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Occupational Disease of Farm Workers

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In California, the agricultural industry experiences the highest occupational disease rate—over 50% higher than the industry in second place, and almost three times as high as the average rate of all industries.

A number of converging circumstances may explain this experience. First are the formidable hazards both new and old on the farm. Second, it is much more difficult to control hazards in orchards and fields than within the four walls of industrial plants. Third, agricultural workers, because of migrant status, seasonal work, language barriers, substandard education, marginal health, and poor hygiene, are the least able of any group to protect themselves against occupational hazards so require more safety supervision than other categories of workers. Fourth, the rapidly advancing technological changes in agriculture have left the industry behind in dealing with occupational hazards, particularly with agricultural chemicals. Concepts in industrial hygiene and industrial medicine commonly used for many years in other industries have not been employed or adapted to the agricultural setting. Such commonplace needs as clean drinking water, wash water, and sanitary facilities are rarely available in the fields and are notably deficient in many living quarters of farm laborers. Yet, both water and soap are vital to the prevention of the most prevalent and most serious occupational diseases occurring on the farm.

In California, in 1962, about 230,000 farm workers were employed *; 83 of them died from occupational causes.[1] In seven instances, the death was attributed to an occupational disease, in the remainder, to a work injury. From 1955 to 1962 inclusive, 29 deaths from occupational disease among farm workers were recorded. Eleven were attributed to heat stroke, four to poisoning from organic phosphate pesticides, and four to tetanus. The remainder were due to miscellaneous causes.

In 1962, there were 2,696 reports of nonfatal occupational disease[2] among agricultural workers, most in farm laborers. Dermatitis, pesticide poisoning, food poisoning, and heat stroke or exhaustion were reported most frequently. Judging from the number and seriousness of fatal and nonfatal occupational disease, heat stroke and pesticide poisoning should be considered the most formidable occupational diseases occurring in agriculture in California. Of the pesticides, it is the highly toxic group of phosphate esters, such as parathion, (O,O-diethyl O-[p-nitrophenyl] phosphorothioate). Thimet (O,-

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* Self-employed farm workers who make up about one third of the total persons working on farms are not included. Their occupational injuries and occupational diseases are not reported and, therefore, not included here.

O-diethyl-S [methylthioethyl] phosphorodithioate), Phosdrin (alpha isomer of 2-carbomethoxy-1-methyl-vinyldimethyl phosphate), Demeton (O,O-diethyl O-[2-(ethylthio)ethyl]-phosphorothioate and O,O-diethyl S-[2-(ethylthio)ethyl] phosphorothioate in 2:1 ratio), and tetraethyl pyrophosphate (TEPP) which present the greatest hazard. Their toxic effects are due to cholinesterase inhibition.

Examples of Occupational Diseases Occurring in California

Example 1.—A young sprayer was found dead in the field in the tractor which had been pulling his spray-rig. He had been pouring and mixing parathion concentrate into the spray-rig tank. Parathion is the most commonly used of the highly toxic phosphate ester pesticides. The estimated fatal dose is about 9 drops orally and 32 drops dermally. In the process of mixing the concentrate, the worker contaminated his gloves inside and out. He rested his gloved hands on his trousers as he pulled the rig to apply the spray. Parathion was absorbed through the skin of his hands and thighs. He began to vomit, an early symptom of parathion poisoning. He could not remove his respirator and he aspirated the vomitus. The diagnosis of poisoning was confirmed by postmortem cholinesterase tests.

Example 2.—About 50 agricultural laborers were picking grapes. In the afternoon, about the same time, all suffered a sudden acute attack of nausea, vomiting, acute abdominal cramps, diarrhea, and about half went into shock. They recovered rapidly and were well in a few days. The physician who first saw them thought that phosphate ester pesticide poisoning was the most likely cause of the outbreak. However, subsequent investigation revealed that no pesticide had been applied to the grapes, but luncheon sandwiches had been left in the field in the hot sun for sometime before eating. Unfortunately, no food was available for examination nor were cholinesterase tests determined for the workers, so that the diagnosis will never be confirmed. However, the clinical course of events is more suggestive of staphylococcal food poisoning. All who ate the sandwiches experienced the same acute symptoms at the same short interval after eating. The kind of phosphate ester poisoning occurring among pickers is not so abrupt in onset, usually does not find the total crew sick in the same degree at the same time, and symptoms and signs of cholinesterase inhibition, in addition to those referable to the gastrointestinal tract, are in evidence—headache, giddiness, blurred vision, sweating, difficult breathing, pinpoint pupils, and muscle twitching, for example.

