HUMAN HEALTH AND SAFETY PROBLEMS IN CALIFORNIA
IN THE USE OF METHOMYL AS A PESTICIDE WHEN
FORMULATED AS A POWDER CONTAINING 90% ACTIVE INGREDIENTS

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In June 1971, methomyl (as produced by DuPont under the trade name of Lannate) was first given registration in California as a pesticide in a powder formulation containing 90% active ingredients. This chemical is a carbamate with the formula S-methyl N-[(methylcarbamoyl)oxy]thioacetimidate. The preparation as distributed for sale was a fluffy powder packaged in 2-pound amounts in plastic jars and in 10-pound amounts in round paperboard cartons.

This product when used as a pesticide was particularly effective against leaf-eating larval forms of insects. The pesticide as sold was labeled with safety warnings that pointed out the need for gloves, respirators and goggles while handling the product. Since this product was not an organophosphate, many users assumed a rather casual attitude toward the safety warnings the first time they worked with this new product.

Lannate proved to be very difficult to work with safely in the out-of-doors. The powder blew about in the slightest breeze or it billowed up and out in all directions even if there was no air movement during the process of transferring powder from the containers into the mixing tank water. The 10-pound drum was equipped by the manufacturer with a long plastic sleeve to get the powder closer to the water or under the water; this resulted in only slightly reduced problems from airborne particles of pesticide.

ACF 59-029 Sept 1, 1976

After mixing even relatively small amounts of the powder, it would accumulate on the face of the person doing the mixing. A respirator and goggles were fairly effective protective mechanisms for short periods of time, but even then, when sweating occurred, the powder on the face was carried by the sweat under the respirator and the goggles resulting in a burning sensation in the eyes and nose. This kind of exposure, in spite of the safety equipment, led to a number of poisonings. When the eyes, nose, and mouth were not protected, toxic amounts of methomyl could easily be taken into the body. Transport through the intact skin did not appear to be a problem before or after the pesticide was mixed with water.

Persons who mixed this powder into water proved to be at high risk of becoming poisoned. Pilots, tractor drivers, and truck drivers sometimes also became ill from exposure, but in almost all cases they were near a mixing tank when the mixing process was underway. Once the pesticide was mixed, there were few poisoning problems.

From June through December 1971 numerous poisonings of persons occurred, probably numbering more than the 107 cases counted. No fatalities were reported. Cases were reported to us by physicians, the State Health Department, local health departments, county agricultural commissioners, our agricultural inspectors in the field, and pesticide applicators.

The manufacturer was notified in August 1971 of the problem and its staff immediately began studies on different formulation procedures and field trials of the newly prepared products.

More information on the safe handling of this product was disseminated to applicators by the manufacturer and by our Department, and this product was reregistered for use in 1972. However, again in 1972,

reports from various sources indicated that clinically significant poisonings of at least 118 persons within 12 months were seen by physicians throughout the State. Interviews with applicators also revealed that many low-grade poisonings probably occurred that resulted in mild symptoms such as miosis and nausea; in these cases the pesticide handler usually quit work for the day or avoided further exposure to methomyl and the symptoms subsided; seldom was a physician consulted. We know of no fatalities during the 1972 season, even though some of the poisonings were rather severe.

The toxicity of methomyl is related to the inhibition of blood and tissue cholinesterases. Poisoning results from accumulation of excessive amounts of acetylcholine in affected organs. In this series of cases, symptoms usually developed within a few minutes to up to an hour after exposure of the face area to the dust, and the severity of the poisoning appeared to depend upon the dosage. Exposure seemed to be primarily by inhalation, but exposure through the eyes occurred in some cases. It was thought that oral exposure other than mouth breathing probably was a minimal factor in these cases. Absorption through the intact skin exposed to powder was also probably of minimal importance in these cases. The LD50's in mg. per kg. for methomyl are about: oral 25 (rats) and dermal (rabbits) more than 5000. The acute inhalation toxicity to rats for methomyl tested as a mist revealed an approximate lethal concentration to be 0.30 mg. per litre in air.

Information came to our attention that numerous persons had become ill in Arizona while attempting to mix the dry formulations of Lannate in 1971 and 1972.

Late in 1972, the California Department of Food and Agriculture notified the DuPont Company that it appeared that the registration of

Lannate should not be renewed in 1973 until a formulation safer for workers to handle was developed. Another pesticide manufacturer (Shell) at that time applied for registration of a similar powder formulation of methomyl (Nudrin); this registration was denied.

The Department at that time summarized its position against further registration of the dry powder form of methomyl as follows:

1. The use of this pesticide would increase substantially because of its efficacy against certain pests.
2. Applicators and their employees who had not previously used this product would have first-time experiences with it; many poisonings could be anticipated. Even for those who had become aware from past experience of the hazards of using this pesticide, with careful attention to safety, previously poisoned persons might still be poisoned again.
3. It was recognized that personnel who mix pesticides are often short-time employees who are difficult to reach with safety programs. It was noted that those persons who undergo a poisoning episode often quit and do not stay around a firm to be a part of the staff that has learned by experience the need for specific kinds of safety procedures for specific pesticides.
4. Although the proper use of respirators and goggles minimized the risk of poisoning, it was apparent there had yet to appear on the market a mask that protects the eyes, nose, and mouth that could be worn comfortably under the extremes of summer heat often experienced in California. Currently available equipment could not be worn comfortably for more than a few minutes when the air temperature was above 85° F. When the protective mask was taken off, the face had to be thoroughly washed immediately

with soap and water to remove the powder. The mask and goggles had to also be washed to remove the toxic dust. It was not logical to expect this sequence of safety procedures to be accomplished repeatedly and adequately under field conditions.

