Possible health hazards of the polychlorinated biphenyls.

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Since the 1930s it has been known that technical products containing polychlorinated biphenyls (PCB) can cause skin changes, so-called chlor-acne, and inflammatory conditions of the eyelids. Liver damage caused by occupational exposure to PCB has been reported from industry, and recently, in 1968, an extensive epidemic of food poisoning in Japan caused by rice oil contaminated with PCB has been reported, in which neurological signs were observed (1).

To evaluate health hazards in connection with a substance which is distributed in the environment, it is necessary to consider at least three factors:

1. The extent of exposure.
2. The risk of accumulation of the substance or its metabolites in the tissue.
3. The toxicity of the substance of its metabolites.

In the following, I will discuss what is known for PCB in relation to these three factors.

The earlier speakers have already described the common use of PCBs and their spread in the whole eco-system, especially in the aquatic environment. This widespread occurrence causes man to be exposed to PCB by food, water and air pollution. The larger part of the population, in the developed countries at least, is exposed to PCB, and this exposure varies between groups of different occupation and of different food consumption habits.

Is there then any risk for accumulation of PCB or its metabolites in the human tissue? The answer is undoubtedly yes. PCB has.

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been identified in human fat in several western countries. Concentrations around 6 ppm have been reported in human fat tissue from West Germany (2), and around 1 ppm in 45% of an examined population in USA (3) Similar figures have been reported from Norwegian autopsy material (4), in which values ranging from 0-5 ppm were found in brain tissues. Two cases in USA have been found to have 200 and 600 ppm in fat tissue (5). Analysis of human breast milk has shown mean concentrations of around 0.1 ppm in West Germany (2). Westöö and Norén (6) in Sweden conducted similar investigations and found a mean concentration in the Stockholm area of about 0.025 ppm. Their investigation was conducted during the period between 1967-1972, and from their results it cannot be excluded that there has been a continuous increase of the concentration of PCB in mother's milk during this period in the Stockholm area. In Japan, not less than a thousand persons were poisoned by PCB contaminated rice oil in 1968 (7). In several of these cases with chronic disease, high concentrations of PCB were found in the tissue eight months after exposure had ceased.

Available data thus strongly indicate a risk of accumulation of PCB in human tissue on prolonged exposure. Present data also give reasons to believe that there is a major difference between different chlorinated biphenyls in this respect. Those that have been identified in human fat are generally the more highly chlorinated ones, pentachlorobiphenyls and up to decachlorobiphenyls (5), while the less chlorinated biphenyls have not been shown to have the same tendency for accumulation and retention in human tissue.

The tendency of PCB to be retained on prolonged exposure does not in itself imply a health hazard. A health hazard will not occur until the concentrations of PCB in critical organs or critical tissue have risen to a toxic level. Our knowledge about the toxicity of the PCBs is very limited and uncertain. Most data concerning the toxicity of PCB is derived from experiments and clinical observations after exposure to technical products of undefined composition with regard to their content of different PCBs as well as to possible impurities originating during manufacture. Vos et al (8) has shown that at least two technical products contain chlorinated dibenzo-

furans, compounds of high toxicity which cause signs similar to those described with so called PCB intoxication, as for instance liver damage and skin manifestations. It has not been possible from the literature to find out whether Kanechlor, the technical preparation that caused the Japanese epidemic, also contains chlorinated dibenzofurans. However, the fact that this product also gave rise to an epidemic of chick oedema disease in Japan (7) indicates that this may have been the case. So far, no studies on the toxicology of a single defined PCB have been published in the literature. Judged from published observations on the toxicity of technical PCB preparations in mammals and clinical observations from the Japanese poison epidemic, and reported cases of occupational disease caused by PCB containing products, the following effects may arise if a sufficient dose of PCB is retained.

1. Induction and stimulation of liver microsomes. Experimental observations indicate that higher chlorinated biphenyls are more effective than lower (9).
2. Liver damage (7).
3. Interference in fat and steriod metabolism with an increase in triglycerides in plasma, and excretion of 17-ketosteroids in urine (10).
4. Interference in porphyrin metabolism with an increased excretion of porphyrins (11).
5. Acneiform dermatitis (7).
6. Changes in the conduction velocity of peripheral nerves and interference in the cerebral cortical function (1).
7. Foeto-toxic effects causing foetal death or congenital abnormalities as well as retarded development (12).
8. Immunodepression (13).

