Mercury Levels in High-End Consumers of Fish

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Consumption of food containing mercury has been identified as a health risk. The U.S. Environmental Protection Agency (U.S. EPA) and the National Academy of Sciences recommend keeping the whole blood mercury level < 5.0 µg/L or the hair level < 1.0 µg/g. This corresponds to a reference dose (RfD) of 0.1 µg/kg body weight per day. All patients in a 1-year period (n = 720) who came for an office visit in a private internal medicine practice in San Francisco, California, were evaluated for mercury excess using the current RfD. One hundred twenty-three patients were tested (93 females, 30 males). Of these, data were statistically analyzed for 89 subjects. Mercury levels ranged from 2.0 to 89.5 µg/L for the 89 subjects. The mean for 66 women was 15 µg/L [standard deviation (SD) = 15], and for 23 men was 13 µg/L (SD = 5); 89% had levels exceeding the RfD. Subjects consumed 30 different forms or types of fish. Swordfish had the highest correlation with mercury level. Sixty-seven patients with serial blood levels over time after stopping fish showed a decline in mercury levels; reduction was significant (p < 0.0001). A substantial fraction of patients had diets high in fish consumption; of these, a high proportion had blood mercury levels exceeding the maximum level recommended by the U.S. EPA and National Academy of Sciences. The mean level for women in this survey was 10 times that of mercury levels found in a recent population survey by the U.S. Centers for Disease Control and Prevention. Some children were > 40 times the national mean. *Key words:* accumulation, amalgam, children, fish, methyl mercury, pregnancy. *Environ Health Perspect* 111:604–608 (2003). doi:10.1289/ehp.5837 available via *http://dx.doi.org/* [Online 1 November 2002]

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Fish accumulate methyl mercury in their tissues, where it becomes strongly bound. Methyl mercury is not removed from fish tissue by any practical cooking method (Chicourel et al. 2001; Morgan et al. 1997; U.S. EPA 1999).

Methyl mercury is absorbed on average 95% when consumed. From the bloodstream, it is taken up by all tissues, with an initial phase of distribution of 1–2 days after a single dose (Clarkson 1997). It is excreted predominantly in the feces but also in urine and sweat. A conversion factor of 1:250 has been used to convert hair to whole blood (4.0 µg/L × L/1,000 g × 250 = 1.0 µg/g; Clarkson 1997; Mahaffey and Rice 1998).

Methyl mercury can accumulate if consumed at a greater rate than it is excreted. It has a strong affinity for sulfhydryl groups in tissues and accumulates to a greater concentration in brain, muscle, and kidney (NAS 2000).

Methyl mercury crosses the maternal to fetal blood compartments, where it binds to red blood cells and other fetal tissues. By the time of parturition, cord blood is on average twice that of the maternal blood concentration. Individual studies have reported mother to cord blood ratios much greater than 1:2 (Bjerregaard and Hansen 2000; Hansen et al. 1990; Vahter et al. 2000; Weiss 1994).

Methyl mercury easily crosses the blood–brain barrier, where biotransformation to inorganic mercury takes place. The brain:blood concentration ratio when the initial distribution phase is completed is between 10:1 and 5:1. Once in the central nervous system, methyl mercury can be demethylated to inorganic mercury. This latter form of mercury has a long half-life in brain tissue and can be measured in years (Clarkson 1997; Davis et al. 1994; Pedersen et al. 1999). The average half-life in blood for methyl mercury in adults is 70 days, in children 90 days, and in lactating women 46 days (Swartout and Rice 2000).

In this article we report the dietary habits and corresponding mercury levels of patients in a San Francisco, California, internal medicine practice who consume excess mercury through fish, many of whom had mercury levels at or greater than the U.S. EPA's RfD.