Example 3.—A 22-year-old field laborer was harvesting seed. In the process, he lacerated his finger in the seed separating machine; ten days later he died of tetanus shortly after admission to a hospital where he was taken because of seizures.

Example 4.—A 16-year-old and a 21-year-old farm laborer were hired to apply a pesticide dust consisting of a 1.5% phosphate ester and a 10% sulfur mixture to strawberries. The estimated adult fatal dose for this phosphate ester pesticide is five drops orally and six drops dermally. The workers used knapsack dusters, starting work at 7:30 AM. At noon, the 21-year-old worker became ill and remained at the side of the field in his car and vomited. After a while, he felt better and drove home. Fortunately, he did not have an auto accident. Workers with phosphate ester poisoning are poor risks with any moving machinery. The 16-year-old worked until 4 PM when he vomited and went home. At 8 PM, he complained of weakness and giddiness and was taken to a physician's office. The boy's clothing was reported to have been covered with sulfur. The physician called the Poison Information Center for information about sulfur which is relatively nontoxic. The boy was sent home with a prescription. At 9:30 PM, the boy became worse and was taken to the local hospital. This time, the label from the pesticide container was brought with the patient. The boy was again sent home although he was unable

to walk. At 7:30 AM the boy was found moribund in his bed, still in his contaminated work clothing. He died in the ambulance en route to the hospital. Death due to phosphate ester poisoning was confirmed by postmortem cholinesterase tests.

The 21-year-old worker, although asymptomatic, reported the next day for a cholinesterase test which confirmed that he had been poisoned by a phosphate ester chemical. He had not worked with phosphate ester pesticides before. The 16-year-old had applied the same pesticide on one occasion two months before.

There were a number of errors committed in the series of events leading to this death: The permit to purchase and apply the pesticide had expired so that it was purchased and applied illegally. The highly toxic phosphate ester was applied by hand duster, a primitive and entirely unsafe method of application. The container label was not read until after the second illness. No medical supervision was provided. No advance arrangements were made with a physician for prompt adequate care in an emergency. The two workers were not instructed about hazards and precautions for using the pesticide. They were not provided with protective clothing. No medical attention was sought for the worker who quit at noon because of illness, and no medical examination was considered for the younger employee who kept on working. The victim was not told to bathe, wash his hair, and change into clean clothes after work. When the boy was taken to a physician, no one could provide information about the pesticide which the workers had applied.

On first visit, the physician released the victim as only mildly ill without ruling out serious poisoning. He should have insisted on seeing a label from the pesticide container. On second visit, the physician was furnished the label but did not follow the medical treatment recommended on it. He may have been confused by two entirely different doses of atropine prescribed. The label listed the large doses which should have been administered, but also listed the conventional dose of atropine by tablet for first aid (the practice of recommending tablets for first aid should be discontinued for reasons demonstrated here and in example 6 which follows). The physician did not call a consultant or the Poison Information Center for information about the pesticide mixture listed on the label. The boy was not kept under close medical observation for 24 hours. He was not decontaminated, and no cholinesterase determination was made.

The supplier of the pesticide did not check the number of permit given by the purchaser to assure that the permit was valid. The product was also misbranded, it contained two to four times the phosphate ester pesticide specified on the label.

This case is something of a classic in that just about every error possible occurred, and avoidance of any one of the more serious errors could have saved the boy.

Example 5.—A farm tractor driver was hospitalized with critical burns of both eyes when ammonia under pressure escaped from a leaky valve on a fertilizer applicator.

Example 6.—A young man came to work as a swamper for an agricultural aircraft operator, and the first day, was put to work steam-cleaning and washing a crop-dusting aircraft. It was reported that he was not informed of any hazard nor was he given any protective clothing or equipment. His clothing was observed to have been thoroughly wet while he was working. In the early afternoon, he complained of not feeling well. His employer gave him two atropine tablets and the swamper returned to work. Not long afterwards, he was found unconscious. He was admitted to the hospital and died several hours later. Apparently, the aircraft he was cleaning had been used to make several applications of one of the highly toxic phosphate ester pesticides. The diagnosis of phosphate ester pesticide poisoning was confirmed by postmortem cholinesterase tests.