5. The formulation of methomyl into pesticides that could be handled safely in the field appeared to be possible and practical. There were substitute pesticides that could be used for pest control in case reformulation was not possible.

The two manufacturers soon presented data on liquid formulations for two new pesticides containing methomyl, Lannate L and Nudrin; these were registered for use early in 1973 and the containers of Lannate powder were scheduled for phasing out at the earliest possible date.

Since the introduction of liquid formulations of methomyl on the market, the reduction of the number of human illnesses in California attributable to exposure of users to methomyl has been dramatic. The exposure of eyes, nose, and mouth to the dust has been eliminated. The oral toxicity of the liquid formulations to rats is about 100 mg. per kg. The dermal toxicity rating of the liquid formulations is greater than 5000 mg. per kg. so the dermal exposures are considered to be of little importance as an illness factor. The few methomyl poisonings now seen (fewer than 10 cases per year) usually are cases involving inhalation of the diluted pesticide in a spray mist by flaggers standing in the line of flight, by pilots flying back through part of a previously applied swath, or tractor-driver applicators driving back into spray mist after making an end-of-field turn. A few cases have been attributed to persons looking into the mix tank without eye protection and having liquid pesticide splash into the eyes.

In certain situations such as treatment of cotton in the extremely

hot midsummer weather of the Imperial Valley with a pesticide mix made from one of the liquid preparations of methomyl, there have been suggestions that there are some phytotoxicity problems, presumably related to the solvent used. This has led one of the manufacturers (DuPont) to develop a water-soluble packet containing methomyl powder. The packets are prepared for use in several different sizes. They are inside an air-tight aluminum foil outer packet. These outer packets are torn open so that the inner packet can be dropped into a mix tank where the package dissolves without any exposure of the mixer-loader to the pesticide. This special-packaged form of dry methomyl powder was registered for use in 1974 and is undergoing additional evaluation. The only problem to date has been a manufacturing problem that can lead to tearing open the inner packet and releasing the dust when the outer packet is opened.

Signs and symptoms of methomyl poisoning reported by physicians in California in the 1972-1973 series of cases included the following: Miosis, blurred vision, extensive sweating, muscle weakness, restlessness, difficulty in walking, tiredness, muscle tremors, bradycardia, severe abdominal cramps, diarrhea, nausea, vomiting, light-headedness, tremors, headache, excess salivation, tenseness, clenched fists, incoherence, and general depression. When blood samples were drawn during the acute phase of the illness and promptly analyzed, cholinesterase depression was found to have occurred. The physicians usually used injections of large doses of atropine sulfate for treatment. Response to treatment was very good and hospitalization usually was not necessary.

Sometimes methomyl formulations are mixed with an organophosphate pesticide such as phosdrin, parathion, methyl parathion or Guthion. To the physician newly established in rural areas, a presumed poisoning of

a mixer-loader following exposure to this type of pesticide mixture presents a diagnostic and a therapeutic challenge. The most probable mode of exposure is important for him to determine in these cases. Usually there is a history of a recent spill on the skin. Most of these episodes are eventually attributable almost entirely to the organophosphate which in liquid formulations usually has a dermal toxicity rating in a very dangerous range as opposed to the relatively safe range of dermal toxicity for liquid preparations of methomyl. The time of onset following a known exposure is important for the physician to determine. Signs and symptoms following methomyl exposure usually occur in a few minutes to up to an hour at most. Symptoms from organophosphate poisoning, depending on the chemical compound, may occur almost immediately or as late as 12 hours after exposure. Onset of symptoms of dermal exposures to organophosphates of the parathion type usually falls in this latter time range.

Exposure of mammals, including man, to methomyl can produce profound depression of serum cholinesterase but this is usually reversed within four hours. Blood must be collected and tests for this enzyme must be completed very promptly or the depression due to methomyl exposure will not be detected. The test methods for this enzyme that involve measurements of pH that are generally used for monitoring exposure to organophosphates are not very satisfactory to detect effects of methomyl exposure. The Ellman test method appears to be better to detect the immediate effects on cholinesterase produced by methomyl; also, this method will detect any effects on cholinesterase produced by organophosphate exposure. Cholinesterase levels usually will return to normal in four hours when the only exposure has been to methomyl. After an exposure of a person to an organophosphate that leads to clinical illness, the

inhibition is not easily reversible, if at all, and it frequently takes more than a month for cholinesterases to return to normal, particularly the red-cell cholinesterase. Atropine sulfate is very effective for treatment of both carbamate and organophosphate poisonings. Studies by DuPont on laboratory animals have shown that the use of 2 PAM (pyridine-2-aldoximine methiodide) is contraindicated in the treatment of poisoning by methomyl. In contrast, 2-PAM is very useful for organophosphate poisoning. It is important for the physician to recognize this difference in antidote action.

SUMMARY

More than 225 poisonings of persons were treated by physicians in 1972 and 1973 in California following exposure to dry formulations of methomyl (Lannate). There were no known fatalities. The route of entry of the dry chemical powder to the body was through eyes, nose, and mouth; inhalation of the powder appeared to be the major problem. The person who mixed the powder into water was at high risk. After the pesticide was reformulated and marketed as a liquid and the use of the dry powder was stopped, there was a dramatic drop in the number of illnesses due to methomyl exposure to fewer than 10 cases per year. Some cases of poisoning still occur when applicators inhale methomyl spray. Recently a dry methomyl preparation has been registered with the powder packaged in water-soluble packets. These packets are dropped into and dissolve in mix tank without exposure of the mixer-loader to billowing pesticide powder.