Methods

All patients in a general internal medicine practice in San Francisco who came for an office visit during a 1-year period were evaluated for risk of mercury excess. The practice is mostly middle to higher income patients. Patients were asked to estimate from a list of fish the average number of times per week or month they ate each fish, and the length of time they were on their current diet. The patients were given an opportunity to add other fish to the list. The average restaurant serving of fish in five local restaurants that subjects frequented was reported to be 5.0–8.0 ounces (150–227 g). Patients were asked to estimate the portion size that they consumed per serving. A reference amount of 170 g or 6-oz can of tuna was used to help patients estimate their intake. Some patients gave a range for their frequency of intake.

The ranges were averaged based on a 28-day month. Portion size was converted to a size of 5.0–8.0-oz (150–227 g) portions per month. Canned tuna was measured in 6-oz (170 g) cans per month. To separate tuna from lobster or crab, sushi and shellfish were placed into separate categories. To estimate risk of mercury exposure, portion size in grams for each type of fish meal eaten by patients was multiplied by the average mercury content of that fish, as determined by published tables [Food and Drug Administration (FDA) 1995; Mahaffey and Rice 1998]. Table 1 shows mercury data used for the 11 most commonly eaten fish for this study population.

Those whose dietary history suggested their mercury intake was at or greater than the RfD for their average monthly intake, 0.1 µg/kg body weight per day, were asked to be screened with a whole blood mercury test. Patients were also tested if they had symptoms consistent with methyl mercury excess regardless of estimated dietary levels of mercury. These symptoms, such as fatigue, headache, decreased memory, decreased concentration, and muscle or joint pain, have been delineated in large epidemiologic studies as symptoms of mercury excess (Fukuda et al. 1999; Harada 1995). The criteria for symptoms were that the patients had sought health care for symptoms or that symptoms affected daily living. Patients were excluded if fish were obtained

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from noncommercial waterways, including fish caught in the San Francisco Bay or local rivers and streams.

Other sources of mercury exposure were investigated through questionnaires and physical exams: silver/mercury dental amalgams; vaccine records; occupational exposure; home environment exposures; supplements such as fish oils, herbs, and medications; cosmetics; drinking water; and other foods.

This study was conducted in a private medical office, and therefore patients chose a variety of clinical labs based on insurance criteria and convenience.

Twelve drawing stations were involved in collecting the specimens. All specimens were collected in a royal blue-top, metal-free tube with ethylenediamine-tetraacetic acid disodium (EDTA-Na_2). The testing was performed at seven laboratories for a total of 225 tests. Specialty Labs of Santa Monica, California, performed 84% of the whole blood tests. Most (98%) of the blood analyses were performed by four labs, using inductively coupled plasma–mass spectrometer (ICP-MS) model HP4500 ICP-MS (Agilent, Foster City, CA). Controls were whole blood I (lot M98-07; Centre of Toxicology of Québec, Sainte-Foy, Québec, Canada) and whole blood II (lot M98-02). Low control standard deviation (SD) was ± 0.36 µg/L with a coefficient of variation of 11.7%; high control SD was ± 1.12 µg/L with a coefficient of variation of 8.4%. Dynamic range of the assay is 2.0–800 µg/L. Specialty Labs participates in the Quebec ICP-MS external proficiency program. They are licensed by California and by California laboratory improvement amendments.

All study patients with unexplained symptoms or mercury levels higher than 5.0 µg/L whole blood or 1.0 µg/g hair were instructed to either stop all fish for 6 months or eat only fish that are known to be low in mercury, such as salmon, tilapia, sole, sardines, or small shellfish.

Results

We evaluated 720 individuals from March 2000 to March 2001. Fewer than 20 patients who met the criteria for testing declined testing.

We tested 123 patients: 93 females and 30 males. All but one lived in San Francisco or the surrounding bay area. Among the occupations held by the study patients were physicians, scientists, banking industry professionals, business owners, internet executives, lawyers, investment brokers, and corporate executives. Retirees and homemakers were also included. Seven children are also represented in the survey.

