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Since 1944 the general U.S. population has been absorbing organochlorine pesticides, which have recently been largely banned because of a concern that they would cause or contribute to the production of liver cancer. This survey is related to the quantities of these pesticides used and the incidence of liver cancer deaths in the U.S. from 1930 to 1972.

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Liver cancer deaths in the continental USA from 1930 to 1972.*

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Since 1944, the general population of the USA has been absorbing DDT or other organochlorine pesticides with food and drink, because of the use of these agents as house and garden insecticides or because of their inhalation in polluted atmospheres. It was in June 1972 that the Environmental Protection Agency ordered the use of DDT banned in the USA, declaring it a potential human carcinogen. Two years later (September 1974), the EPA's Chief Administrative Law Judge suspended the use of aldrin and dieldrin, to "eliminate an imminent hazard." And on July 30, 1975, Russell E. Train, Administrator of the EPA, announced the suspension of chlordane/heptachlor because they pose an unreasonable risk and "imminent hazard" to the American people.

publications, "Pesticide Situation" and "Pesticide Review." "Domestic disappearance" is defined as: "the quantities that leave the U.S. manufacturers' premises for (1) intermediate use (manufacture of other chemicals), (2) consumer use (industry, agriculture, home and garden, etc.), and (3) formulation (which may or may not include direct export after formulation)."¹

From 1950 to 1970, the quantity of DDT manufactured was in excess of 1.2 billion kilograms, while its "domestic disappearance" was about half this amount. From 1950 to 1972, the aldrin-toxaphene group reached a total of 865.6 million kilograms manufactured, with a domestic disappearance of 706.6 million kilograms (Table I).

Apart from some consideration for the environment in general, the primary reason for these bans was the concern that these organochlorine compounds would cause or contribute to the production of cancer of the liver in the USA population. Obviously, the quantities of these pesticides which might contribute to this dread disease are of interest. Table I presents a summary of the quantities of DDT and of the aldrin-toxaphene group (aldrin, chlordane, dieldrin, endrin, heptachlor, and toxaphene) manufactured in the USA and their "domestic disappearance" in this country. These data were obtained from the USDA

Since it is impossible to prove a biological negative, the only approach that will provide useful information is an attempt to prove the positive—in this case, an increased incidence of liver cancer deaths in the years following the introduction into our environment of DDT and related organochlorine pesticides. Our approach to this hypothetical question was to review the vital statistics of the USA from a period before the introduction of these compounds (1930) in the expectation that some trend in the incidence of liver cancer in the U.S. population might be uncovered. The data and information for this review were obtained from publications of the U.S. Bureau of the Census² and from personal communications with the Project Statistician of the American Cancer Society, Inc.³

*This is part of a report presented by Dr. Wm. B. Deichmann at the Fourth International Symposium, Chemical and Toxicological Aspects of Environmental Quality, in Munich, Germany, September 9-10, 1975.

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TABLE I
Manufacture and Domestic Disappearance* of the Major Organochlorine Pesticides
Taken from USDA "Pesticide Situation" and "Pesticide Review"***
(Thousand pound units given in the publications converted to thousand kilogram units)

"DOMESTIC DISAPPEARANCE" (IN THOUSAND kg UNITS)						
YEAR	U S PRODUCTION OF		DDT (1944)***	ALDRIN	(1954-)***	BENZENE- HEXACHLORIDE (1947)***
	DDT	ALDRIN- TOXAPHENE GROUP		CHLORDANE	(1945-)	
				ENDRIN	(1954-)	
				HEPTACHLOR	(1957-)	
				TOXAPHENE	(1952-)	
				STROBANE	(1946-)	
	IN THOUSAND kg UNITS				(1964-69)	
1950	35,200	---	26,100	17,100		3,800
1951	47,800	---	32,800	22,700		4,300
1952	45,000	22,000	31,500	17,100		5,000
1953****	37,800	13,000	28,100	15,500		3,300
1954	41,000	20,300	20,300	16,000		3,800
1955	56,300	34,600	27,800	25,600		3,500
1956	62,600	39,000	33,800	27,700		4,200
1957	55,800	33,900	32,000	23,600		3,000
1958	63,300	44,200	30,000	35,500		2,500
1959	70,100	39,100	35,400	33,000		1,900
1960	73,800	40,800	31,400	34,100		2,300
1961	79,200	46,700	28,800	35,200		2,200
1962	73,100	47,800	30,200	37,000		1,100
1963	84,600	47,700	27,500	35,700		600
1964	61,200	47,600	27,000	37,000		---
1965	63,400	53,500	22,500	40,000		---
1966	63,400	58,700	19,300	39,000		---
1967	46,500	54,000	14,400	39,000		---
1968	62,600	52,200	13,500	17,400		---
1969	55,300	48,300	12,100	40,400		---
1970	26,700	39,900	9,000	28,000		---
1971	---	52,300	6,000	38,300		---
1972	---	64,000	10,600	47,800		---
TOTALS:	1,204,700	865,600	550,100	702,600		41,500

*Domestic Disappearance** refers to "the quantities that leave the manufacturers' premises for: (1) intermediate use (manufacture of other chemicals), (2) consumer use (industry, farmers, home & garden use &c), (3) formulation (which may or may not include indirect export after formulation)."