Example 7.—Because of engine trouble, an agricultural aircraft pilot attempted a forced landing in an unplanted field. The plane rolled into a fence and turned over. The hopper of the airplane contained a dust formulation of TEPP, another of the phos-

phate ester pesticides. The estimated adult fatal dose for TEPP concentrate is one drop orally or dermally. The pilot was not injured but was covered with dust. He walked a distance of 50 ft to a field worker, stated he felt fine, and asked for a drink of water. After drinking the water, he began to vomit and almost immediately became unconscious. By the time the ambulance arrived, the pilot was dead and the ambulance driver, the pathologist, and the mortician became ill from handling the body.[3]

Example 8.—Although this example is not an occupational disease, it is included to illustrate that poisoning of children can result from the same mistakes in handling farm chemicals that lead to occupational disease. An 18-month-old child of an agricultural aircraft pilot was found at home in a state of acute respiratory distress, semiconscious, and with pinpoint pupils. In the hospital, she was placed in a resuscitator and treated by a skilled physician for severe organic phosphate poisoning from which she recovered. On the morning of the illness, her father had come home after applying a highly toxic phosphate ester pesticide. He was reported to have cleaned his boots with paper towels and then threw the towels in the wastebasket and placed his boots in the bathroom. The child either contacted the boots or the paper in the wastebasket.

In connection with these three examples of poisoning arising from the agricultural aircraft operations, it is of interest to note that there is no group inside or outside agriculture which has experienced a more formidable record of occupational injury and disease than the agricultural aircraft industry. This group has taken the brunt of the technological demands of agriculture in the application of pesticides. Pesticides are applied by air to about half the acreage treated for pest control in California. Since this state uses over 20% of the nation's pesticides, its agricultural aircraft pilots apply about 10% to 15% of the nation's pesticides, but at a price. One pilot is killed in an air accident for each million acres treated (53 pilots killed and 54 million acres treated in California, 1950 to 1961, inclusive. The number of licensed agricultural pilots rose from just over 300 in 1950 to 700 in 1961). In addition to the highest fatal injury rate of any occupation on record in California, agricultural aircraft is unique in another respect—over half its disabling work injuries are due to pesticide poisoning. For most industries, occupational disease accounts for 5% or less of total work injuries. However, considering the amount of pesticides and other agricultural chemicals applied by this industry, the cost in occupational disease is considerably less than among farmers and ground applicators who apply the other half of these chemicals.

Example 9.—Two young milkers in a dairy became ill with brucellosis within two months of each other. Both workers complained of gradual onset of fatigue, fever, headache, and overwhelming fatigue. Lymphadenopathy was prominent in the younger victim who was not as ill as the second worker who was hospitalized for several weeks.

Example 10.—Beginning in 1949, there have been at least six sizable episodes reported where outbreaks of parathion poisoning occurred among farm workers picking fruit (oranges, peaches, pears, grapefruit, grapes, olives). In 1959, about 275 orange pickers were poisoned in a series of outbreaks. The interval between application of pesticides and the harvest of edible crops is predicated on the time when the pesticide residue on the crop will be below legal tolerance (1 ppm for parathion) and thus considered safe for market. It had been assumed that by this time, the parathion would have declined sufficiently to make the orchards safe for the workers. This assumption was obviously incorrect under certain circumstances not understood until recently. In August of 1963, over 90 peach pickers became sufficiently ill with parathion poisoning over a period of several days to seek medical attention. Although most of the 90 cases were mild or moderate, about one third were hospitalized and there was one death. Of the approximately 5,000-6,000 pickers in the area, 70 were selected at random and tested during the outbreak. About half of the 70

workers showed significant reduction of cholinesterase levels but were either asymptomatic or had not sought medical aid for symptoms. Leaf and fruit samples and spray schedules were obtained, both in the dozen orchards involved in the outbreak and in orchards not involved. It became obvious that the unusually heavy spraying with parathion during the spring and summer to combat the oriental fruit moth had resulted in a heavy deposit on the leaves in the orchards producing illness. Because the leaves had a greater surface area, they had collected more pesticide than the fruit. This study confirmed the earlier contention of Quinby and Lemmon [4] and others that dermal exposure from the leaves of the heavy foliage was the most likely source of the problem. However, the heavy spraying schedules were the clue to why there was excessive residue on the leaves, but the amount of residue did not account sufficiently for the occurrence of poisonings. The presence of more toxic breakdown products of parathion, such as Paraoxon (diethyl *p*-nitrophenyl phosphate), is strongly suspected.