One hundred sixteen patients had a whole blood level as their initial test; seven patients had a hair level analysis. Of the blood levels tested, 103 (89%) were ≥ 5.0 µg/L, 63 (54%) were ≥ 10 µg/L, 19 (16%) were ≥ 20 µg/L, and 4 were > 50 µg/L. The mean was 14.0 µg/L. Hair levels ranged from 1.55 to 14.81 µg/g.

Four adult patients had received thimerosal-containing vaccinations within 60 days before testing. The minimum time intervals from vaccine to mercury test for these patients ranged from 14 to 49 days. Their levels ranged from 9.9 to 35.4 µg/L. The minimum time interval for children from vaccine to mercury test was 12 months.

The number of silver/mercury dental amalgams seen in the patients on this survey ranged from 0 to 14. Most patients who had fillings had gold or composite. Some patients, including one with a mercury level of 76.0 µg/L, reported having all amalgam removed at least 2 years before testing.

Sushi consisted of multiple combinations, including ahi, yellow tail, mackerel, salmon, eel, and sea urchin. Many patients reported eating only ahi as sushi. Shellfish consisted of shrimp, prawns, crab, mussels, oysters, and scallops. Only two patients reported eating lobster. Nearly all sashimi was in the form of ahi.

Eighty-nine of the 123 patients were statistically analyzed. Specialty Labs performed 90% of the tests; 34 were excluded from further statistical analysis for the following reasons: some patients were unable to recall their diet, hair analysis was done instead of a blood level, patients were consuming fish oil supplements that may contain mercury, and some patients stopped fish consumption or delayed testing (one patient had stopped eating fish for 2 months and had a blood concentration of 9.0 µg/L, whereas two others delayed 2–3 weeks and had levels of 13 and 11 µg/L). All other patients obtained their initial test before or within a few days of stopping fish consumption. The seven children were not used for statistical analysis because of the increased half-life compared with adults as well as their greater serving size:body weight ratio compared with adults. Two patients consumed noncommercially caught fish. Although both individuals caught these fish in federal waters, they did not have a commercial license, so their data were not used for statistical analysis. Their mercury levels were 4.6 and 12.9 µg/L.

Table 1. Average methyl mercury level in fish as reported by the Mercury Study Report to Congress (Mahaffey and Rice 1998).

Species	Average wet weight Hg (µg/g)
Sea bass	0.157
Crab	0.117
Flounder	0.092
Halibut	0.25
Lobster	0.232
Salmon	0.035
Scallops	0.042
Shark	1.327
Shrimp	0.047
Snapper	0.25
Swordfish	0.95
Ahi	0.38[a]
Tuna	
Average	0.206
Light skipjack	0.13
Light yellow	0.218
Albacore	0.20

[a]Data from FDA (1995).

Statistical analyses of baseline levels of mercury in 89 adults revealed the following: The level of mercury ranged from 2 to 89.5 µg/L for the 89 subjects. The mean level was 14.5 µg/L, and the median was 11.2 µg/L; 82 subjects had levels greater than 5 µg/L, and 16 subjects had levels greater than 20 µg/L. There was no difference in the distribution of mercury level in men and women. The mean for 66 women was 15 µg/L (SD = 15), and for 23 men the mean was 13 µg/L (SD = 5). Ages ranged from 27 to 87 years (median age, 49 years; mean age, 50 years), and a slight increase of mercury level with age was not statistically significant (increase of 0.15 µg/L per year; $p = 0.21$). Seventy-seven subjects reported the number of years they had been on their current diet. The mean was 9.3 years (median = 6 years), with a range from 1 to 30 years. Mercury levels decreased slightly with diet years, but the decrease was not statistically significant (decrease of –0.06 µg/L per year; $p = 0.8$).

Subjects consumed 30 different forms/types of fish. Table 2 shows correlations between fish consumption and mercury levels for fish consumed by 20 or more subjects. Swordfish had the highest correlation with mercury level (Pearson correlation = 0.71, $p = 0.001$). This was the only fish with a significant positive correlation with mercury level. Red snapper and sole consumption correlated negatively with mercury level, but only red snapper was statistically significant (Pearson correlation = –0.39, $p = 0.03$). No other correlations were significant. Because multiple factors that univariately affected mercury level were not seen, multivariate analysis was not performed. Cause and effect regarding symptoms is not addressed in this article.

