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Review

Historical Perspective of Pesticide Poisoning in Japan and Measures Taken by the Japanese Association of Rural Medicine

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Abstract

The use of pesticides has rapidly increased in Japan since the end of World War II, significantly reducing work burdens and boosting food production. In the meantime, pesticides, responsible for poisoning and environmental pollution, have for many years posed grave issues that have had to be tackled by scientists of rural medicine for a long period. The Japanese Association of Rural Medicine, founded by the late Toshikazu Wakatsuki, has grappled with those issues for many years. Above all, the association has fulfilled its social obligations, such as by bringing the toxicity of organic mercury to light in animal tests to prompt the government to prohibit its use, and by casting light on birth defects caused by defoliants aerially sprayed during the Vietnam War to urge U.S. military forces to break off herbicide warfare. As it has become possible to make less toxic pesticides available for farm work in recent years, death-inducing accidents have seldom occurred during the spraying of pesticides, and the association's activities are now at a low ebb. Now that pesticides, which after all are biologically toxic compounds, are openly used on farms, there is the need to pay constant attention to their impacts on the human body and the environment. In the future, it is necessary to epidemiologically probe into chronic impacts on the human body and contribute to the prevention of pesticide poisoning in Southeast Asia.

Key words: pesticide poisoning, preventive study, clinical case study, farmer's spraying practices

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Introduction

If you say you are from Japan at some international scientific congress, you will often be asked about the aftermaths of the notorious Sarin mass-poisoning incident in Tokyo in 1995 in which 12 subway passengers were killed and at least another 5,000 poisoned. In January 2008, an incident in which insecticides were deliberately added to fried Chinese dumplings was officially disclosed. In late May of that year, chloropicrin mass poisoning occurred in Kumamoto. Those incidents revealed that the threat of pesticides to the human body evidently still remains.

The Japanese Association of Rural Medicine (JARM) has continued to grapple with pesticide poisoning as a core issue for the science of rural medicine since the early 1960s. Here in this report, we will historically review past developments and look at the direction of the association's future activities.

Chemical Pesticides in the Initial Phase

Now that pesticides, which after all are biologically toxic compounds, are openly used on farms, there is the need to pay constant attention to their latent impacts on the human body and the environment.

Historically, the prototypes of organic phosphorus, most frequently used around the world today, were used for the Holocaust during World War II. Those gases include Sarin and Soman, among others. They were developed by Bayer AG. Also developed at the same time was parathion, an insecticide, that caused many poisoning deaths in Japan and many other countries in the postwar years[1].

After the end of World War II, the use of pesticides increased at a rapid pace, reducing work burdens on the part of farmers and boosting food production. In the meantime, pesticide poisoning and environmental deterioration occurred one after the other. In 1962, Rachel Carson[2] released her masterpiece *Silent Spring*, focusing worldwide attention on the adverse impacts of pesticides on the environment and so forth.

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Start of JARM Studies on Pesticides Poisoning

Faced with the frequent occurrence of pesticide poisoning in rural Japan, Dr. Wakatsuki established the Nagano Prefectural Institute of Rural Medicine in 1963 in line with the thought that "studies would be performed (even though medical scientists do not specialize in chemical poisoning itself) to prevent health disorders" [3]. With the Nagano group serving as the mother body, the Japan Rural Medicine Study Group and the Japan Institute of Rural Medicine were founded in 1965, starting animal tests in the following year.

The chronic toxicity of phenyl mercury was brought to light in animal tests. The disclosure that some of this chemical agent would turn into methyl mercury eventually led to a legal ban on the use of phenyl mercury[1].

In 1966, JARM organized the Pesticide Poisoning Study Group (PPSG) to concentrate all its efforts on research work.

Faced with rising public opinion, Japan, the United States and European nations prohibited the use of parathion around 1970. Also, the spraying of dichloro-diphenyl-trichloroethane (DDT), benzene hexachloride (BHC) and other organic chlorine insecticides was forbidden as their environmental residues were significantly high.

Field Surveys on Pesticide Sprayers

JARM-PPSG conducted nationwide surveys from 1973 to 1976 to cast light on the use of pesticides by farm workers. The survey area covered five prefectures and six districts from Tohoku in the north to Kyushu in the south.

Sugaya *et al.*[4] checked and studied the activities of groups for prevention of pesticide poisoning in Akita Prefecture. They stressed the necessity of a regular and comprehensive health screening program that includes checks on blood and hepatic and renal functions. In Nagano Prefecture, Matsushima *et al.*[5] conducted fact-finding surveys on the basis of entries made by pesticide sprayers in what was described as a "health diary" in that district of Nagano Prefecture, which specialized in the cultivation of highland vegetables. They argued that the descriptions in the diary were useful in enhancing the consciousness of farm workers about their own health management. Nagata *et al.*[6] checked into the spraying of pesticides by apple and grape cultivators in northern Nagano Prefecture. They disclosed that the use of organic phosphorus insecticides and nicotine sulfate were responsible for the outbreak of poisoning. Uchida *et al.*[7] investigated areas in Chiba Prefecture where pears and vegetables were cultivated. They reported abnormal brain waves were frequently observed among pesticide sprayers. Kato *et al.*[8] surveyed tangerine and vegetable cultivators in Mie Prefecture. They emphasized the need both for sophisticated health management for pesticide sprayers and for guidance on farm workers' nutritional intake. Takamatsu *et al.*[9] surveyed tomato, eggplant and strawberry cultivators and detected pesticide-related findings among one-third of male strawberry planters. They supported voluntary measures by farm workers moves to cut back on the use of pesticides.

