CONSIDERATION OF HUMAN EXPOSURE TO MALATHION USED IN POPULATED AREAS

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The studies presented here supplement those of C. M. Gjullin[1, 2] during 1954 and 1955 in Merced County, California, and were made to estimate human hazard in the event it becomes necessary to use malathion to combat mosquito vectors of disease in populated areas. Measures of human exposure were obtained by methods developed by various industrial hygienists and by the Communicable Disease Center of the U. S. Public Health Service.[3] The discussion here relates to single exposures to malathion, not to frequently repeated exposures. Exposures in the same order of magnitude repeated at intervals of less than one week might require further consideration since the effects of malathion may be cumulative.

The first figure in Figure 1 shows the exposure of a man standing ten yards downwind from a Husman spray generator applying malathion at the rate of 12 gallons per linear mile.

The second figure shows the exposure of a man working in the open during airplane application of malathion from an altitude of 70 feet at the rate of .46 lb. per acre.

The third figure shows the exposure of a man working in a schoolroom with doors and windows open during airplane application of malathion from an altitude of 70 feet at a rate of .46 lb. per acre.

Amounts of malathion per square centimeter of surface area deposited upon various parts of the body are given with lines pointing to the respective body areas.

It can be seen that outside during airplane application where rather large droplets up to 350 microns in diameter were falling almost vertically, the head and chin gave considerable protection to the front of the neck. Amounts found on the back of the neck were in the order of 1.77 micrograms per cm^2 while on the front of the neck they were about one-fourth of this, or .45 microgram per cm^2. Relatively less protection to the front of the neck resulted from exposure to the smaller, horizontally windborne droplets produced by the Husman generator. In this case .36 microgram per cm^2 was found on the back of the neck, and three-fourths of this amount or .26 microgram per cm^2 was found on the front.

Inside the schoolroom, where probably only particles under 3 microns in diameter were present, the distribution of malathion upon body surfaces was quite uniform, ranging from .25 to .56 microgram per cm^2.

Our measures of body surface deposits thus support the contention that a simple canopy would provide considerable protection to a man working in sprays consisting of large droplets, while commensurate protection for a man working in very fine aerosols would require protective clothing covering nearly his entire body.

Total amounts of insecticide found on exposed skin and total amounts inspired during the entire period of exposure are listed below each figure. We can estimate the amount of protection afforded by the building by comparing the total exposure figures of the man indoors, whose inspiratory and skin exposures were 23.5 and 984 micrograms respectively, with those of the man outdoors during aerial application whose inspiratory and skin exposures were 109.2 and 3,556 micrograms respectively. Roughly, the outdoor exposures were four to five times higher than indoor exposures.

One way to estimate possible hazard from exposure to malathion is to measure blood cholinesterase levels. This was done

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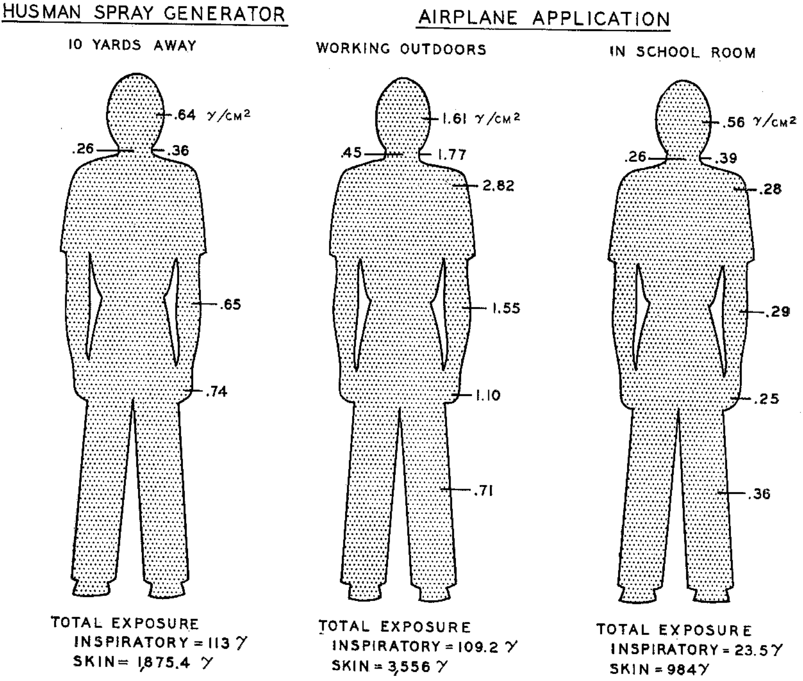
for another man exposed to spray from the Husman generator 23 times during a two-week period.[4] The amounts of malathion averaged 696 micrograms by the inspiratory route and 2,565 micrograms (range 50 to 8,818 μg) on the skin. The cholinesterase activity levels of this man showed no changes due to malathion absorption during the two weeks of exposure. Exposures of the two men during aerial application were not repeated and thus were considerably less than the cumulative exposure of the man repeatedly exposed.

Another means of estimating the amount of hazard involved in a given exposure is to compare that exposure with LD_{50}'s or other measures of animal sensitivity to poisons. Although animals cannot be depended upon always to react to toxins as humans do, such comparisons can often be of value in making very rough estimates of toxicity. Comparison can best be made on a basis of milligrams of insecticide per kilogram of body weight. The highest inspiratory exposure of the three work situations occurred to the man exposed by the Husman generator. This exposure amounts to .01 milligram of malathion per kilogram of body weight. The only animal LD_{50} we have to compare this with is the rat intraperitoneal LD_{50} of 750 milligrams per kilogram.[5] The highest skin exposure of the three work situations also occurred to the man exposed by the Husman generator. His exposure amounted to .13 milligram of malathion per kilogram of body weight. For rabbits, the dermal acute minimum lethal dose is 6,150 milligrams per kilogram.[6] We can see then that our highest total exposures would have to be multiplied by factors of 50,000 for skin and 75,000 for inspiratory exposures in order to approach lethal animal levels. Thus, on the basis of our findings,

FIGURE 1

MALATHION EXPOSURES IN PLANADA STUDY, 1955



we can state that single applications of malathion in amounts used in these studies constitute no hazard to the normal human population.

Measures of fallout and surface deposition were made by chemical analysis of filter paper discs 32 centimeters in diameter. These discs were placed on horizontal surfaces outdoors, and inside ceilings, walls, and floors of chicken sheds and of a schoolroom within the test area. The results of these measurements are presented in Table 1.

TABLE 1. Surface deposit[1] of malathion airplane application planada study, 1955.

	Ceiling	Wall	Floor	Horizontal outdoor surfaces
Range	.09–.25	.08–.16	One Sample	1.6–9.8
Average	.14	.11	.12	4.7

[1] Micrograms per cm^2.
Source: State of California, Department of Public Health, Planada Study, 1955.

Average indoor surface deposits ranged from .11 to .14 microgram per square centimeter. These are roughly 3 percent of the average outdoor surface deposit which was 4.7 micrograms per square centimeter. Since ceiling, wall and floor surfaces each received about the same amount of deposit, we can postulate that particles which entered buildings must have been too small to follow Stokes law and thus were all below 3 microns in size. It follows then that about 97 percent of the insecticide was present in droplets too large to reach the inside surfaces of buildings. *Culex tarsalis* mosquitoes resting on these inside surfaces were thus exposed to only about 3 percent of the malathion applied. Decreasing the droplet size of insecticide so that a larger proportion is below 3 microns would appear to be the only way of increasing the exposure of mosquitoes which continue to rest inside the shelter of buildings during spray application.

References

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