Sixty-seven patients were followed over time with serial blood levels after stopping or greatly reducing intake of fish with moderate

Table 2. Fish consumption and correlation with mercury.

Fish	No. subjects	%	No. meals[a]	Pearson correlation
Canned tuna	69	78	3.65	–0.02
Salmon	66	74	4.60	0.21
Swordfish	64	72	1.94	0.71
Halibut	60	67	2.00	0.04
Ahi steaks	57	64	2.74	0.20
Sea bass	56	63	1.54	–0.04
Sushi	47	53	2.60	–0.01
Red snapper	33	37	1.32	–0.39
Shellfish	33	37	2.54	0.11
Sashimi	24	27	2.03	0.33
Sole	24	27	2.56	–0.36

[a]Average per month.

to high mercury content. Mercury levels declined rapidly in the first 3 weeks followed by a slower reduction over time. All but two patients reduced their level to < 5.0 µg/L by 41 weeks. These two individuals continued to eat large predatory fish. Reduction in levels over time is significant ($p < 0.0001$). The average rate of decline for all 67 patients with two or more mercury measurements is 4.4% per week. The decline appears linear on a log (Hg) scale, but there are at most four time points for any patient. Most declines are based on two measurements. Figure 1 shows blood mercury levels in 21 subjects with three or more measurements over time. The thick black line shows an exponentially declining fit to data from all 67 subjects. The horizontal dashed line is at 5 µg/L.

Seven children are represented in this survey (Table 3), ranging in age from four months to 12 years. Exposure from fish was from 10 different types. Tuna accounted for five of the types of fish meals consumed. The parents reported sushi and sashimi to be primarily ahi. Two of the children did not eat fish.

One child, a 50-lb, 7-year-old boy, had an initial hair level of 14.81µg/g. He had been eating fish most of his life, and had been consuming his current regimen of albacore steaks, ahi steaks, canned tuna, and salmon for the last 4 years. Before this, the mother was unable to estimate how much fish was eaten and what types. In 1999, he ate king mackerel twice a week for 6 months. After fish consumption was stopped, hair and blood levels began to decline. At 31.86 weeks without fish, his hair level was 0.89 µg/g (Figure 2).

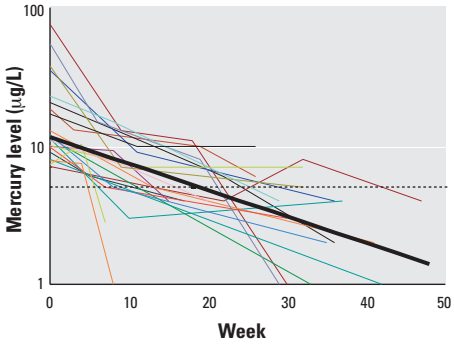

Figure 1. Blood mercury levels in 21 subjects with three or more measurements over time. Levels for individual patients are designated by straight lines. The thick line shows an exponentially declining fit to data from all 67 subjects. The horizontal dashed line is at 5 µg/L.

Subject 81, whose initial blood level was 26 µg/L, is a 17-month-old boy who ate small adult portions of eight servings of salmon and eight servings of sole every month. He also breast-fed twice a day while his mother's level was 9.0 µg/L (Table 2). His mother ate the same fish meals, only slightly larger portions, whereas the father ate closer to 8-oz portions and his level was 8.0 µg/L. After not eating fish for 3 months, the boy had a 2-in-long hair sample taken at the scalp, which had a mercury level of 4.27 µg/g. At 4 months, his hair level was 2.63 µg/g. A follow-up blood level at 8 months was < 5.0 µg/L.

A 4-month-old girl with a hair level of 3.06 µg/g did not eat fish or have any thimerosal. Her exposure appeared to be solely from her mother, whose blood level while breast-feeding was 16.5 µg/L.