Example 11.—A young farm worker fainted in a bar after one glass of beer. Because of the peculiar bluish-red color of his face and neck, a physician was called who hospitalized the victim. He recovered in about four hours. Inquiries were made to determine the nature of the black powder which covered the workman's clothing. It was found to be a fertilizer, calcium cyanamide. When it is inhaled or taken orally at the same time as alcohol, sudden systemic effects, manifest by headache, shivering, staggering, and dyspnea become evident. If enough alcohol is taken, serious pulmonary complications may develop, otherwise, the victim recovers in a few hours. The peculiar color of the skin is apparently due to cyanhemoglobin or cyanhematin.

Example 12.—Twenty-five farm laborers planting cotton in the hot San Joaquin Valley became suddenly ill with the nausea, headaches, giddiness, blurred vision, sweating, and other symptoms typical of phosphate ester poisoning. They had been unloading bags of Thimet-treated cotton seeds from trucks, loading the planters, and piling and burning the empty bags. No washing facilities or protective clothing were available to these workers. Protective clothing to prevent skin absorption of this highly toxic pesticide must be air cooled to be feasible in 105 F weather. The estimated adult fatal dose of Thimet is three drops orally and nine drops dermally. Here is a situation which calls for industrial hygiene engineering controls to alter the work processes to make feasible a safer handling procedure.

Example 13.—A 15-year-old farm laborer was tipping grape vines on a 105 F July day in the San Joaquin Valley. He complained of nausea, dizziness, headache, excessive sweating, and numbness of both arms. He developed severe muscle cramps and fell to the ground. He was taken to the emergency room of a nearby hospital where extreme pallor, and elevation of temperature, respiration, and pulse were noted. The patient responded well to ice packs, fluids, and bed rest. This worker had suffered a heat stroke. He had no water or salt provided in the field.

Many other examples of occupational disease on the farm could be presented to illustrate the variety of serious and growing problems facing the farmer, his employees, and their physicians. It is important to emphasize the new and growing occupational and rural health problems arising from the use of pesticides and other agricultural chemicals. Health hazards which have been a problem on the farm for hundreds of years are also present today—heat stroke and tetanus, for example. These problems require that physicians serving agricultural areas possess skills in toxicology and occupational medicine to serve their communities adequately. These demands are formidable enough without the addition of several hundred different farm chemicals calling for expert knowledge in industrial toxicology. However, four suggestions should be of considerable assistance in facing this task. First, every physician in an agricultural area should have on his desk the *Clinical Handbook on*

Economic Poisons, Emergency Information for Treating Poisons.[5]

Second, each physician should be prepared to recognize and treat adequately poisoning from the phosphate ester anticholinesterase pesticides mentioned above. Poisoning from this group of chemicals is by far the most prevalent and most serious, accounting for over 70% of pesticide poisonings among farm workers. The effectiveness of the antidotes and other treatment is such that medicine has much to offer in treatment. Victims who have absorbed several times the fatal dose can be saved with prompt and adequate medical management.

Third, the physician must know how to identify a pesticide properly. Inadequate identification of chemicals to which workers have been exposed is the most common difficulty noted in reviewing the physicians' reports of occupational disease from chemicals in California. Several hundred commonly used pesticides have markedly different effects which require different kinds of treatment. The important initial distinction is whether or not a pesticide is a phosphate ester anticholinesterase agent. If it is, treatment is specific and very effective and the cholinesterase test for red cells and plasma should be carried out. For almost all other kinds of farm chemicals, treatment of poisoning is largely symptomatic and there are few laboratory tests available to assist in diagnosis. The treatment for phosphate ester pesticide poisoning is of little or no value for poisoning from other kinds of chemicals and is contraindicated for some (example: atropine sulfate is contraindicated in pentachlorophenol poisoning). A common mistake is to assume that a farm chemical is a phosphate ester when it is not.

