New York State Health Planning Commission

HEALTH ADVISORY COUNCIL

EMPIRE STATE PLAZA, TOWER BUILDING, ROOM 1161, ALBANY, NEW YORK 12237 518 474-[illegible]

HUGH L. CAREY
GOVERNOR

KEVIN M. CAHILL, M.D.
CHAIRMAN, HPC

THOMAS P. DOWLING
CO-CHAIRMAN

SAUL FARBER, M.D.
CO-CHAIRMAN

WILLIAM F. LEAVY
DIRECTOR, HPC

REPORT OF THE AD HOC COMMITTEE ON THE HEALTH IMPLICATIONS OF PCBs IN MOTHERS' MILK

January 7, 1977

MONS 012986

Membership of the Ad Hoc Committee

on the Health Implications

of PCBs in Mother's Milk

David Axelrod, M.D. (Member)
Director of Laboratories, and
Commissioner's Special Assistant
on Toxic Substances
N.Y. State Department of Health

Laurence Finberg, M.D. (Member)
Director of Pediatrics, Montefiore Hospital,
Prof. of Pediatrics
Albert Einstein College of Med., and
Member, Comm. on Environmental Hazards
American Acad. of Pediatrics

Theodore Hullar, Ph.D. (Member)
Deputy Commissioner
N.Y. State Dept. of Environmental
Conservation

Robert W. Miller, M.D. (Member)
Chief, Clinical Epidemiology Branch
National Cancer Institute, and
Chairman, Comm. on Environmental Hazards,
American Acad. of Pediatrics

Norton Nelson,Ph.D. (Consultant)
Director, Inst. of Environmental Med.
New York University Medical Center
Chairman, EPA Advisory Committee on Health and Ecology

George Reader, M.D. (Member)
Chairman, Dept. of Public Health
Cornell University Medical Center

Merril Eisenbud, Sc.D. (Chairman)
Prof. of Environmental Medicine
New York University Medical Center

Introduction

The polychlorinated biphenyls (PCBs) are a versatile group of industrial chemicals that have been widely used for more than 40 years. In 1970, it became apparent that PCBs had been accumulating as trace pollutants in many bodies of water, and were capable of such a high degree of biomagnification that fish were contaminated to levels frequently above those at which the FDA recommends that restrictions on human consumption be imposed.

The subject of human poisoning by PCBs came to worldwide attention as a result of an outbreak of cases in 1968 among Japanese who consumed rice oil contaminated by PCBs from a leaking heater in which they were used as a heat exchange fluid. The disease has become known as "Yusho", which means rice oil disease, and by 1975, a total of 1,291 patients with this disease had been registered in 22 prefectures of western Japan. The patients complained initially of a type of acne known to be associated with exposure to certain chlorinated hydrocarbons, and had, among other signs and symptoms, brown pigmentation of the skin and nails, increased eye discharge, swelling of the eyelids, and transient visual disturbances. Infants born to the affected mothers had low birth weights and also showed transient darkening of the skin. It is significant that the only cases of non-occupational human PCB poisoning reported to date are those reported from the Yusho incident.

One measure of the severity of PCB exposure is the body burden (the quantity of PCBs stored in the body), which was

estimated in the Japanese by analysis of body fat, as well as the lipid fraction of blood and milk. Similar measurements were made elsewhere in Japan, and it was found that many persons without symptoms of any kind had body burdens comparable with those found in Yusho patients. It is believed that this seeming inconsistency can be explained by the fact that the PCBs in the rice oil contained polychlorinated dibenzofurans (PCDFS), a related family of chemicals which are between 200 to 500 times more toxic than the PCBs. It was reasoned that the PCDFs may have been formed by decomposition of the PCBs in the heat exchanger in which they were maintained at high temperature for an extended period of time.

Although the Japanese studies seemed to be reassuring so far as the Japanese public was concerned, there has been insufficient attention given the matter in the United States, as a result of which no epidemiological studies have been undertaken in this country, except for a series of measurements of the PCB content of maternal milk.

PCB Contamination in Fish in New York State

An earlier ad hoc committee, on which some of the present committee served, was convened about one year ago to consider the implications of PCB contamination in fish taken from the Hudson River by commercial and sports fishermen. In our report of December 18, 1975 it was recommended that certain restrictions be imposed on Hudson River fishing, and this was done jointly by

the Department of Health and Department of Environmental Conservation in their announcement of February 24, 1976. It became known that Lake Ontario fish were also contaminated in excess of the FDA limit, and a limited ban on Lake Ontario fish was accordingly also imposed in the same announcement.