Two gynecologists from our facility screened 22 of their patients very early in pregnancy for a short period of time. The gynecologists did not use the RfD to guide them in their testing, but the patients were consumers of commercial fish. A whole blood level was obtained on all of these patients; 13 patients had mercury levels < 5.0 µg/L, 2 were between 5.0 and 9.9 µg/L, and 7 were between 10.0 and 19.9 µg/L. Specialty Labs performed all lab tests on these patients (Figure 3).

Specialty Labs conducted an internal laboratory survey in 2002 of 66 random specimens submitted to their lab for copper and zinc analysis for nutritional evaluation (collected in EDTA-Na_2 tubes and run on the same machine as the mercury analysis). Specialty Labs receives specimens from a broad range of areas across the United States. Mercury levels on those specimens ranged from 0 to 18.5 µg/L. The average was 1.9 µg/L, with an SD of 2.7; 94% were below 5.0 µg/L.

Discussion

In this study we have identified a subpopulation at risk for mercury excess. All individuals were able to give the number of years that they had been choosing large predatory fish for regular consumption. This change in fish consumption pattern usually followed a life change, such as a new job, marriage, graduation from college, moving to the San Francisco Bay area, or achieving a higher income from other means. Higher economic status and education level appear to be risk factors. Most individuals did not eat fish as an infant or child, did not prefer a strong fish flavor, and did not like bones in their fish. They were also not deterred by the price of their fish. This study confirms the hypothesis in the Mercury Study Report that "consumers not limited by income, who consume a large portion of their dietary protein from fish, especially if they choose large predators such as swordfish, sea bass, etc., would be at risk for exposure to mercury" (Mahaffey and Rice 1998).

The U.S. Centers for Disease Control and Prevention (CDC) estimated the U.S. mean total blood mercury level to be 0.3 µg/L for children ages 1–5 and 1.3 µg/L for women ages 16–49 (CDC 1999). The mean level for women in our survey was 10 times that of mercury levels found in this recent CDC population survey (CDC 1999). Our survey found that children had > 40 times the national mean.

Fish consumption was positively correlated with mercury elevations in the study patients. Swordfish had the highest positive correlation, but 19 adult patients (21%) had levels > 5.0 µg/L and did not eat swordfish. None of the children were currently eating fish listed on the U.S. Food and Drug Administration (FDA) advisory (tile fish, swordfish, king mackerel, and shark), yet all five who ate fish had levels exceeding the RfD. Further advisories would be needed to reduce mercury accumulation in high-end consumers.

Snapper consumption correlated negatively with mercury level even after adjustment for swordfish consumption. Recently, the FDA collated mercury samples of fish from four surveys conducted between 1978 and 2000. Ten fish labeled as red snapper were tested. The mean was 0.60 µg/g, with a range of 0.07–1.46 µg/g (FDA 2001). A recent investigative report on fish that

Table 3. Mercury levels and diets of seven children.

Patient no.[a]	M/F ratio	Age	Time on diet	Mercury level[b]	Breast-feeding	Fish meals per month										Mother's level[b]
						Halibut	Sashimi	Sea bass	Shell-fish	Sushi	Albacore steaks	Ahi steaks	Canned tuna (6-oz cans)	Salmon	Sole	
2	F	12	5 yr	11.2 µg/L					6			3				18.5 µg/L
52	F	4 mo		3.06 µg/g	Only											16.5 µg/L
67	F	5	1 yr	13.0 µg/L									8			7.4 µg/L
69	M	3		< 5.0 µg/L												7.4 µg/L
81	M	17 mo	6 mo	26 µg/L	2×/day									8	8	9.0 µg/L
104	F	11	9 yr	3.5 µg/g		1	3	3		8			2	3		8.0 µg/L
117	M	7	4 yr	14.81 µg/g					4		2	2	6	4		1.65 µg/g

Abbreviations: F, female; M, male; mo, months; yr, years.
[a]Patients 67 and 69 are siblings. [b]µg/L is a whole blood level; µg/g is a hair level.

included red snapper found that of 11 supermarket samples labeled as red snapper, only four actually were ([Anonymous.] 2001). An uncertainty exists as to the mercury content of the fish sold as red snapper.

