Comparative Study of DDT and its Derivatives in Human Blood Samples in Norfolk County and Holland Marsh, Ontario

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INTRODUCTION

It has been found that there is a definite relationship between 2,2-bis (p-chlorophenyl) 1,1,1-trichlorethane (DDT) derived materials in blood and those present in human depot fat. The blood can, therefore, be used as an epidemiological tool in the assessment of the total body burden of DDT in various populations. Although DDT and its derivatives such as 2,2-bis (p-chlorophenyl)-1,1-dichloroethylene (DDE) and 2,2-bis (p-chlorophenyl)-1,1-dichloroethane (DDD) have been widely disseminated, there is, at present, no indication that these materials pose a threat to human life or longevity (Brown, 1970). Hayes and Dale (1961) have stated that the severity of clinical signs of poisoning is directly proportional to the concentration of the unmetabolized compound in the brain. The amount of DDT derived material in the blood approximates that present in nervous tissue (Dale 1966). DDT and other chlorinated hydrocarbon compounds are stored in the depot fat tissue, and the examination of biopsy materials from such areas may not give a reliable indication of acute DDT poisoning. In practice, the amount of DDT present in the blood is of greater importance than the storage in the depot fat. Davis et al. (1968) determined p,p'DDT and p,p'DDE concentrations in blood from 84 occupationally exposed individuals in South Florida. They found that DDT levels in the blood samples were transient and related to recent exposure of the workers. Radomski et al. (1971) found that there were close correlations between blood and fat concentrations of p,p'DDE, p,p'DDT and β-hexachloro-cyclohexane.

The levels of chlorinated hydrocarbon pesticides in human depot fat from Canadian residents have been published by Read and McKinley (1961), Brown (1967) and Ritcey et al. (1973).

DDT has been used in agriculture in large amounts in Norfolk County and Holland Marsh for many years. Norfolk County is a tobacco growing area, and the soil is composed of sandy loam, whereas Holland Marsh, a market garden area, has a muck type soil. Norfolk County abuts the north shore of Lake Erie. Holland Marsh is 30 miles north of Metropolitan Toronto. The methods of application of DDT and the life styles of these two populations differ, and it is of interest to compare the body burden of DDT and its derivatives between residents from these two locations.

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METHODS

Paired samples of adipose tissue and blood were obtained from autopsies on accident victims residing in Norfolk County. Blood samples were also collected from 52 persons who had been engaged in the agricultural application of DDT in the county. 315 samples of blood were taken from residents of Holland Marsh.

METHOD FOR ORGANO-CHLORINE PESTICIDES ANALYSIS IN HUMAN BLOOD

Four ml. of whole blood and 10 ml. of pesticide-free acetonitrile were placed in a flat bottom flask. The sample was shaken for 20 minutes with the aid of a "Niagara shaker." Then 25 ml. of distilled water was added to the 10 ml. acetonitrile extract and re-extracted three times with 25 ml. of redistilled hexane in a separating funnel. One gram of hexane-washed anhydrous sodium sulphate was added to the hexane extract. The supernatant hexane was transferred to a flash evaporator and evaporated to approximately 0.5 ml. The residue was taken up in 2 ml. of hexane, and then an aliquote of 6 microlitres of the sample was used for analysis by gas liquid chromatography.

METHOD FOR ORGANO-CHLORINE PESTICIDES ANALYSIS IN HUMAN DEPOT FAT

About 1 g. adipose tissue was ground with 10 g. of hexane-washed anhydrous sodium sulphate, using a mortar and pestle. This was then placed in the glass thimble of a Soxhlet extractor, and the mortar was rinsed with acetonitrile, this rinsing being added to the thimble. A total of 120 ml. of acetonitrile was used for the extraction of the fat. The sample was extracted for six hours, using the Soxhlet extractor. The acetonitrile extract was evaporated down to 5 ml., when 50 ml. of distilled water was added. The aqueous mixture was extracted three times with 50 ml. of hexane in a separatory funnel. The hexane extract was then evaporated to 10 ml. and passed through a column containing a mixture of Florisil and Celite in a ratio of 4 to 1 by weight. This was overlaid by 1/2 inch of hexane washed anhydrous sodium sulphate. The sample was eluted with 200 ml. of 6% ether in hexane. The eluate was evaporated down to 0.5 ml. The sample was then made up to a volume of 4 ml. with hexane, and an aliquot of 6 microlitres of the sample was used for analysis by gas liquid chromatography.

RESULTS

Paired samples of adipose tissue and blood were analysed for total derived DDT. It was found that the mean values of total derived DDT for adipose tissue and blood were 5.83 and 0.032 p.p.m. respectively, and there was a statistically significant correlation between total derived DDT in fat and blood. See Figure 1.