**The values for "domestic disappearance" were supplied by courtesy of W. B. Weaver, Associate Librarian, University of Florida, Gainesville, Florida.

***Year the pesticide was introduced. (Strobane was included in this group from 1964 to 1969.)

****Beginning with 1953, the six pesticides of the aldrin-toxaphene group were lumped together in *Pesticide Situation*, and only one figure is given for the group. For 1950, 1951, and 1952, individual figures were published, but are presented in this table as the total.

It was not until 1949 that the National Office of Vital Statistics began to classify cancer of the liver and biliary passages in some detail, differentiating between:

"Malignant neoplasm of biliary passages and of liver (stated to be *primary* site)."

"Malignant neoplasm of liver (secondary and unspecified) not stated whether *primary* or *secondary*," and "secondary" (emphasis added).

From 1930 to 1972 the total number of liver and biliary cancer deaths increased from 10,833 to 11,622, while the U.S. population increased from 123 million to more than 208 million. Thus, the death rate (per 100,000 population) due to all liver cancers decreased from 8.8 in 1930 to 5.6 in 1972. This decrease in the liver cancer death rate was gradual and essentially continuous with the exception of the period 1942-1946 (World War II), when a large segment of the younger U.S. population was removed from the continental USA. The increase in the percentage of older

people, who are more prone to liver diseases and liver cancer deaths, was reflected in the temporarily increased death rate, from 7.6 in 1940 to 8.5 in 1945.

Since 1949, with improved diagnostic and reporting procedures, there has been, as expected, a constant and marked decrease in the rate of liver cancer deaths diagnosed as "No stated whether primary or secondary" and referred to as "unspecified"—from 3.7 in 1949 to 1.5 in 1972. The improvement in diagnosis and reporting is further reflected, as expected, in an increase in the cancer identified as metastatic to the liver, reported as "... *secondary*"—from 0.29 in 1949 to 0.95 in 1972. This increase, however, is too modest to be accurate and is in disagreement with the general experience in this country, in that metastatic cancer of the liver is much more frequent than primary liver cancer. Simultaneously, for the period 1949 to 1960 there was a modest increase in reported death

TABLE II
Liver Cancer Deaths in the Male and Female Population of the Continental United States

1 YEAR	2 POPULATION OF CONTINENTAL U.S.A. (EXCLUDING ARMED FORCES OVERSEAS)	3 CANCER OF LIVER AND BILIARY PASSAGES		4 MALIGNANT NEOPLASM OF BILIARY PASSAGES AND OF LIVER (STATED TO BE PRIMARY SITE)		5 MALIGNANT NEOPLASM OF LIVER (NOT STATED WHETHER PRIMARY OR SECONDARY)		6 MALIGNANT NEOPLASM OF BILIARY PASSAGES AND OF LIVER TOTAL OF THOSE STATED TO BE PRIMARY SITE (COLUMN 4a) PLUS THOSE NOT STATED WHETHER PRIMARY OR SECONDARY (COLUMN 5a)		7 MALIGNANT NEOPLASM OF LIVER SECONDARY	
		3a NUMBER OF DEATHS	3b DEATH RATE PER 100,000	4a NUMBER OF DEATHS	4b DEATH RATE PER 100,000	5a NUMBER OF DEATHS	5b DEATH RATE PER 100,000	6a NUMBER OF DEATHS	6b DEATH RATE PER 100,000	7a NUMBER OF DEATHS	7b DEATH RATE PER 100,000
1930	123,078,741	10,833	8.8								
1931	124,039,648	10,664	8.6								
1932	124,840,471	10,858	8.7								
1933	125,578,763	10,550	8.4								
1934	126,373,773	10,618	8.4								
1935	127,250,232	10,439	8.2								
1936	128,053,180	10,376	8.1								
1937	128,824,829	10,034	8.0								
1938	129,824,939	10,124	7.8								
1939	130,879,718	9,948	7.6								
1940	131,954,144	9,768	7.4								
1941	133,060,045	9,846	7.4								
1942	133,770,500	10,204	7.6								
1943	133,971,000	10,972	8.3								
1944	132,622,000	11,177	8.4								
1945	132,137,000	11,207	8.5								
1946	139,893,408	10,804	7.7								
1947	143,375,000	10,572	7.3								
1948	146,045,000	10,598	7.3								
1949	148,558,000	10,438	7.0	4,432	2.98	5,570	3.7	10,002	6.7	436	0.29
1950	150,697,361	10,848	7.2	4,653	3.09	5,658	3.8	10,311	6.8	537	0.36
1951	153,383,000	10,323	6.7	4,753	3.09	4,943	3.2	9,696	6.3	627	0.41
1952	157,022,000	10,468	6.7	4,946	3.15	4,881	3.1	9,827	6.2	641	0.41
1953	158,306,000	10,440	6.6	5,121	3.23	4,726	3.0	9,847	6.2	593	0.37
1954	161,183,000	10,227	6.3	5,237	3.31	4,425	2.7	9,662	6.0	565	0.35
1955	164,308,000	10,320	6.3	5,328	3.25	4,258	2.6	9,586	5.8	734	0.45
1956	167,259,000	10,284	6.1	5,622	3.36	3,967	2.4	9,589	5.7	695	0.42
1957	170,293,000	10,641	6.2	5,692	3.34	4,037	2.4	9,729	5.7	912	0.54
1958	173,232,000	10,476	6.0	5,948	3.43	3,688	2.1	9,636	5.6	840	0.48
1959	176,420,000	10,367	5.9	6,077	3.44	3,431	1.9	9,508	5.4	859	0.49
1960	179,323,175	10,668	5.9	6,248	3.48	3,482	1.9	9,726	5.4	942	0.53
1961	182,953,000	10,578	5.8	6,359	3.47	3,192	1.7	9,551	5.2	1,027	0.56
1962	185,822,000	10,474	5.6	6,423	3.46	2,958	1.6	9,381	5.0	1,093	0.59
1963	188,531,000	10,655	5.7	6,324	3.35	3,222	1.7	9,546	5.1	1,109	0.59
1964	191,334,000	10,843	5.7	6,425	3.36	3,264	1.7	9,689	5.1	1,154	0.60
1965	193,818,000	11,083	5.7	6,589	3.39	3,195	1.6	9,784	5.0	1,299	0.67
1966	195,857,000	11,083	5.7	6,584	3.36	3,149	1.6	9,733	5.0	1,350	0.69
1967	197,863,000	11,355	5.7	6,845	3.45	3,136	1.6	9,981	5.0	1,374	0.69
1968	199,861,000	11,251	5.6	6,805	3.40	2,981	1.5	9,786	4.9	1,465	0.73
1969	201,921,000	11,340	5.6	6,626	3.28	3,012	1.5	9,638	4.8	1,682	0.83
1970	203,235,298	11,355	5.6	6,626	3.25	2,932	1.4	9,558	4.7	1,797	0.88
1971	206,212,000	11,482	5.6	6,728	3.26	2,880	1.4	9,608	4.7	1,874	0.91
1972	208,230,000	11,622	5.6	6,616	3.18	3,038	1.5	9,652	4.7	1,970	0.95
1973	209,844,000										
1974	211,390,000										