Subsequent analyses of Lake Ontario fish have indicated that the highly toxic chlorinated hydrocarbon, Mirex, is also present and on September 14, 1976 the Department of Environmental Conservation, after certification by the Department of Health, placed limited restrictions on the taking of fish known to be contaminated with Mirex.

Fish from fresh waters contaminated with PCBs are the main route of human exposure to PCBs. Samples of fish from both the Hudson River and Lake Ontario have been collected for PCB analyses since 1972. The analytical chemistry of the PCBs and other chlorinated hydrocarbons are complex, and since concentrations of these compounds in fish, vary from species to species, place to place, and time to time, formidable obstacles are placed in the way of obtaining adequate information about the levels of contamination. The PCBs exist in more than 200 isomeric forms. During the past four years, a total of approximately 1000 fish have been analyzed for PCBs in New York State by several organizations including the State's Departments of Environmental Conservation and Health, the U.S. EPA, and the U.S. FDA.

Despite these seemingly large numbers, it is difficult to be sufficiently quantitative about the extent of human exposure.

There is a wide variability of the levels of reported contamination. For example, the mean concentration of PCBs in ten samples of Coho salmon from Lake Ontario was 5.9 ± 3.2 parts per million, which suggests the likelihood that 10.0% of the Lake Ontario Cohos may exceed 10 parts per million. The mean concentration in 41 samples of lake trout was 6.5 ± 4.7 parts per million, which indicates that 23.0% of the fish may exceed 10 parts per million.

Seventeen samples of fish collected from various parts of Lake Ontario in 1976 were analyzed for Mirex and DDT. It was found that the two are highly correlated (r^2= 0.764), so that a person consuming a fish high in PCBs is likely to be consuming excessive Mirex as well. An even stronger association has been shown in the relationship between PCBs and DDT metabolites (r^2= 0.96).

The present FDA limit for PCBs in fish is 5.0 parts per million. The Canadians have dropped the limit to 2.0 parts per million, and it is possible that the FDA will follow suit. Should this action be taken by FDA, additional species of fish from the Hudson River and Lake Ontario would be in excess of the limit.

A major uncertainty is the extent to which New York State residents are violating the prohibitions against consumption of fish from these two bodies of water. Commercial fishing is relatively simple to regulate, but there is less certainty with respect to sports fishing. It is estimated that prior to

the ban, Lake Ontario accommodated about 665,000 fishermen-days per year. It is estimated that the Hudson River accommodated 80,000 fishermen-days in 1974.

Reported Values of PCBs in Human Fat and Maternal Milk

The concentration of PCBs in human fat and milk have been measured in a number of countries. Japanese investigators have shown that the PCB content of the lipid fraction of human milk is comparable with the PCB concentrations in adipose tissue. Much of the lipid fraction of maternal milk thus originates from the pool of body fat rather than fats contained in food consumed during the immediate period of lactation. Transfer of PCBs to the infant is thus determined by the history of PCB consumption by the mother over a considerable period of time. A mother who has regularly consumed PCB contaminated foods cannot reduce the PCB content of her breast milk by abstaining from consumption of contaminated fish for a few days or weeks.

Data from Canada demonstrate the presence of 1-2 ppm in fat from a majority of persons tested.

The lipid fraction of eighty samples of human milk from different areas of the U.S. have also been analyzed. All but two samples contained detectable amounts of PCB ranging from 0.4 to 10.6 ppm. The average concentration of all samples was approximately 1.7 ppm. No data are available from New York State up to the present time.

A Michigan study of PCB blood concentrations in persons

who regularly consumed Lake Michigan sport fish provides the most extensive data on the relationship between exposure and blood concentration. The following conclusions were reached from those studies:

1. PCB blood levels (whole blood) ranged from 0.007 ppm in persons who ate no fish to a maximum of 0.366 ppm for a person eating Lake Michigan fish.

2. There was a direct relationship between the size and quantity of sport species of fish eaten and the PCB levels found in human blood.

3. Those who annually consumed 24 or more pounds of sport fish from Lake Michigan had a mean blood PCB value of 0.073 ppm; persons annually eating 6 pounds or less had a mean level of 0.020 ppm; persons who ate no fish averaged 0.017 ppm. Since the PCBs are known to concentrate in fat, which is present in blood in the amount of 0.65%, the lipid fraction in the blood of heavy fish eaters may be in excess of ten ppm.

4. The level of PCB found in the blood of participants did not change significantly from year to year, nor did it diminish significantly when fish consumption was eliminated for up to nine months.

5. The PCB levels observed in cooked fish were lower than expected from reported levels in raw fish. This is presumably due to the fact that some of the fat is lost during boiling or frying.

