A Brief Overview of the Epidemiology of Dioxins and Furans

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This presentation discusses health effects associated with exposure to dioxins and furans. Sources of these exposures are discussed briefly as a preface to examining studies of exposed populations and their reported health effects.

Sources of Exposure to Dioxins and Furans

Because dioxins and furans are produced as contaminants of other chemicals, exposure is to a range of chemicals and to a variety of isomers of dioxin and furans. Most sources result in both occupational and environmental exposure (Hutzinger and Fiedler, 1989; Rappe et al., 1987). Industrial sources include the chemical industry, which produces and uses chlorophenols and their derivatives, as well as other chlorinated products. Paper and pulp processes and products as well as metal refining and smelting are additional sources (Amendola et al., 1989). Dioxins and furans are also released by numerous combustion sources such as municipal and hazardous waste incinerators as well as power plants and industries using wood or fossil fuels (Rappe et al., 1987). The heating of polychlorinated biphenyls (PCBs) results in contamination of the PCBs with various dioxins and furans (Hutzinger and Fiedler, 1989).

Environmental sources include food, cigarettes, pentachlorophenol-treated wood, automobile exhaust, residential heating systems and forest fires. There have also been environmental exposures that were due to unintentional reactor releases: probably the most well known incident occurred in Seveso, Italy (Reggiani, 1978). Japan and Taiwan both experienced occurrences of mass food poisoning due to consumption of chemically-contaminated rice oil (Kuratsune, 1989; Rogan, 1989).

Studies of Human Exposures to Furans

Research on human health effects due to the polychlorinated dibenzofurans (PCDFs) does not match the magnitude of research performed on the dioxins. However, the data derived from research on the toxicity of the polychlorinated dibenzodioxins (PCDDs) is considered to be also representative of the toxicity of PCDFs (Poland and Knutson, 1982). This is because the chemical structures of both are similar, both produce similar responses, although with varying potency, and both are believed to act by similar mechanisms.

Groups exposed to PCDFs (the Yusho and Yu-Cheng incidents, and fires and explosions involving PCB-containing electrical transformers and capacitors) have been studied to examine the toxicity to humans associated with the PCDFs. However, victims of these incidents were exposed to other toxic contaminants in addition to the PCDFs, including PCBs and PCDDs. Because several toxic contaminants were present, it cannot be precisely determined which of the toxic effects were due to PCDF exposure.

Most of the information available on the health effects of PCDF exposure comes from descriptive studies and cross-sectional medical studies. The observed health effects involve the dermatologic, neurologic, respiratory, immunologic, reproductive, and gastrointestinal systems (Elo et al., 1985; Fitzgerald et al., 1989; Kuratsune, 1989, Rogan, 1989). Dermatologic effects include acneform eruptions, black comedones and hyperpigmentation. The neurologic effects include transient subjective complaints (headache, dizziness and paresthesias of the limbs), and reduced sensory and motor nerve conduction velocities. The pulmonary

effects include chronic bronchitis and mild declines in pulmonary function. Immunologic effects include alterations in the levels of immunoglobulins, helper T-cells and suppressor T-cells. The gastrointestinal effects that have been found include elevations in SGOT, SGPT, alkaline phosphatase, triglycerides and urinary uroporphyrins. Finally, children born to mothers with Yusho or Yu-Cheng had low birth weight, developmental delays, natal teeth, and hyperpigmentation of the skin.

There have been only a few mortality studies of cohorts with PCDF overexposure. A preliminary report of a mortality study conducted 11 years after the Yusho incident observed that Yusho men had statistically significantly increased mortality due to all cancers combined, liver, and respiratory cancer (Kuratsune, 1987). A study of workers exposed to chemicals from an electrical transformer fire three years earlier observed no statistically significant elevation for any cause of death (Fitzgerald, 1989).

Studies of Human Exposure to 2,3,7,8-TCDD

Because the isomer 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) is the most toxic of the 75 isomers of dioxin, most research studies have focused on this isomer. Case reports and epidemiologic studies of human exposure to substances contaminated with 2,3,7,8-TCDD have been conducted since the early 1950's (Table 1). Some populations were exposed as a result of being employed in the production

Table 1. Health Effects Observed in Population Exposed to 2,3,7,8-TCDD

System	Condition	Population	Reference
Dermatologic	Chloracne	Production Workers	Suskind, 1984 Moses, 1985 May, 1973
		Seveso Residents	Reggiani, 1978
Neurologic	Reduced Pin Prick	Production Workers	Moses, 1984
	Reduced Conduction Velocity	Seveso Residents	Filippini, 1981
Hepatic	Enzyme changes	Production Workers	May, 1973 Moses, 1984
		Missouri Residents	Hoffman, 1986
		Seveso Residents	Ideo, 1985 Mocarelli, 1988
	Porphyria Cutanea Tarda	Production Workers	Bleiberg, 1964
	Lipid Changes	Production Workers	Suskind, 1984
Cardiovascular	Heart Disease Angina	Production Workers	Suskind, 1984
Pulmonary	Acute Bronchitis	Production Workers	Baader, 1951
	Reduced Pulmonary Function	Production Workers	Suskind, 1984
Malignancy	Basal Cell Carcinoma	USAF Ranch Hands	Lathrop, 1984
	Non-Hodgkin's Lymphoma	Sprayers, Forestry	Hardell, 1981
	Hodgkin's Disease	Sprayers, Forestry	Hardell, 1983
	Soft Tissue Sarcoma	Sprayers, Forestry	Hardell, 1979
	Nasal Cancer	Sprayers, Forestry	Hardell, 1982
	Stomach Cancer	Production Workers	Thiess, 1982

of 2,4,5-trichlorophenol (TCP) and its derivatives. Other study populations included those exposed during the spraying of phenoxy herbicides on crops or in the spraying of Agent Orange in Vietnam. Other studies involved residents of communities contaminated with tainted oil (Missouri, U.S.A.) and industrial effluent (Seveso, Italy). The condition reported most frequently in these studies involves the skin (chloracne). Other outcomes were reported less frequently, including disturbances of the neurologic system, liver, lipid levels, cardiovascular, pulmonary, and immunologic systems, as well as increased incidence of some malignancies. Specific outcomes reported in the literature are listed in Table 1.

Because of the limitations of the studies performed to date and the inconsistencies in their findings, NIOSH is conducting a mortality study and a cross-sectional medical study. The retrospective cohort mortality study includes all U.S. workers assigned to the production of substances contaminated with 2,3,7,8-TCDD (Fingerhut et al., 1990). The cross-sectional medical study involves a subset of these production workers (Sweeney et al., 1989). Analysis of two organ systems has been completed to date. An association between exposure to TCDD-contaminated materials and adverse health effects has not been found in either the respiratory system (Calvert et al., 1990) or the peripheral nervous system (Sweeney et al., 1990). Evaluation of the relationship between exposure to TCDD and mortality is currently in progress at NIOSH, in Seveso, Italy (Bertazzi, 1989), and in several countries under the coordination of the International Agency for Research on Cancer (IARC) (IARC Working Group, 1990).

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