rates for "malignant neoplasm of biliary passages and liver, stated to be *primary site*"—from 2.98 to 3.48, followed by a drop to 3.18 in 1972 (Table II).

It is expected that similar analyses conducted on smaller population groups, limited as to sex, age, occupation, race, religion, etc., would reveal deviations from the report presented. To arrive at valid conclusions for such individual groups, it would be necessary to consider, for each group, at least the following variables: (1) extent of exposure to specific organochlorine pesticides, (2) dietary habits including dietary deficiencies, and (3) the extent of exposure to the well recognized human hepatotoxic substances, including certain synthetic industrial and household chemicals, certain anesthetic agents and drugs, and radioactive materials. The increasing incidence of alcoholic cirrhosis and its relationship to liver cancer deaths deserves mention. According to a review on "Alcoholism and the Risk of Cancer,"⁵ "... the chance that a patient with alcoholic cirrhosis will subsequently develop a hepatoma has been reported to range from 8 to 30% and the longer the cirrhotic patient lives the greater the risk of this tumor."

Conclusions

1. Based on the U.S. vital statistics for the general USA population, the total death rates for cancer of the liver and its biliary passages (classified individually as "primary," "secondary," and "not stated whether primary or secondary") lead one to the conclusion that there has been a significant, almost constant decrease in the total rate of liver cancer deaths, namely, from 8.8 in 1930 to 8.4 in 1944 (when DDT was introduced) to 5.6 in 1972. This almost constant decline in total liver cancer death rates for the past 42 years fails to support the "positive," namely, clearcut evidence, of any increase in liver cancer deaths since the introduction of the first organochlorine pesticide into the U.S. environment. This decrease in liver cancer deaths is even more significant in light of the increasing life span of the people of the USA, which has resulted in an increased percentage of the population "at risk" to liver cancer over these years. True, the data presented do not provide specific information for a particular organochlorine pesticide, nor for that matter for any of the synthetic or "natural" chemicals that are known to be hepatotoxic in man.

2. If any of the organochlorine pesticides actually do possess very low potential for causing liver cancer in man, we consider it most unlikely that general population studies would uncover this fact. As we have often said, the population groups that should be studied in detail for liver and other cancers are those who are engaged in the manufacture, formulation, and extensive use of these compounds. Experience has shown that adverse effects of chemicals are generally observed first in those who are occupationally exposed.
3. Obviously, the incidence of liver cancer deaths presented in this report is no more accurate than the original death certificates which provided the data for the U.S. vital statistics. *In spite of the limitations inherent in the interpretation of such data, this report, to say the least, should remind us that today—more than 30 years after the introduction of DDT—we have no evidence whatsoever that DDT is carcinogenic in man.*

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