
Public Health Concerns in the Exposure of Grape Pickers to High Pesticide Residues in Madera County, Calif., September 1976

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MOST OF THE 47,000 RESIDENTS OF MADERA COUNTY in the fertile San Joaquin Valley of California are engaged in agriculture or depend on it indirectly for their livelihood. The county's population swells in the growing and harvesting seasons as migrant workers, among them several thousand illegal aliens, come to work in the fields. During the summer and fall, the sheriff's deputies and border patrolmen pick up hundreds of illegal aliens who are sent back to Mexico; many, however, return to the county in a few days.

Several varieties of grapes for wine and table use as well as raisins are produced in Madera County. Aided by chemical fertilizers and pesticides, grape production has increased markedly. The growers rely heavily on organophosphorus pesticides that are highly toxic to human beings—even in the diluted solutions that are sprayed in aerial and ground applications on the grape foliage, usually in late July.

In California, the licensing and control of pesticide applications to crops are regulated by the Department of Food and Agriculture at the State level and by the county agriculture commissioner at the local level (California Administrative Code, Title 3, ch. 4, subch. 1, Group 2, Article 23). To protect field-

workers from harmful exposure, the county agriculture commissioner advises the grower of the proper interval after spraying before workers may safely enter the fields. The grower is required to post re-entry dates conspicuously on the borders of sprayed fields so that workers are informed. Every employer who uses organophosphorous compounds is required to have an emergency medical plan, including arrangements for proper medical care of workers who are accidentally exposed to harmful levels of pesticides.

Re-entry date, the emergency medical arrangements, the fields and crops to be treated, the pesticide, and numerous environmental factors (for example, wind drift or presence of specific hazards to neighboring animals or crops) are reviewed before the agriculture commissioner issues a pesticide spraying permit to a grower. Kahn (1) has pointed out that, even with these safeguards, during the harvest season numerous pickers are poisoned by toxic pesticide residues on various fruit crops throughout the San Joaquin Valley. Davies and associates (2) have pointed out the impracticality of monitoring pre-entry blood cholinesterase levels when large numbers of agricultural fieldworkers are involved.

The Madera Incident

About 9:30 pm on September 9, 1976, Dr. A, a private practitioner in Madera, called the health officer to report that he had already treated in his office that

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evening 25 field hands from a 2,300 acre vineyard, and he now had another large group of workers, brought in by the same labor contractor, who were suffering from nausea, vomiting, dizziness, and weakness. They appeared to be suffering from chemical poisoning. They responded favorably to Tigan and atropine; no hospitalization was necessary.

Following the conversation with Dr. A, the health officer called the physician at the emergency room of the community hospital, who affirmed that a number of fieldworkers had been treated for nausea, vomiting, and weakness on September 8 and 9. Further questioning revealed that 15 workers had been seen on September 8, and 2 of these were hospitalized; 9 had been seen the next day, but none were hospitalized. At 11 pm on September 9, with this information at hand, the health officer notified the county agriculture commissioner, and arrangements were made to begin a joint investigation at the vineyard the next morning.

Investigation. About 9:30 am on September 10, we visited the fields where the pickers who became ill had worked the previous day. A crew of pickers had been removed from one of the suspected fields just before we arrived because two workers had become ill. The ranch foreman reported that no pesticide had been used since the applications of dialifor (Torak) and phosalone (Zolone) in July. Samples of fruit and foliage were obtained, and the fields were closed until tests for residues of these compounds could be run.

Possible contamination of the workers' food and water with pesticides was ruled out in the subsequent investigation, although it was likely that many pickers had eaten unwashed grapes on September 9. The owner was advised not to send workers who had been ill into fields where organophosphorus compounds had ever been used. The California Department of Food and Agriculture and the State health department were notified of the incident, and these agencies sent professional and technical manpower and a mobile laboratory to Madera to aid in the followup study.

On September 11, arrangements were made with the labor contractor for the State team to obtain blood samples from consenting workers when they came to get their pay checks. These blood samples were taken to a State laboratory in Sacramento, where results of blood analyses confirmed significantly (less than 80 percent of normal value) depressed plasma and red blood cell cholinesterase levels among all 19 workers tested. On September 15, the vineyard owner was ordered not to harvest grapes from two suspected

fields and to provide medical supervision for all hand-pickers. This care, begun on September 16, included a cholinesterase blood test and medical examination for signs and symptoms of pesticide poisoning. The Madera County Health Department provided a mobile examining unit and a public health nurse, who drew 85 blood samples that were analyzed at the State laboratory.