All those achievements eventually led to the preparation of an all-inclusive pamphlet for the prevention of pesticide poisoning accidents, as will be elucidated later[10].

Later, efforts were also made across the nation to probe into the reality of pesticide poisoning accidents in farm work. For instance, Fukushima *et al.*[11], taking note of dichlorvos (DDVP) spraying in melon vinyl greenhouses in Shimane Prefecture, measured the concentration in the air and serum. They stressed the use of protective glasses and face covers as protective gear. Suenaga[12] investigated the consciousness of eggplant and strawberry cultivators about pesticide spraying and also whether they wore protective gear when they sprayed pesticides. He concluded that their consciousness was not necessarily high.

Dermal and Allergic Disorders caused by Pesticides

When it comes to poisoning and other disorders caused by pesticides, dermal and allergic disorders cannot be overlooked. Nomura *et al.*[13, 14] stepped up studies on diagnostic criteria and patch tests of pesticide-inducing dermal disorders, contributing to the establishment of survey methods. Matsushita *et al.*[15] surveyed and analyzed allergic contact dermatitis caused by organic phosphorous insecticides. Ueda *et al.*[16] made a generalization of farm work-related allergic diseases, pointing out that importance is attached to DDVP, chlorothalonil and benomyl, among others.

In recent years, chemical burns have drawn increasing importance to dermal disorders. Arimatsu *et al.*[17] checked into the artificial coloration of tangerines and the dermal disorders of farm workers engaged in the spraying of chemicals for the prevention of decomposition, disclosing that half of sprayers, depending on the district, suffered from dermal disorders. Horiuchi *et al.*[18] accumulated and analyzed data on pesticide-caused dermal disorders they encountered while Horiuchi was serving as a dermatologist at the Saku Central Hospital in eastern Nagano Prefecture. They argued that the outbreak of dermal disorders was on the downswing as a whole but that there were no signs of a drop in the occurrence of chemical burns, cautioning particularly about penetrative alkali burns caused by calcium polysulfide. Oyatsu *et al.*[19] assigned to the same hospital as Horiuchi, reported about debridement and skin grafting they performed as plastic surgeons for chemical burns caused by calcium polysulfide.

Contributions to Prevention of Pesticide Poisoning

When it comes to pesticide poisoning, it is important to contribute to its prevention and, in fact, a wide variety of activities have evolved in many parts of Japan for prevention. For instance, Matsushima[10] came out with a comprehensive and colorful brochure under the title of *Pesticide Poisoning and Health Management* with the cooperation of the Society for Aging-derived Disease Prevention. Nagami *et al.*[20] came across cases of chemical burns caused by calcium polysulfide and compiled a pamphlet for their prevention.

Surveys on Clinical Cases of Pesticide Poisoning

As upwards of 100 hospitals are affiliated with JARM, meaningful studies may well be performed by accumulating data on cases they have encountered.

The PPSG[21] began to survey clinical cases in 1967. The survey was continued for the next 23 years, and data on more than 3,000 clinical cases were accumulated. The PPSG[22] compiled data on 31 cases and published them in the *Journal of the Japanese Association of Rural Medicine*. Including a case of delayed neuropathy caused by the organic phosphorus insecticide leptophos reported by Nishigaki *et al.*[23], many cases that would attract the attention of medical scientists were introduced in the journal. The collection of data on those cases signifies a necessity often emphasized by Shosui Matsushima, who often says, "Even if you only collect a single case, you should probe it deeply."

As those surveys continued, it came to light that regional significant differences emerged year by year between the facilities involved in the surveys, and it was decided in 1990 to suspend them. With Toshio Matsushita[24] designated as the leader of the survey team, the PPSG resumed its research work, and a new form of questionnaire was prepared with attention focused on the effects of chronic poisoning. This form was used again in 1996 and 1997 when Matsushita[25] surveyed pesticide poisoning. Nishigaki *et al.*[26], who took over the activities, cast light on trends in pesticide poisoning between 1997 and 2003. The questionnaire form used for those surveys, however, was criticized as it contained too many detailed items to take a poll. On the other hand, this form later enabled Nagami *et al.*[27] to perform an elaborate study of paraquat poisoning around 2000.

