VALIDITY OF HAIR ANALYSIS FOR DIAGNOSIS OF MERCURY STATUS

by

MICHAEL F. ZIFF, D.D.S.

In recent years, the value of measurements of mercury in blood and urine has been subjected to a great deal of attention and controversy. Defenders of the use of dental mercury fillings claim that low urine and blood mercury values prove that the fillings are harmless, even though the American Dental Association and the National Institute of Dental Research have publicly admitted that there is no correlation between the toxic effects of mercury and the levels of mercury found in the urine and blood.1,2 As early as 1964 Goldwater and associates stated that "those investigators who have studied the subject are in almost unanimous agreement that there is poor correlation between the urinary excretion of mercury and the occurrence of demonstrable evidence of poisoning".3 This position has been thoroughly reinforced through the years with documentation and expert opinion.

The same can be said for blood mercury levels related to exposure to mercury vapor, although there is some validity related to recent exposure to ingested organic and inorganic mercury compounds. Magos, summarizing the research done by himself and a number of others, pointed out that inhaled mercury vapor passes from the blood into body tissues very rapidly after exposure.4 Blood mercury measurements would therefore have to be performed immediately after exposure to reflect increased levels resulting from inhalation of mercury vapor.

Relation of measured levels of mercury in the urine and blood to "normal" values presents another falacy, since the so-called "normal" values were derived from population groups heavily infested with mercury dental fillings. Valid comparisons would require relating to control groups not possessing the influencing factor being investigated. It would seem that the only experts that value urine and blood mercury measurements have not troubled themselves with scientific documentation or support, namely, the defenders of dental mercury fillings.

Table of Contents

REVIEWS/ABSTRACTS
Silver amalgam fillings cause mercury accumulations in primates. Dancher et al.............................11
Low mercury levels and childhood intelligence. Marlowe et al.....12
Peripheral neurotoxicity in workers exposed to inorganic mercury compounds. Singer et al.............................12

FORUM
Am Academy of Biological Dentistry.................................12
Am Quack Association.....................................................12
International Academy of Oral Medicine and Toxicology.........12

© 1988 B by Bio-Probe, Inc. The Bio-Probe Newsletter is published bi-monthly. Editorial office is at 4401 Real Ct., Orlando, FL 32808. Subscription price $65.00 per year. Postage paid at Orlando
The analysis of hair for mercury levels is another story. Although the ADA and the NIDR place little value on hair mercury analysis (1), the U.S. Environmental Protection Agency (EPA) offers a different position. In a document reviewing over 130 references, the EPA states "human hair is a meaningful and representative tissue for antimony, arsenic, cadmium, chromium, copper, lead, mercury,..."(5) The EPA also stated that "for measurement of levels of toxic metals for long periods or especially of exposure to a dangerously high level during a past period, hair appears to be superior to blood and urine for certain toxic elements concentrated in the hair."(5) In another EPA document, Jenkins reported that "of the 14 trace elements considered in this report, human hair is excellent for biological monitoring of arsenic, cadmium, chromium, lead and mercury."(6)

In 1983, Airey reviewed 113 references and concluded "mercury is deposited in the hair as it grows, and the amount deposited reflects the body burden of mercury."(7) Airey also stated "this increased concern about the health of persons exposed to very low environmental mercury concentrations is because mercury causes subclinical effects at low concentrations. The symptoms are difficult to detect and measure. For example, slightly increased levels of mercury in hair have been associated with decreases in academic ability. Also, reduced productivity and development of asthenic vegetive syndrome, a subtle behavior change, can occur".(7)

Manson and Zlotkin, in a 1985 article printed in the Canadian Medical Association Journal, stated that "the analysis of hair for trace elements is potentially a safe, noninvasive and extremely useful diagnostic tool, but it has not yet been proven to be reliable or to reflect the status of trace elements elsewhere in the body. As well, little is known about the normal ranges of concentrations of elements in the hair or about the physiologic and pharmacologic factors that affect the concentrations."(8)

The opinion of Manson and Zlotkin differs from that of Airey and the EPA, so examination of the available data may be helpful towards resolution of the dilemma.

PROBLEMS WITH ANALYSIS

In 1985, Barrett sent hair samples from two healthy teenagers to thirteen commercial laboratories performing multinmineral hair analysis.(9) The reported levels of most minerals varied considerably between identical samples sent to the same laboratory and from laboratory to laboratory. Barrett concluded that "commercial use of hair analysis in this manner is unscientific, economically wasteful, and probably illegal."

Although Barrett’s findings are certainly worthy of consideration, his conclusions are overly dramatic, if not downright inflammatory. Schoenthaler capably addressed Barrett’s data and conclusions.(10) Schoenthaler pointed out that the results were severely biased by the obvious ineptitude of a few of the labs, an unfortunate circumstance that has been demonstrated in the analysis performance on other widely accepted medical tests. The majority of labs were in statistical agreement on the analysis.

What Dr. Barrett failed to do was to draw some relationship of the validity of hair analysis in relation to the validity of the millions of blood tests ordered by physicians annually. Accordingly, and to place "the other side of the coin" in proper perspective, let's look at an astounding example.

The College of American Pathologists (CAP) conducts inter-laboratory comparisons of laboratories that do analysis (blood, urine, etc.) for hospitals and physicians. In their 1985 survey, 5000 laboratories were given identical blood samples to analyze; nearly 50% produced unacceptable results.(11) How many erroneous diagnostic decisions, possibly resulting in unnecessary treatment, are based on flawed and incorrect blood analysis? Does Dr. Barrett consider these analyses "unscientific, economically wasteful, and probably illegal"? It appears that Dr. Barrett is recommending throwing out the baby with the bath water.
A reasonable recommendation, better serving the patient, would be to exercise prudent care in the selection of an analysis facility.