On September 17, the owner secured the services of a Fresno private practitioner, Dr. C., who assumed the field medical supervision of the workers, and subsequent blood samples were sent to an approved biomedical laboratory in Fresno. By September 22, residual pesticide levels on foliage were low enough to allow harvesting of one quarantined field, but workers with dangerously depressed (less than 80 percent normal) cholinesterase levels were not allowed to harvest grapes by hand. On October 1, 117 rows of the second field were released for picking, but the foliage on the remaining 137 rows was found to have a residue of the pesticide Torak of 73.8 ppm. Hand harvesting of these remaining rows was not authorized because of the high risk of further illness among exposed workers. However, the owner was given permission to machine harvest the remaining grapes on October 5.

Results. Checks with the hospital and the emergency room and private physicians' offices and field interviews with the workers revealed that approximately 108 of a crew of 120 grape pickers became ill with pesticide-related symptoms on September 8 and 9. Of these 108 pickers, 75 (including 2 hospitalized) were treated on those dates (table 1) and 33 did not seek medical attention. On September 10, two additional workers were treated at the emergency room and possibly six others at Dr. A's office. Some of the six workers might have been treated previously on

Table 1. Treatment of 86 grape pickers by physicians, Madera County, Calif., September 1976

Date	Place treated			
	Hospital emergency room	Dr. A's office	Dr. B's office	Dr. C's office
September 8	15 (2)	...	...	...
September 9	9 (0)	49 (0)	...	...
September 10	2 (1)	6 (0)	...	...
September 15 . . . .	...	...	2 (0)	...
September 21 . . . .	...	...	...	3 (0)
Total	26 (3)	55 (0)	2 (0)	3 (0)

NOTE: Figures in parentheses are the numbers of pickers hospitalized.

September 8 or 9. Three pickers were admitted to the hospital for periods of 24 to 72 hours. Only one person was considered seriously ill, requiring 24 hours of intensive care. Further illnesses of the grape pickers after September 10 were not well documented; however, treatment of two workers on September 15 was reported by Dr. B, another Madera practitioner, and Dr. C recalled treating three workers on September 21 while he was performing field supervision for the owner.

On September 17, two additional labor contractors brought crews to the vineyard, and these workers came under medical surveillance. Cholinesterase determinations were made for a total of 407 workers through October 4. Two State-approved private laboratories performed the majority of the determinations, using plasma levels of 0.41–1.65 Δ ph/hr and red blood cell levels of 0.55–1.25 Δ ph/hr as normal ranges. Results of the tests are shown in table 2. Of the 407 workers, 138 (33.9 percent) had either abnormal plasma or red blood cell cholinesterase levels at their first examination. A total of 96 workers had two or more cholinesterase determinations. Of 540 plasma or red blood cell cholinesterase determinations, 370 or 69 percent were reported as abnormal by the laboratory performing the tests. In view of the high percentage of abnormal cholinesterase determinations during the first week of investigation, it is remarkable that more workers did not require hospitalization.

Residue degradation studies on the sequential fruit and foliage samples obtained from a number of suspected fields were performed by both University of California and chemical manufacturers' research workers. These studies, reported by Enos and Maddy (3), revealed that during the first 2 weeks of harvest the grape pickers were exposed to residues of Di-

methoate, Methomyl, Omite, Torak, and Zolone. Except for Omite, all are cholinesterase inhibitors. Estimated total foliage levels of these compounds during the first 2 weeks of harvest were as follows:

Compound	Estimated ppm	Estimated effect
Dimethoate	13.3	Negligible
Methomyl	1.5	Negligible
Zolone	<58.0	Nontoxic
Zolone Oxon	<2.4	Nontoxic
Torak	100.0	Highly significant

It was estimated that the workers were exposed to foliage containing up to 57 ppm of Zolone and up to 2.3 ppm of Zolone Oxon, which were not considered to be toxic to the grape pickers. However, the finding of alternate rows of high- and low-residue levels of Torak and Torak Oxon on both fruit and foliage in fields was considered highly significant by Enos and Maddy (3). It was estimated that the workers in one field harvested on August 28 were exposed to 100 ppm of Torak and to a level of at least 40 ppm residual Torak in the field harvested on September 8, the day illness was first noted. A third field that was harvested on September 9 was estimated to have had as high as 75 ppm Torak residual. The second and third fields also had high levels of Zolone, which could have contributed (either synergistically or additively) to the toxic effect.