6. Eighty-two percent of those who exceeded the state's

recommended maximum intake (no more than one meal per week or 24 pounds per year) of Lake Michigan fish received an estimated annual dose of PCB which was greater than that approved by the Food and Drug Administration as the maximum annual dose of PCB which should be received over a protracted period of time. The estimated intake in Michigan ranged from 0.49 µg PCB/Kg body weight/day to 3.94 µg PCB/Kg body weight/day and averaged 1.7 µg/Kg body weight/day. The Food and Drug Administration recommends that PCB intake not exceed 1 µg/Kg body weight/day for long-term exposure.

Japanese workers have attempted to correlate the relationship between the reported blood and milk levels of PCBs. Their data suggest that the level of PCBs in the milk fat is approximately 300 times the blood level. An independent study of the relationship between adipose tissue and blood PCB levels provided a factor of approximately 230. (If we take the blood lipids to be 0.65% by weight of whole blood, and assume all the PCBs to be in the lipid fraction, the concentration of PCBs in blood lipids should be about 150 times the concentration in whole blood.) Using these data, we would expect that persons who ingested 24 or more pounds of sport fish per year from Lake Michigan would secrete PCBs in maternal milk at a concentration of approximately 22 ppm; persons who ate no fish would have a mean level of approximately 5.0 ppm. The mean age of the Michigan group was 45.9 years, considerably older then lactating mothers. Whether this would have a significant affect on the body burden is not known.

Milk measurements provide an indication of the relative risk of transuterine intoxication of the fetus as well as a measure of the risk to the nursing child.

Bearing in mind that the lipid fraction of maternal milk in the United States has been shown to range as high as 10.6 parts per million PCB with a mean of 1.7 parts per million, the potential risk due to absorption of PCBs by the fetus or infant takes on a new significance on the basis of data from primate experiments in the laboratories of Dr. James Allen at the University of Wisconsin. Dr. Allen reported marked fetal intoxication in eight Rhesus monkeys fed 5 parts per million PCB. Only one live infant was born to these animals. Among eight monkeys fed 2.5 parts per million PCB, five live infants were born and, at two months of age, showed symptoms of PCB intoxication attributed to consumption of PCB-containing milk from their mothers. Three milk samples taken from the mothers varied from 0.154 to 0.397 parts per million whole milk. On the assumption that the PCB was contained in the lipid fraction, which in Rhesus is about 4% by weight of whole milk, the lipid fraction contained 3.8 to 10 parts per million. The PCB in the lipid component of the fourth sample was measured directly and found to be 16.4 parts per million. The PCB content of the milk lipids being fed the Rhesus infants was thus in the range of the higher values found in U.S. surveys of maternal milk.

There is evidence that the PCBs used in the Allen experiments were contaminated by PCDFs, but insufficient quantitative

information is available to define the extent of their influence on the observed effects. However, there is no reason to believe that the degree of PCDF contamination would be comparable to that found in the Yusho incident.

While it is comforting to know that there have been no reports of PCB injury among members of the general public, despite the fact that generalized PCB contamination has probably existed for as long as 20 years, it cannot be assumed that PCB poisoning has in fact not occurred among breastfed infants of mothers who routinely consume above-average quantities of fish from fresh waters known to be contaminated with PCBs. There have been no public health studies in this country that would give us these assurances, and one cannot be certain that physicians attending the infants would be alert to the subtle effects that may occur in a small percentage of babies. Moreover, such observations would of necessity be confined to the short-term effects and not to those that may develop later in life.

Breast Feeding -- Relevant Nutritional, Psychological, and Socioeconomic Factors

Breast feeding is the optimal manner for infant feeding. The reasons are nutritional, immunological, psychological, maternal health, hygienic, convenience, and economic.

The nutritional value relates to several factors of relative rather than of absolute importance. First, the percentage of calories and protein is rather low (about 8%) but excellent growth is nevertheless obtained, probably owing to the superior biological value of the specific lactalbumen. The most recent data on the superiority of human milk protein relate to its

taurine content and the role of this amino acid in the developing central nervous system. The carbohydrate, lactose, and fat are present in appropriate amounts, and because the mineral content per calorie is low compared to other animal milks, optimal growth may occur without excessive solute load for renal excretion. Compared to other milks, the phosphate content is low, permitting good calcification of the skeleton provided that Vitamin D either is supplemented or formed in the skin by sunlight exposure. All of the other vitamins are adequately contained in human milk.

The particular mixture of caloric sources in human milk leads to colonization of the intestine by a predictable microbiologic flora which may be adapted to specific human infant needs both in a nutritional and immunologic sense.

