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STUDIES WITH DICHLORVOS RESIDUAL FUMIGANT AS A MALARIA ERADICATION TECHNIQUE IN HAITI

III. TOXICOLOGICAL STUDIES

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During the third treatment cycle of the studies (April, 1963) complaints were received from the workers concerning headaches, rash on the forearms, and diarrhea. Since this treatment was completed in two weeks by six brigades versus the six weeks required by two brigades previously, it was assumed the complaints could have resulted from careless handling of the dispensers because of the lesser degree of supervision that was available to the larger number of brigades. Therefore, to evaluate the possible hazard to the personnel handling the dichlorvos dispensers, toxicological studies were made of the personnel involved during the fourth treatment cycle (August–September, 1963).

METHODS

Such personnel fell into three categories:

A. Treatment brigades. Twelve men removed the old dispensers in each house and installed the new units. Each man used a plastic bag held by a shoulder strap to carry a supply of new dispensers in their plastic cages. Each man wore work clothes, had cotton gloves assigned, and worked 5.5 eight-hour days per week under the supervision of a brigade chief. The only irregularity detected in the applicators’ work hygiene was their failure to wash the cotton gloves provided. The gloves accumulated a layer of wax formulation and could have provided the opportunity for significant dermal absorption. The applicators were subsequently advised to wash these gloves regularly.

B. Brigade chiefs. Two men supervised treatment brigades and had minimal contact with the dichlorvos dispensers.

C. Preparation group. Four laborers, stationed at the field office, removed old wax dispensers from their plastic cages and inserted new ones.

Each new dispenser had to be removed from an individual storage tube but the dispenser could be inserted into the plastic cage without the worker contacting the dichlorvos wax. Each man had rubber gloves but no special work clothing. Work was performed 5 eight-hour days per week. The plastic cages were emptied in the open air but were recharged with new dispensers under a shed. Although the shed had only a single wall, little movement of air was observed.

All personnel were Haitians and the four men in the preparation group were regular National Malaria Eradication Program (SNEM) employees that had handled both dichlorvos and DDT in previous treatment cycles. The preparation group personnel had not had any previous occupational contact with insecticides. The average age of the 18 men was 33 years.

A history, physical examination, and two cholinesterase determinations were obtained during the week prior to dichlorvos application. The workmen were then observed for as long as 3 weeks during the treatment cycle. Cholinesterase levels were determined twice a week in the members of the brigades and the brigade leaders, and three times a week in the four laborers. All personnel were observed for signs and symptoms of organic phosphate insecticide poisoning.

Cholinesterase was determined (in a field laboratory) by the micro Michel method on venous blood collected in heparinized Vacutainers. Blood samples usually were obtained in the morning before work had begun.

Air samples were taken on 4 days inside the sheds where the laborers were handling the new dispensers. Sampling was made at two sites at the 4- and 6-foot levels on 2 days, and 3-, 4-, and 6-foot levels on the other 2 days. In addition, air samples were obtained at 2- and 6-foot levels in six occupied houses containing old dispensers and in the same houses within a few days after retreatment.

Each sample was obtained by drawing air through two Greenburg-Smith type impingers connected in tandem. The impingers were charged with 25 ml 0.004-normal sodium hydroxide and
connected to a battery-operated vacuum pump. The solutions resulting from a single sampling were rinsed into one shipping bottle and brought to Savannah for analysis. The samples were analyzed by the total phosphorus method described by the Biology/Chemistry Section.

RESULTS

A number of abnormalities were revealed by the preliminary history and physical examination. Eight of the personnel complained of recurrent, vague gastrointestinal symptoms. A history of venereal disease, usually gonorrhea, was elicited from seven. Three individuals had recent symptoms of chills and fever suggestive of malaria but a blood smear for malaria parasites was negative in all three men. The following abnormalities were noted on physical examination: palpable liver, 4 men; blood pressure 160/90 or above, 3; various types of skin rash, 4; enlarged inguinal rings, 2; unilateral diminished hearing, 2; cataract, 1; and a pterygium in 1 man. One workman had the murmur of aortic stenosis while a 32-year-old applicator had a probable aneurism in the left side of his neck. Individuals with significant abnormalities were referred to a clinic for further evaluation.

Several instances of minor illness, including continuing vague gastrointestinal symptoms, were reported during the period of exposure. The symptoms that led to complaints in the third cycle of application did not appear during the study. The 12 personnel that installed the dispensers and the 4 laborers who prepared them exhibited no symptoms or signs suggestive of organic phosphorus compound intoxication.

All personnel had normal hematocrits. Figure 1 illustrates the average cholinesterase determinations of the 4 laborers and the 12 applicators. In both groups during the period of observation there was no depression of RBC cholinesterase. Minor fluctuations of RBC cholinesterase occurred from week to week. However, in both the applicators and the laborers, there was a moderate depression of plasma cholinesterase. The laborers had a greater depression of the plasma cholinesterase than did the applicators, which aligns with the greater degree of their exposure to dichlorvos.

