eye disorders (6%), as shown in the right graph of Figure 2. During spraying, among others, pesticide exposures affect mainly the respiratory organs, skin, eyes. In our survey, important toxic effects in these situations involved not only acute poisoning but also dermal disorders.

The pesticides responsible for the clinical cases arising during spraying, among others, varied greatly. The most frequent inducer was organophosphate insecticide (20%), followed by bipyridylium herbicide (8%), calcium polysulfide (7%), and soil fumigants (6%), as shown in the right graph of Figure 3. Calcium polysulfide and soil fumigants are known to be highly toxic to skin.

Analysis of the outcomes of the cases incurred during spraying, among others, showed that most (89%) recovered, as shown in the right graph of Figure 4.

The factors contributing to the onset of the pesticide-related cases were chosen by the physicians from the 13 factors listed in Figure 5. The main factors were insufficient protective measures (31%), followed by carelessness (16%) and inadequate information (11%), as shown in Figure 5. In Japan, farmers often give precedence to labor efficiency, and protection against pesticide exposures remains insufficient.

Dermal Disorders

The clinical cases incurred during spraying, among others, included a considerable number of dermal disorders. Dr. Nobuyuki Horiuchi of our hospital has published an atlas of 134 such clinical cases with 244 color photographs. Dr. Horiuchi recommends as preventive strategy against pesticide-induced dermatitis suitable

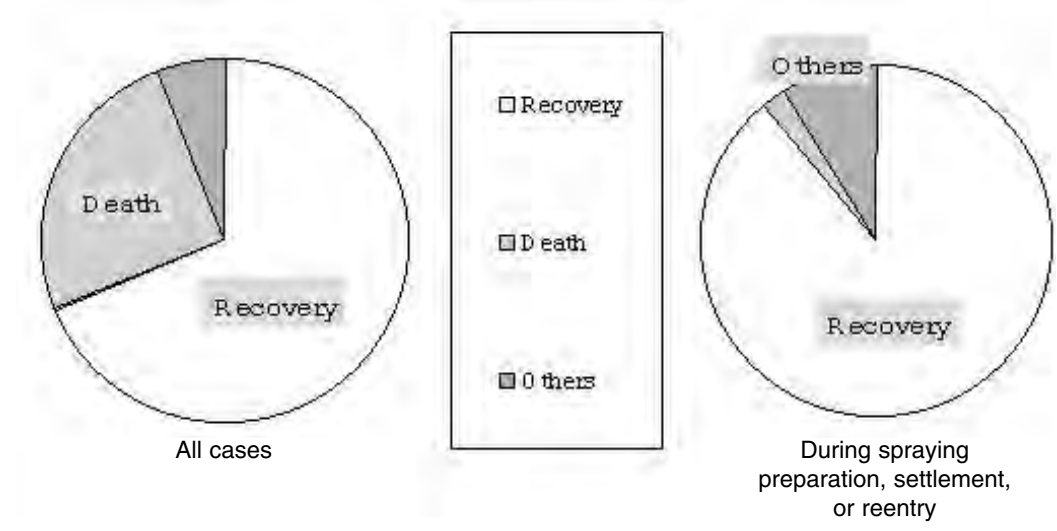


Figure 4—Outcomes of the cases in the survey, 1998–2002.

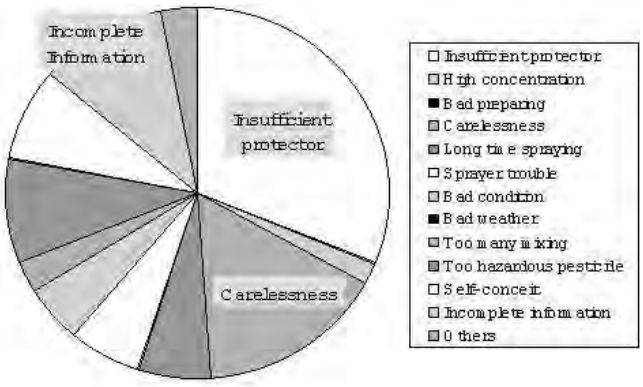


Figure 5—Factors contributing pesticide toxic effects during spraying, preparation, settlement, and reentry.

information about the chemicals involved, sufficient protection, improvements in spraying methods, using only recommended concentrations of the chemicals, and taking a shower after spraying. [6]

Paraquat Poisoning

The outcomes of the cases in our survey are tabulated by main pesticide in Table 1. The cases caused by paraquat are divided into three categories: 24% preparation, 5% preparation, and "paraquat poisoning, but concentration unknown." The table shows significant a difference in the associated death rates between paraquat and other pesticides.