Individuals showed large variability in mercury levels even after adjustment for dietary history. Factors that can account for this are individual variation in kinetics among different individuals, a wide range of mercury levels in the fish consumed, the timing of test in relation to the fish consumed, and inaccuracy of dietary recall.

Variation among laboratories could also be a source of concern, but the SD reported for whole blood mercury levels by these labs of < 1.0 μg/L for the low control and < 2.0 μg/L for the high control is small compared with the measured levels in our subjects. No clustering of data or inconsistencies were seen with respect to laboratory values. The five highest analyses reported in this study were performed at five different labs. All five subjects consumed swordfish. The subject with the highest mercury level of 89.5 μg/L ate the most servings of swordfish, at an average of 14 servings per month. Four of the five subjects ate ahi steaks also. These high levels in the five subjects are consistent with the mercury levels reported in the fish being consumed.

There is no standardization for clinical labs in the interpretation of results. Some labs give occupational levels considered "safe" and will give such statements as normal is < 13 μg/L at the end of the shift at the end of a work week. For those clinicians trying to assess their patients using the current RfD for intake of methyl mercury, this makes interpretation of the results unclear. A whole blood mercury analysis tests for the concentration of the element regardless of its chemical form. The test is reproducible between labs within the SD of the machine performing the analysis. For labs that give the occupational level, the clinician has to write on the requisition "titer to < 5.0 μg/L."

Many patients in this study took longer than 21 weeks to reduce blood levels to < 5.0 μg/L and or hair levels to < 1.0 μg/g. Their high consumption of mercury is most likely causing accumulation, and this can pose a health risk. Accumulation in different organs can be quite variable. As an example, a recent report on trace elements in idiopathic dilated cardiomyopathy (IDCM) showed an increase of > 10,000 times more mercury in myocardial tissue than in skeletal muscle in all patients with this condition. The mean mercury level in cardiac muscle was 22,000 times higher in IDCM patients than in control subjects (178.4 μg/g vs. 0.008 μg/g; Frustaci et al. 1999).

Recent studies have also found associations between exposure to methyl mercury and impairments of the immune and reproductive systems. Adverse effects occurred with even modest elevations of mercury (Fukuda et al. 1999; NAS 2000).

A study of Finnish men evaluated the effects of mercury on coronary heart disease. Men in the highest tertile (= 2.0 μg/g) of hair mercury content had a 2.0-fold (95% confidence interval, 1.2–3.1; p = 0.005) age- and coronary heart disease-adjusted risk of anterior myocardial infarction and a 2.9-fold (95% confidence interval, 1.2–6.6; p = 0.014) adjusted risk of cardiovascular death compared with those with a lower hair mercury content (Salonen et al. 1995). A follow-up in the year 2000 confirmed that fish-oil–derived fatty acids reduce the risk of acute coronary events; however, a high mercury content in fish could attenuate this protective effect (Rissanen et al. 2000).

The American Heart Association promotes an increase of omega-3 fatty acids in the diet but encourages a variety of sources such as fatty fish, flaxseed, flaxseed oil, canola oil, soybean oil, and nuts. They recommend at least two servings of fatty fish per week to confer cardioprotective effects (Krauss et al. 2000).

If the data on cardiovascular risk from the Finnish studies hold for additional populations, the blood mercury levels achieved by most of our study population indicate a general adult population at risk. Given that fish consumption is promoted to reduce the risk of coronary heart disease, the need to improve information and publicity on the risks entailed is great.

Multiple epidemiologic studies have been ongoing in other countries, to study the effects of low-level prenatal exposure to methyl mercury. Adverse effects in children are judged to occur when, during pregnancy, the mother's blood contains more than 15 μg/L, equivalent to 4–5 μg/g in hair (Mahaffey 1999). Our survey demonstrates the need for prepregnancy screening in patients with high consumption of fish.