Identification of a chemical to which a worker has been exposed often requires considerable ingenuity on the part of the physician. Taking the worker's word for it can be misleading. Checking with the employer and obtaining the label from the pesticide container, as well as finding out exactly how and when the exposure took place, is the basis for a valid diagnosis. The label on the original container will list the chemical ingredients in the formulation which can then be checked for toxicological data with the Poison Information Center, in a text such as *Clinical Toxicology of Commercial Products, Acute Poisoning, Home and Farm,*[6] or the handbook previously recommended. Medical consultants in agricultural toxicology are rare but available through the larger companies manufacturing farm chemicals. It is important to consider all of the ingredients in a pesticide formulation. Sometimes, the solvent in which the pesticide is mixed is also a toxicological consideration. When the label is not available, sources of help include farm and health agencies such as the Agricultural Commissioner, state or local health or labor departments, and farm advisers. Physicians should learn what hazardous pesticides are used in the community and where and when exposures to these chemicals may be occurring so that they are better prepared to deal with poisoning emergencies as well as offer advice about prevention.

Fourth, physicians should recognize that the most important service they can perform is in the prevention of occupational disease from farm chemicals. There are several different methods. Physicians can provide good medical supervision for groups of farm workers. For example, in California agriculture, all workers regularly using the toxic group of phosphate ester pesticides must be medically supervised.[7] The minimal legal requirement for medical supervision consists of: (*a*) advance planning for prompt care of any emergency, (*b*) arranging for and interpreting the baseline and periodic cholinesterase tests so that excessive exposure is detected and corrected before illness occurs, and (*c*) deciding when workers must be removed from exposure to phosphate ester pesticides and when they may return to work after a poisoning episode or after a significant reduction in cholinesterase activity.

Physicians can provide educational information for farmers who are their patients. Physicians can speak to various community groups on farm safety, and physicians can cooperate with the appropriate local agricul-

tural, safety, and health agencies so that adequate health considerations are taken into account in educational and regulatory affairs of agencies concerned with the use and control of pesticides.

Summary

In California, agriculture experiences the highest occupational disease rate of any industry—three times as high as the average of all industries. A number of converging circumstances may explain this. First, there are formidable hazards both new and old on the farm. Second, it is much more difficult to control hazards in orchards and fields than within an industrial plant. Third, agricultural workers need more safety supervision than other categories of workers. Because of migrant status, seasonal work, language barriers, substandard education, marginal health, and poor hygiene, they are the least able of any group to protect themselves against occupational hazards, particularly agricultural chemicals. Concepts in industrial hygiene and industrial medicine commonly used for many years in other industries have not been employed nor adapted to the agricultural setting. Such commonplace needs as clean drinking water, wash water, and sanitary facilities are rarely available in the fields, and are notably deficient in many of the living quarters of farm laborers. Yet, water and soap are vital to the prevention of the most serious occupational diseases occurring on the farm.

In 1962, in California, there were about 2,700 reports of nonfatal occupational disease coming from 230,000 farm employees. Dermatitis, pesticide poisoning, food poisoning, and heat stroke were most frequently reported. From 1955 to 1962, a total of 29 cases of fatal occupational disease were reported—11 attributed to heat stroke, 4 attributed to pesticide poisoning, and 4 from tetanus. The remainder were attributed to miscellaneous causes. Judging from the seriousness and number of reports, heat stroke and pesticide poisoning are the most formidable occupational diseases in California agriculture.

Examples of various occupational diseases occurring on the farm are presented to illustrate the serious and complex health problems entailed in the production of food and fiber.

Physicians in farm areas can become the industrial physicians for agriculture and help prevent occupational disease and injury. Four specific suggestions are offered to the rural physician to assist him with pesticide poisoning problems: he should possess the *Clinical Handbook on Economic Poisons*[5]; he should know how to identify the offending pesticide when confronted with a poisoning emergency; he should become skilled in the recognition and treatment of phosphate ester poisoning; and he should be prepared to provide good medical supervision for employees working with pesticides.

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