THE RELATIONSHIP BETWEEN TOTAL

DERIVED DDT (PPM) IN BLOOD AND IN FAT

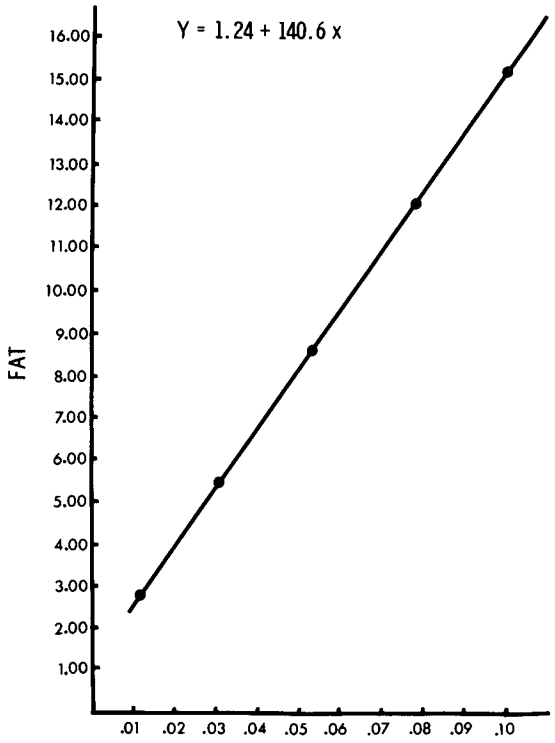

FIG. I

104 samples of blood were taken from healthy residents of Norfolk County, and 315 samples from healthy residents of Holland Marsh. The total derived DDT content was higher in the residents of Norfolk County. The median values of total derived DDT in Norfolk County and Holland Marsh were found to be .021 and .011 p.p.m. respectively. The results are given in Table 1. The comparison of these two areas is given in Figure 2. It is considered that the presence of DDT in the blood is a reliable indicator of the severity of recent exposure to this material. Derivatives of DDT are not indicators of recent exposure but do represent a gauge of the body burden of this material. The derivatives determined in

TABLE 1

TOTAL DERIVED DDT (p.p.m.) IN HUMAN BLOOD SAMPLES

	No. of Samples	Mean	Median	Range
Norfolk County	104	.032	.021	.004 - .102
Holland Marsh	315	.016	.011	.001 - .084

the present study are DDE and DDD. Table 2 is a summary of the percentage of subjects containing DDT and its derivatives in blood samples.

TABLE 2

OCCURRENCE OF DDT AND ITS DERIVATIVES IN HUMAN BLOOD SAMPLES

	No. of Samples	% of Samples Containing		
		p,p'-DDT	p,p'-DDE	DDD
Norfolk County	104	10	100	16
Holland Marsh	315	5	100	2

DISCUSSION

It has been found that there is a definite relationship between total derived DDT in human blood and that present in human depot fat.

A survey carried out on 26 persons who were exposed during the formulation of DDT preparations showed higher levels of DDT and its derivatives in blood than the blood samples from Norfolk County and Holland Marsh. The blood levels of the 26 subjects for DDT, DDD and DDE were found to be .030, .010 and .023 p.p.m. respectively.

The median value for total derived DDT is greater in Norfolk County than in Holland Marsh. It is presumed that the applied DDT is much more firmly bound in the muck soil of Holland Marsh than it is in the sandy loam of Norfolk County. Exposure to chlorinated hydrocarbon pesticides has been cited in the etiology of blood dyscrasias. The hemoglobin levels for men and women of

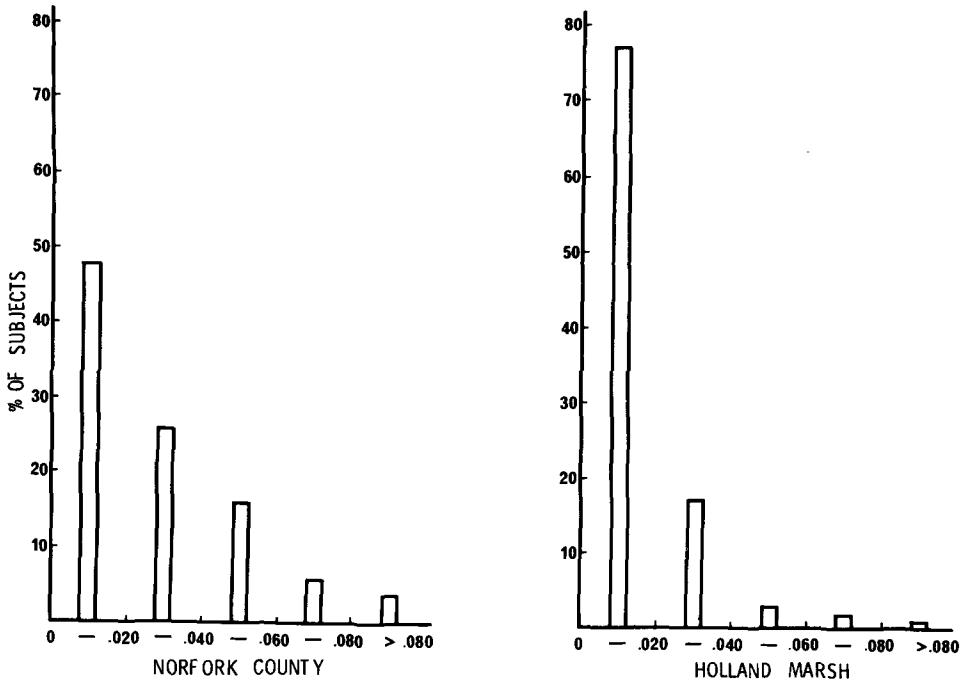

FIG. 2. TOTAL DERIVED DDT (ppm) IN HUMAN BLOOD SAMPLES

Norfolk County and Holland Marsh were within normal limits. Therefore, absorption of DDT does not seem to have any effect on erythropoiesis of red cells. A significant amount of DDT may enter the body by inhalation of air-borne particulates containing DDT. Weibel et al. (1966) found DDT in a concentration of 1.2 µg./l. in a rainwater sample collected at Cincinnati, Ohio. They also report the presence of chlordane, heptachlor epoxide, DDE, Ronnel, dieldrin and 2,4,5-T in a dust cloud covering Cincinnati in January, 1965. The prohibition of the application of DDT and its related compounds during recent years resulted in a reduction in the total body burden in man. There

has been no evidence to suggest that there is any effect on the health of the population at large. The substitution of other pesticides for DDT is and will likely be a source of health hazard because of the great variety of pesticides and the careless application of these chemicals. It cannot be denied that DDT presents an ecological problem, but from the point of view of human health it is relatively innocuous.

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