In Japan, paraquat poisoning has been of grave concern to physicians in ICUs for more than 30 years. Beginning in the late 1960s, 24% preparations of paraquat were sold, but these were found to cause many deaths, so in the late 1980s low-concentration products began to be sold alternatively. But even with the 5% preparations, the death rate remains high (>70%). Chishiro[7] found that "the decrease of paraquat concentration in the product does not decrease the death case rate in Japan."

Proudfoot et al.[8] proposed a criterion for predicting the outcome of paraquat poisoning by the plasma concentration relative to the passed time since exposure. Saving the lives of victims of paraquat poisoning has been the subject of many investigations by numerous physicians in Japan and elsewhere. Proudfoot's criterion has been useful for more than 20 years,[9–11] but clinical treatment of paraquat poisoning remains largely ineffective.

In contrast, most (>90%) of the victims of toxic effects of two alternative herbicides, glyphosate and glufosinate, have recovered. Compared with the outcomes associated with these alternative herbicides and other pesticides, the death rate from paraquat poisoning is extremely high, and many physicians in ICUs in Japan hope for a ban on paraquat.

Huang[12] in China and Van der Hoek et al.[13] in Sri Lanka have reported that the hazardous organophosphate insecticides are going to be phased out in their countries. On the other hand, people are beginning to buy and use herbicides. Consequently, the use of paraquat is aggravating the main problem of pesticide toxicity to their countries.

The Inter-organization Programme for the Sound Management of Chemicals[14] has classificated pesticides by hazardousness. This classification has contributed to decreases in pesticide poisoning by phasing out extremely or highly hazardous pesticides (Class Ia or Ib) in the world. It would be appropriate to assign paraquat to Class I, like captafol, which was categorized as Class Ia by reason of carcinogenicity.

International Programs for Prevention of Pesticide Poisoning

The WHO Global Information Network on Chemicals' survey questionnaire on pesticide poisoning, devel-

TABLE 1. Outcomes of Poisonings and Other Toxic Effects of Pesticides and Herbicides in the Cases in the Survey, 1998–2002

	No. of Cases			
	Total	**Recovery**	**Death**	**Other**
Paraquat				
5% paraquat with 7% diquat	49	12	36	1
24% paraquat	9	1	7	1
Preparation unknown	14	—	14	—
Other herbicides				
Glufosinate	14	11	1	2
Gryphosate	15	13	1	1
Organophosphates				
Fenitrothion	32	26	3	3
Malathion	13	12	—	1
Dichlorvos	9	5	3	1
Dipterex	7	7	—	—

oped in 1997, has been used in carrying out hospital-based surveys on pesticide poisoning in Asia since 1998.[15] This program will identify the hazardous pesticides used in the surveyed countries and list the pesticides that need to be phased out.

On the other hand, to decrease the incidence of pesticide poisonings during the condition spraying, among others, it is important to communicate with farmers directly. FAO has been exploring the concept of community integrated pest management (CIPM) in Asia in recent years.[16] In this program, Murphy et al.[17] surveyed the occurrence of pesticide poisonings with illustrated self-report sheets and advised farmers of the trend of pesticide poisoning once a month for a year in Vietnam, with the result that the farmers phased out the use of hazardous pesticides of their own accord.

CONCLUSION

Clinical cases of pesticide poisoning and other pesticide-induced disorders throughout the nation were collected from the hospitals affiliated with the Japanese Association of Rural Medicine during 1998–2002 and analyzed. Related problems, especially paraquat poisoning, were examined.

An international project surveying pesticide poisonings has been undertaken by the WHO Global Information Network on Chemicals in Asia since 1998.[15] In addition, FAO is exploring CIPM.[16] With the aim of decreasing the effects of pesticide toxicity in Japan and elsewhere in Asia, we hope to participate in such projects in the future.

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