It cannot be excluded that the PCB products used in experimental studies, and those to which cases of poisoning have been exposed, have contained impurities like chlorinated benzofurans. Thus, some of the above listed effects may, partly or entirely, have been caused by such impurities.

Epidemiological investigations in Japan indicate that the dose of Kanechlor in affected persons was an average around 2 g, and

varied from 0.5 g and upwards (7). Other data, elucidating dose response relation for toxic effects caused by PCBs in man, are not available. It has to be pointed out, however, that the Japanese figures relate to Kanechlor and do not permit conclusions about different types of chlorinated biphenyls and the occurrence of toxic impurities in Kanechlor cannot be excluded.

CONCLUSION

The conclusion is that it is today impossible to estimate the health hazards to man due to long term exposure to PCB, as we lack knowledge about their toxicity. There is an appreciable exposure to these compounds in our communities and there is an evident tendency to accumulation of chlorinated biphenyls in human tissue. It cannot be excluded that the present spread of PCB in the environment can involve significant health hazards in the long rung, and it cannot be excluded that there is a continuous increase of exposure. It is questionable whether steady state between pollution and distribution in the eco-system is obtained at present.

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REFERENCES

1 Yoshiyuki Murai and Yoshigoro Kuroiwa. Peripheral neuropathy in chlorobiphenyl poisoning, Neurology, Vol. 21, Nov 1971.

2 L. Acker und E. Schulte. Über das Vorkommen von chlorierten Biphenylen und Hexachlorbenzol neben chlorierten Insektiziden in Humanmilch und menschlichem Fettgewebe, Naturwissenschaffen 57, 497, 1970.

3. Harold A. Price and Robert L. Welch. Occurrence of Polychlorinated Biphenyls in Humans, Env. Health Perspectives, Experimental Issue no. 1, 73-78, 1972.

4. John Erik Bjerk. Rester av DDT og polyklorerte bifenyler i norsk humant materiale, T. norske Lægeforen., 92, 15-19, 1972.

5. Francis J. Biros, Annita C Walker and Angela Medbery. Polychlorinated Biphenyls in Human Adipose Tissue, Bulletin of Env. Contamination & Toxicology, Vol. 5, No. 4, 1970.

6. Gunnel Westöö and Koidu Norén. Levels of organochlorine pesticides and polychlorinated biphenyls in Swedish human milk, Vår föda, vol. 24, nr 4, 1972.

7. Masanori Kuratsune, Takesumi Yoshimura, Junichi Matsuzaka, and Atauko Yamaguchi. Epidemiologic Study on Yusho, a Poisoning Caused by Ingestion of Rice Oil Contaminated with a Commercial Brand of Polychlorinated Biphenyls, Env. Health Perspectives, Experimental Issue no. 1, 119-128, 1972.

8. J.G. Vos, J.H. Koeman, H.L. van der Maas, M.C. ten Noever de Brauw and R.H. de Vos. Identification and Toxicological Evaluation of Chlorinated Dibenzofuran and Chlorinated Naphthalene in Two Commercial Polychlorinated Biphenyls, Fd Cosmet. Toxicol., Vol. 8, 625-633, 1970.

9. David R. Bickers, Leonard C. Harber, Attallah Kappas and Alvito P. Alvares. Polychlorinated biphenyls: Comparative effects of high and low chlorine containing Aroclors® on hepatic mixed function oxidase, Research Communications in Chemical Pathology and Pharmacology, Vol. 3, No. 3, 1972.

10. Masanori Kuratsune. An Abstract of Results of Laboratory Examinations of Patients with Yusho and of Animal Experiments, Env. Health Perspectives, Experimental Issue no. 1, 129-136, 1972.

11. J.G. Vos and R.B. Beems. Dermal Toxicity Studies of Technical Polychlorinated Biphenyls and Fractions Thereof in Rabbits, Toxicology and Applied Pharmacology, 19, 617-633, 1971.

12. Ichiro Funatsu, Fumio Yamashita, Yushi Ito, Shin Tsugawa, Takako Funatsu, Takashi Yoshikane, Masao Hayashi, Toshi Kato, Michiaki Yakushiji, Gen Okamoto, Seiichiro Yamasaki, Tadashi Arima, Tsuneko Kuno, Hayami Ide and Ichiro Ide. Polychlorbiphenyls (PCB) induced Fetopathy, The Kurume Medical Journal, Vol. 19, No. 1, 1972.

13. J.G. Vos. Toxicology of PCBs for Mammals and for Birds, Env. Health Perspectives, Experimental Issue no. 1, 105-117, 1972.

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