The nutritional benefits of human milk are maximal for about three months, after which other foods should be added to the infants diet.

Breast feeding also provides immunologic benefits to the infant from antibodies and perhaps other immunologic components in the colstrum and more mature milk. These factors are most important in the early weeks of life, and it is possible that partial protection extends for up to three months.

The psychological virtues of mother-infant interaction promoted by breast feeding is generally thought to be the most important of all benefits. The unique intimacy of the two-organism homeostatic system is clearly desirable. The period

of optimum duration is controversial but consensus would indicate somewhere six to nine months to be maximal.

For all of the foregoing reasons, breast feeding for human infants is desirable. None of the reasons, however, would warrant a significant risk of poisoning. Artificial feeds have been adequately demonstrated to provide satisfactory early nutrition, and our total societal development has proved superbly adequate to protect the lives and well being of artificially fed infants. Even the psychological interaction is not precluded by artificial feeding, though perhaps in some circumstances reduced.

The period it takes to establish a good milk supply varies from four to six weeks. Therefore, recommendations for and against breast feeding probably ought not to consider periods of less than ten to twelve weeks for the total lactation. In a situation such as the present where risks are being balanced against benefits, there are two levels at which the decision may be properly made. Where the risk seems high, the decision not to nurse at all would be appropriate. Where the degree of risk is mild or unknown, a shortened period of nursing could be realistically considered. The body burden of PCB in the infant obtained from the mother comes prenatally from transplacental transmission and potentially from milk. The risk may be minimized by reducing the total dosage the infant receives through a shorter nursing period.

Summary

1. The only known instances of non-occupational human poisoning from PCB was the Japanese rice oil incident in 1968.

2. PCB measurements in human lipids in many parts of Japan revealed levels as high as the lower range of those seen in connection with the rice oil incident, but no effects of PCB intoxication were observed.

3. It has been postulated that the rice oil disease resulted, at least in part, from contamination of the PCBs with polychlorinated dibenzofurans (PCDFs), possibly produced by the degradation of PCBs in the heat exchanger used in preparation of the rice oil.

4. There are great technical difficulties in PCDF analysis and accordingly there have been few measurements of PCDFs in the environment or in human tissues.

5. Recent experiments with Rhesus monkeys at the University of Wisconsin have demonstrated that severe PCB intoxication occurs in Rhesus infants born to mothers fed PCB-contaminated food. Whereas in Yusho, PCDFs may have played a role, there is no reason to believe this was true to the same extent in the Wisconsin experiments.

6. The levels of PCB in the Rhesus milk were comparable with the upper range of PCB contamination found in human milk samples in the United States and Canada.

7. Although no symptoms of PCB poisoning have been reported in this country, it is important to note that no studies have been undertaken, and it is possible that infrequent symptoms of intoxication are being overlooked by the attending physicians if they occurred infrequently.

Recommendations

In view of the above facts, this committee recommends the following:

1. The warning and prohibition in regard to human consumption of fish taken from contaminated waters issued by the Health Department on February 24, 1976, and the Department of Environmental Conservation on September 14, 1976, should be reissued and given wide publicity.

2. Mothers whose dietary habits regularly include more than two meals per week of fish from waters known to be contaminated with PCBs should be instructed to consult with their physicians and consider the advisability of terminating breast feeding at the end of three months.

3. A statement concerning the position of this committee in this respect should be communicated to the chapter and district chairmen of the American Academy of Pediatrics with the request that the statement be communicated by the Academy to its members and to the medical profession generally.

4. An epidemiological study should be undertaken immediately with the following objectives:

a. To determine the extent of contamination of human breast milk in areas of the high risk populations: i.e., along the shores of Lake Ontario and the upper reaches of the Hudson River.

b. To establish the relationship between milk levels, maternal blood concentration, cord blood concentration, placental concentration, and colostrum concentration at birth, and to examine trends in milk and maternal blood concentration

over time.

c. To investigate the correlation between PCB/total organic chlorine levels and a number of specific signs or symptoms in the newborn.

d. To follow breast fed and non-breast fed infants over a period of time and look for differences in incidence of a number of specific effects.

e. To generate other hypotheses about toxic effects of chronic low dose PCB exposure in children.

f. To establish a cohort of exposed children for follow up studies of suspected long-term effects.

g. To provide nursing mothers and potential nursing mothers information upon which to weigh risks and benefits from nursing.

5. Because the role of the polychlorinated dibenzofurans has not been fully defined, and because there is a dearth of measurements of PCDFs in environmental and biological samples, steps should be taken immediately to develop simplified PCDF analytical procedures so that measurements can be facilitated in the future.