At the end of 2.5 weeks of exposure, the average plasma cholinesterase of the applicators was still within normal limits with the lowest individual cholinesterase at 0.38A pH units/hr. It was not possible to observe the workmen throughout the 6 weeks of dichlorvos application. However, maximal depression of plasma cholinesterase for the 4 laborers was reached in about a week; there was no further change in average values during the final 2 weeks of observation. The cholinesterase values of the workers also did not change significantly during the final two weeks.

The two brigade leaders showed no inhibition of plasma or erythrocyte cholinesterase, confirming their minimal exposure to dichlorvos. Air samples from two locations 4 feet above the floor level in the preparation shed prior to the unwrapping of new dispensers each showed 0.01 μg of dichlorvos per liter of air. After the completion of one day's operation in which new dispensers were prepared for field use, the air concentration of dichlorvos from the same positions was 0.40 and 0.48 μg/l. The following day (after completion of the day's work preparing new dispensers) six air samples were taken while the laborers were cleaning the shed. The dichlorvos concentration per liter of air was 1.52 μg at the 3-foot level; 0.49, 0.57, 1.31, and 2.13 μg at the 4-foot level; and 1.65 μg at the 6-foot level. The sample which contained 2.13 μg was taken from approximately the center of the work area and the lowest concentrations (0.49 and 0.57 μg) were from samples from the open front of the shed. The following day, samples were taken from the same positions, starting 15 minutes after the laborers had begun to unwrap dispensers. The air concentrations ranged from 0.29 to 1.18

![Figure 1. Effect of exposure to dichlorvos on the red cell and plasma cholinesterase of treatment brigades (A) and the preparation group (C). The enzyme levels of the brigade chiefs (B) are not shown but remained entirely normal. The periods of exposure to dichlorvos are shown by arrows.](image-url)
Dichlorvos concentration in micrograms/liter of air samples from houses in Haiti containing dispensers 1 and 16 weeks old

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<th>Location and house number</th>
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† Sampled Aug. 21, 1963.

µg/l of air. As in the previous day's sampling, the lowest concentration was from the two samples from the open front of the shed. The highest concentration was from the sample near the back of the shed at the 6-foot level.

Air samples taken at 2- and 6-foot levels in 6 houses containing 4-month-old dispensers showed a dichlorvos concentration at both levels of 0.01 µg/l at 11 of the 12 sampling sites. The twelfth site, which was at the 2-foot level, gave a reading of 0.08 µg/l. After retreatment of the same houses, the dichlorvos concentration in the identical positions (2- and 6-foot levels) ranged from 0.01 to 0.15 µg/l (Table 1). Additional samples were also taken from the two different houses at 2- and 6-foot levels and the concentration ranged from 0.09 to 0.17 µg/liter. The average concentration for all positions (2- and 6-foot levels) was 0.10 µg/l. No difference was noted between concentrations in samples from the two sampling levels.

**Discussion**

Although a moderate reduction in plasma cholinesterase was observed, there was no inhibition of erythrocyte cholinesterase during the period of observation. Rasmussen et al. also found that plasma cholinesterase was the most sensitive indication of exposure to dichlorvos. No illness attributed to dichlorvos could be elicited. Asymptomatic cholinesterase depression also has been observed with human exposure to a number of the organic phosphorus insecticides. However, if dichlorvos is distributed over long periods of time in malaria eradication programs, it appears desirable to conduct a prolonged study of workmen engaged in the handling of the dichlorvos dispensers.

In treating homes, it is necessary that the number of applicators per unit volume be adjusted to the ventilation and other factors that influence the concentration. The Haitian houses had more ventilation than those studied by Funckes et al. and by Mathis et al. in Upper Volta. Thus, a relatively high application rate (1 dispenser per 165 cubic feet compared to 1 per 500 cubic feet used in Upper Volta) was required to produce approximately the same concentration of dichlorvos—0.01 to 0.17 or a mean of 0.10 µg/l in Haiti, as compared to 0.03 to 0.21 or a mean of 0.1 µg/l in Upper Volta. Funckes et al. considered an average level of 0.1 µg of dichlorvos per liter of air as offering no hazard to the house occupants because they found no effect on the inhabitants of homes in which the dichlorvos concentrations were from 0.17 to 0.84 µg/l, a mean of 0.43 µg/l. The levels were recorded in special tests where the
rate of installation was 1 unit per 60-88 cubic feet.

The absence of complaints of the type made during the third treatment cycle could possibly be attributed to the closer supervision exercised during the fourth cycle. Because gastrointestinal symptoms are common in Haiti, the complaint of diarrhea during the third cycle could easily have arisen from many causes other than pesticides.

SUMMARY

Complaints of headache, skin rash, and diarrhea among workers who unpacked and distributed dichlorvos dispensers for malaria control led to a study of men who did the same kind of work in the next cycle of application. Mild to moderate depression of plasma cholinesterase in two groups of workers corresponded with their degree of exposure. Red cell cholinesterase was not affected. There was no recurrence of the complaints that led to the study, and no signs or symptoms of intoxication by an organic phosphorus compound were discovered.

REFERENCES