Enos and Maddy reported that these findings of high residues could not be explained by the growers' records of application dates and amounts applied. This led to the filing of a criminal complaint by the California Department of Food and Agriculture with the district attorney of Madera County against the grower; 27 counts of violating the California Food and Agriculture Code were listed. The grower subsequently pled *nolo contendere* to seven of the counts,

Table 2. Abnormal¹ cholinesterase determinations among 407 grape pickers, Madera County, Calif., September 10–October 4, 1976

Cholinesterase result	Dates reported					
	Sept. 10–16		Sept. 17–Oct. 4		Total	
	Number	Percent	Number	Percent	Number	Percent
Total, first test	102	100.0	305	100.0	407	100.0
Abnormal plasma	98	96.1	38	12.5	136	33.4
Abnormal red blood cells	96	94.1	12	3.9	108	26.5
Total, all tests	131	100.0	409	100.0	540	100.0
Abnormal plasma	127	96.9	94	23.0	221	40.9
Abnormal red blood cells	124	94.7	25	6.1	149	27.6

¹ Includes all determinations below 0.41 Δ ph/hr for plasma and 0.55 Δ ph/hr for red blood cells.

including use of Torak without a valid permit and not maintaining a record of such use. He was fined \$1,750.

In December 1976, representatives of the Division of Industrial Safety, California State Industrial Relations Department carried out a somewhat belated investigation relating to failure of physicians to file first reports of occupational injury with the Division of Labor Statistics and Research. As a result of this investigation and on recommendation of the State Division of Industrial Safety, the California Division of Labor Statistics and Research fined Dr. A \$700 for failure to report his treatment of occupational, pesticide-related illness on workmen's compensation forms as prescribed under the State Labor Code.

Discussion

The pesticide poisoning of 86 grape pickers probably constitutes the largest single incident of such poisoning among fieldworkers that has been reported. Only through the cooperation of several State and local agriculture and health agencies was the continued exposure of high-risk workers avoided. As in many epidemics, a variety of factors—socioeconomic, regulatory, and medical—can be identified as contributing to the unnecessary illnesses.

First, the 2,300-acre vineyard was a large commercial operation for producing wine grapes. Its owners were primarily engaged in business in Fresno, and they depended on foremen to oversee the operation of the ranch. Wineries contract early in the year with the growers for the total grape crop, and as a result, they dictate the dates of harvest. Most of the grapes were harvested by handpicking; labor was supplied by a Mexican farm labor contractor, who guaranteed to have workers when the harvest was ready. Few of the crew of 120 laborers spoke or understood English, and the owners and the ranch foreman depended on the labor contractor to communicate with his crew.

The contractor later stated that the winery started to harvest about 2 weeks before the first workers became ill on September 8. He noted that the vineyards were not posted with signs. Further, he said that when the workers became ill, he asked the ranch foreman if the field had been sprayed recently, but was assured that it had not been. The contractor became frightened when he received many calls from his crew on the evening of September 9, and he took them to Dr. A, his physician, who saw approximately 49 workers at his office that night. All of them were treated and told not to go to work; however, many reported to the fields the next morning.

Of the 26 crew members seen September 8–10 at the hospital emergency room, many were diagnosed as having possible pesticide poisoning and, after blood samples were drawn, they were treated and released with the instruction to check with the hospital on September 10 for their blood test results. Many of the 15 workers who came to the hospital on September 8 were back in the field the next day. Had the emergency room physician or staff alerted the health officer or the county agriculture commissioner of the 15 cases of suspected pesticide poisoning on September 8, the subsequent pesticide illnesses could have been averted.

Although a California law requiring any physician treating possible pesticide-caused illness to report it to the local health officer was passed in 1970 and guidelines for physicians on diagnosis and treatment of pesticide poisoning victims were published in 1971 and 1974 by the State health department, most physicians in this area were not familiar with the law or the publications. In addition, most physicians are reluctant to fill out a workmen's compensation form, "Doctor's First Report of Work Injury" on Mexican farmworkers in this area. Early in 1976 the Division of Labor Statistics and Research of the State Department of Industrial Relations issued "CAL/OSHA Record Keeping Guidelines: Recordability, Medical Treatment and First Aid." This form was confusing to area physicians because it did not state clearly whether suspected pesticide poisoning cases requiring only one emergency room visit were reportable.