Given the long time intervals between vaccines and blood test for our study, the contribution of ethylmercury was negligible compared with diet (Stajich et al. 2000). Similarly, the mercury contribution from silver/mercury dental amalgams for our study population was insignificant compared with diet (Kingman et al. 1998).

The patients in the study were consistent in their consumption patterns. They consumed fish purchased at certain markets and restaurants on a regular basis. Only a few patients had some variation at times. Most patients had the same diet when they traveled and tended to visit coastal areas. It would be expected that places such as New York; Maine; Florida; Hawaii; Martha's Vineyard, Massachusetts; and Los Angeles, Monterey, Santa Cruz, and San Diego, California, could demonstrate similar data. Because we were trying to determine the cause of symptoms in the study patients, we took a dietary history that encompassed the entire year. Patients were also asked to give an average estimate of intake and how long they were on their current diet. This consumption pattern appeared to be part of a lifestyle.

Cause and effect regarding symptoms was not fully addressed in this study for the following reasons. A chart review of symptomatology on all patients presenting to the office in the 1-year period of the study was not done. Therefore, a comparative analysis for the purpose of controls is not available. Many patients who present to their doctor have symptoms that may be caused by other conditions. It is difficult to determine whether mercury is causing or exacerbating these symptoms, especially in cases of autoimmune phenomena, chronic fatigue syndrome, fibromyalgia, depression, sinusitis, coronary artery disease, and menopause, to name but a few, where there is either a possible link to or an overlap of symptoms with mercury exposure. Second, the subjective nature of symptoms makes standardization difficult. Last, because only mercury was tested in these individuals, other contaminants responsible for symptoms cannot be ruled out. Often the clinician recommends elimination diets to establish whether the patient is affected by an exposure. It is important to demonstrate the normalization of blood mercury levels for clinicians who may want to try this as a diagnostic approach for certain individuals.

In conclusion, in this 1-year survey of an internal medicine practice in San Francisco,

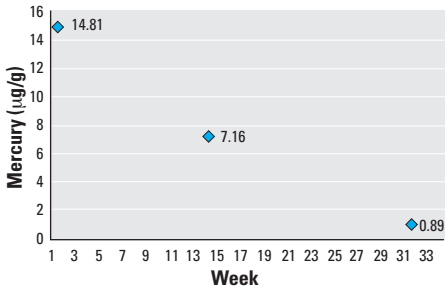

Figure 2. Hair mercury decline in a 7-year-old boy.

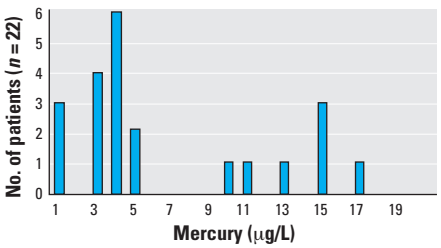

Figure 3. Mercury levels in 22 pregnant patients.

California, a substantial fraction of patients had diets high in fish consumption. Of these, a high proportion had blood mercury levels exceeding the maximum level recommended by the U.S. EPA and National Academy of Sciences. Women of reproductive age and pregnant women were found to have levels considered unsafe for the developing fetus. Mercury levels in peripheral blood and hair correlated with fish consumption, particularly swordfish. When subjects abstained from fish, these high levels of mercury were easily reduced, but this took longer than 21 weeks for many individuals.

Because fish consumption is promoted as preventing heart disease and as good nutrition, we might expect to see patients who have excess fish intake showing side effects caused by the contaminants that are present. Therefore, dietary histories that encompass fish consumption should become part of a comprehensive health screening to identify those at risk for mercury accumulation. Likewise, testing of mercury content in fish needs to continue. The results and advisories should be readily available where fish are sold to reduce the risk of mercury excess and accumulation during a lifetime of fish consumption.

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