Later, this survey was taken over by the Pesticide Poisoning Team of the Japanese Association of Rural Medicine as a special research project. With Tatsuo Shiigai serving as leader, this team came out with a simpler form of questionnaire and performed surveys from 2005 to 2007. In 2008 and subsequent years, the team has carried on its activities under the leadership of Shusuke Natsukawa[28]. For ongoing clinical studies, the team is expected to utilize the approach reported in the 1984 Report on Clinical Cases[22].

Herbicide Warfare in Vietnam War

In 1960, the United States went to war against Vietnam. Not knowing what to do with the do-or-die resistance put up by the Vietnamese liberation army, the expeditionary U.S. forces began to massively spray defoliants in 1961 in what they described as herbicide warfare. Zenzaburo Funazaki[29] joined a Japanese survey team. Serving as chief of the Fourth Japanese Fact-finding Team from November through December 1970, he joined Ton That Tung in Hanoi to conduct a joint survey and later reported about birth defects. This report had a significant impact on world opinion, and President Richard Nixon was compelled to call off herbicide warfare in the spring of 1971.

Paraquat

In Japan, attention was focused on paraquat, a non-selective herbicide, as a pesticide that could cause many deaths. At the 34th Congress of the Japanese Association of Rural Medicine, where Wakatsuki served as president, a resolution was adopted against the spraying of paraquat[30]. As the JARM membership consisted mainly of medical workers assigned to hospitals under the umbrella of the National Federation of Agricultural Cooperatives for Health and Welfare, a series of heated arguments developed between them and the pesticide users. After the discussions, the JARM released a statement (1) suggesting that paraquat should be classified as a specific poisonous substance and (2) that there should be ongoing, thorough guidance on protective gear to be utilized when using paraquat. In the face of this declaration, the makers of paraquat reduced the concentration from 25% to 5% in 1986. As deaths continued to occur after that, Ichinose *et al.*[31] and Nagami *et al.*[27] reported that the reduced concentration did not effectively drop the rate of deaths from suicide poisoning. Moreover, Nagami *et al.*[27] argued there was the need for stricter control of distribution because the curves proposed by Proudfoot *et al.*[32] in 1979 for distinction between life and death remained valid even though 30 years had since elapsed and a therapy for prevention of death from shock or multi-organ insufficiency had yet to be worked out.

Studies on Chronic Effects of Pesticides

There have been numerous studies on the chronic effects of pesticides in Western countries, including large-scale cohorts[33–35], but as things stand in Japan, very few studies

are underway.

The study of Watanabe *et al.*[36] on clinical cases with carcinogenesis is the only one reported to the JARM. Matsushita[37] and Fujita *et al.*[38] called on the Pesticide Poisoning Study Group to begin studies on the effects of chronic poisoning, but this proposal was not put into action. Natsukawa[28] has begun to survey the effects of pesticides on flower petal cultivators. It is hoped that this study will develop into an epidemiological study. The effects of exposure to pesticides are expected to be re-evaluated in relation to cancer cohorts[39], and Saku Central Hospital and Hiraka General Hospital are participating in this endeavor under the sponsorship of the National Cancer Center.

Messages to International Society

As elucidated earlier, Funazaki[29] contributed to efforts to call off herbicide warfare in Vietnam. Oura *et al.*[40] compared pesticide poisoning between Japan and China and presented in the Asian Congress of Rural Medicine. Ando *et al.*[41] reported about clinical cases of pesticide poisoning and the therapies used to treat them by members of the Japanese Association of Rural Medicine to the international journal on rural health. Moreover, Asanuma *et al.*[42] historically reviewed on pesticide poisoning in Japan — the Saku district, in particular — and on activities for the prevention of pesticide poisoning to the same journal.

Future Tasks

The Pesticide Poisoning Group under a special study project of the Japanese Association of Rural Medicine is playing a key role in studies on pesticide poisoning. One of the main tasks concerns a survey done on clinical cases of pesticide poisoning with the cooperation of many JARM research workers, and this survey is expected to develop further in the future. Moreover, there are calls for realization of a philosophy that penetrates Matsushima's admonition, "Even if you only collect a single case, you should probe it deeply."

As JARM members, many research workers have strived to start epidemiological studies on the chronic effects of pesticides, only to fail. It is hoped that the survey that Natsukawa has just begun on flower petal cultivators will serve as the key that may pave the way for the start of epidemiological studies by the JARM.

The nervous and mental disorders caused by organic phosphate and other insecticides — above all, the developmental disorders of infants — have become the talk of the medical community in recent years. There is a need to establish a system under which they may be brought to light, along with neonicotinoid and other relatively new insecticides.

Pesticide poisoning will continue to be a grave issue for Asian countries. It may be difficult to perform epidemiological studies on the chronic effects of pesticides in this region, therefore the JARM have to contribute to such studies. Coordination not just with activities of the Asian Association of Rural Medicine but also with WHO surveys on clinical cases[43, 44], FAO's Community Integrated Pest Management (CIPM)[45, 46] and other international organizations must also be taken into account.

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