Before the 1976 incident, most pesticide protection regulations promulgated by the State were aimed at preventing serious exposures of mixers, applicators, flagmen, and other workers who handled or processed pesticides. Harvest hands were protected if they observed the posted re-entry dates approved by the county agricultural commissioner. Consequently, accidental or deliberate misapplications cannot be anticipated in this system of regulation.

The system cannot function well without good communications among (a) the employer and his workers, since he is responsible for their education and safety in handling pesticides and (b) the physicians, the local health officer, and the agriculture commissioner to provide proper surveillance of pesticide workers and to avoid continued exposure of workers to toxic levels of pesticides.

Comment

The unprecedented sanction against a practicing physician by the California Division of Labor Statistics

and Research has many implications related to the practice of medicine, public health, and preventive medicine in general. Fewer practitioners will be available in the future to provide emergency or contract services for fieldworkers. Although there are gaps in the data, such as the exact dates of spraying and the exact substances applied to fields where the grape pickers were exposed, investigation of this incident has provided extensive documentation and followup of many factors contributing to the hazardous exposure to anticholinesterase compounds of the largest reported number of fieldworkers in a single vineyard. This incident has been cited by several State legislators, government officials, and labor advocates as the reason for their attempts to transfer responsibility for pesticide safety and enforcement from the State Department of Food and Agriculture to any one of several other State agencies.

New re-entry standards for fields sprayed with Torak have been promulgated by the State Department of Food and Agriculture as a result of the Madera incident. The Assembly-Senate Audit Committee of State Government has recommended that the Department of Food and Agriculture develop

plans jointly with the counties for enforcement of pesticide standards.

These efforts, however—like most pesticide control activities in the past—emphasize regulation and enforcement by government officials, approaches that are not in the traditions of public health. I do not believe that more regulations and stricter enforcement procedures will achieve better pesticide controls. Greater energies should be invested in communicating the need for improved work practices and demonstrating to growers and farmworkers the proper handling and use of pesticides.

References

1. Kahn, E.: Pesticide related illness in California farm workers. *J Occup Med* 18: 693-796, October 1976.
2. Davis, J. E., et al.: Worker re-entry safety. VII. A medical overview of re-entry periods and the use of urinary alkyl phosphates in human pesticide monitoring. *Residue Rev* 62: 42-57 (1976).
3. Enos, R., and Maddy, K. T.: Report of the pesticide poisoning of 118 farm workers exposed to Dimethoate, Methomyl, Omite, Torak, Phosaladne, and their residues while harvesting grapes near Madera, California, on September 8, 9, and 10, 1976. Report to the director of agricultural chemicals and feed, California Department of Food and Agriculture, 1977.

SYNOPSIS

McCLURE, C. DEAN (Madera County (California) Health Department): *Public health concerns in the exposure of grape pickers to high pesticide residues in Madera County, Calif., September 1976. Public Health Reports, Vol. 93, September-October 1978, pp. 421-425.*

Approximately 80 grape pickers working in a Madera County vineyard were treated for nausea, vomiting, and weakness at the local hospital or a private physician's office between September 8 and 10, 1976. Combined action and investigation by the Madera County health officer and the county agriculture commissioner, with professional and technical assistance from the California Department of Food and Agriculture and the California State Department

of Health, averted further harmful effects from exposure to hazardous organophosphorus residues to more than 400 grape pickers working in a 2,300-acre vineyard.

Investigation failed to reveal the exact compounds or dates of application but established sufficient evidence of high (estimated 75-100 ppm) foliage residues of dialifor (Torak) at the time of onset of illness among grape pickers working in the suspected fields. Abnormally low plasma or red blood cell cholinesterase levels, or both, were found in 138 (33.9 percent) of 407 workers first tested and reported between September 10 and October 4, 1976. A total of 98 (96.1 percent) workers tested before September 17 had abnormally low determinations reported

by two State-approved laboratories.

Civil action by two State agencies resulted in fines. The owner of the vineyard was fined on seven counts of improper pesticide procedures and application. A private practitioner in Madera County was fined for not filing appropriate reports to the California State Division of Labor Statistics and Research. Poor communications between employer and the workers, employer and the regulating agencies, and physicians and the regulating agencies contributed to the unnecessary illnesses. Improving communications through education and training of these groups seems more likely to prevent additional pesticide-related illness in California than additional legislation and regulations.