It is widely acknowledged that hair samples may be contaminated with minerals from sources outside of the body (exogenous contamination), such as shampoos and hair rinses or airborne contaminants. As Gibson pointed out (12), investigators have shown that by employing careful, standardized washing procedures, the effects of these exogenous materials can be minimized, if not completely eliminated. A wide variety of washing procedures using water, organic solvents, detergents and shampoos have been shown to be effective in removing exogenous contaminants from hair.

This position was disputed by Chittleborough (13), who claimed that pre-analysis treatment of hair clearly removed significant amounts of endogenous (from within the body) elements along with the exogenous elements, thereby altering the significance of the obtained results. Chittleborough advocated a holistic, no-wash policy for hair analysis.

Gibson also pointed out the necessity for standardization of the collection procedures for hair samples. Gibson recommends that only hair strands 1-2 centimeters in length, cut close to the occipital region (high nape of the neck) of the scalp be used for analysis.(12)

**Atomic Absorption Spectrophotometry (AAS)** The most widely used procedure for determining the most abundant trace elements in human hair. This procedure is rapid, simple, inexpensive, and widely available. Unfortunately, this method requires relatively large samples of hair, at least 200 milligrams, which severely hampers its use in infants. Moreover, AAS analysis results in destruction of the sample, thereby limiting its usefulness in measuring concentrations of more than a few select elements.

**Neutron Activation Analysis (NAA)** This method is specific, nondestructive, and can be used for the determination of several elements at the same time. Large samples are not required, so it is much more useful for analysis of infants’ hair. Unfortunately, this technique is more expensive and less readily obtainable.

**Proton (or Particle) Induced X-ray Emission (PIXIE)** A relatively new technique that is reliable and non-destructive. The absolute concentrations of elements in a single hair can be determined, as well as the distribution of these elements along the length and across the diameter of the hair. This technique is not readily available as yet.

**AVERAGE (NORMAL) HAIR MERCURY LEVELS**

The term *normal* is actually a misnomer when used by the medical and dental professions to describe health as determined by accepted paramaters of diagnosis and testing. The so-called normal levels of ingredients found in the human body and tissues are determined by surveying a large number of subjects to establish ranges and averages for these ingredients in the general population.

It has been estimated that 70-80% of the adult population of the United States has one or more mercury dental fillings. It has been scientifically demonstrated that these people are chronically exposed to mercury vapor released throughout the lifetime of these fillings. It has also been scientifically demonstrated that even small amounts of mercury vapor have a detrimental effect on numerous aspects of metabolism.

Since a large percentage of the subject sample is environmentally contaminated by a metabolic poison (mercury), medical test parameters must be considered only "average," not "normal" or "healthy." Hair mercury concentrations must also be viewed in this manner, since no studies have been conducted to determine concentrations of mercury in the hair of subjects with and without dental mercury fillings.
Friberg and Vostal reported on "normal" concentrations of mercury in human hair.(14) The authors stated that the subjects were not exposed occupationally to mercury, and that data on their fish consumption was not available. Data from the following studies was presented:

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>NUMBER</th>
<th>MEAN MERCURY LEVEL (mcg/g)</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada</td>
<td>776</td>
<td>1.8</td>
<td>Perkins &amp; Jervis, 1965</td>
</tr>
<tr>
<td>England</td>
<td>840</td>
<td>5.1 (males)</td>
<td>Coleman et al, 1967</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6.9 (females)</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>94</td>
<td>4.2</td>
<td>Yamaguchi &amp; Matsumoto, 1966</td>
</tr>
<tr>
<td></td>
<td>73</td>
<td>6.0</td>
<td>Hoshino et al., 1966</td>
</tr>
<tr>
<td>New Zealand</td>
<td>33</td>
<td>2.2</td>
<td>Bate &amp; Dyer, 1965</td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Scotland</td>
<td>26</td>
<td>8.8</td>
<td>Nixon &amp; Smith, 1965</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>5.5</td>
<td>Howie &amp; Smith, 1967</td>
</tr>
<tr>
<td>U.S.</td>
<td>33</td>
<td>7.6</td>
<td>Bate &amp; Dyer, 1965</td>
</tr>
</tbody>
</table>

Samples from the two JapÌ£nese studies were analyzed with the chemical Dithizone Method; all of the rest used NAA.

Friberg and Vostal also reported on two Japanese studies investigating levels of methylmercury in hair:

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>2.8 (males)</td>
<td>Sumino, 1968b</td>
</tr>
<tr>
<td>26</td>
<td>1.7 (females)</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>2.4</td>
<td>Ueda &amp; Aoki, 1969</td>
</tr>
<tr>
<td>6</td>
<td>7.0 *</td>
<td></td>
</tr>
</tbody>
</table>

* Subjects who ate only unpolished rice; 44% was methylmercury.

Since the 1972 Friberg and Vostal document, there have been several investigations that provide data on general population hair mercury levels. Gonzalez and associates measured mercury in the hair of residents of Madrid, Spain, utilizing AAS.(15) They found a mean concentration of 7.96 mcg/g in the general population and 12.7 mcg/g in occupationally exposed workers. The authors also noted that in 1971 a "Swedish Expert Group" had established an upper limit for hair mercury of 6.0 mcg/g.

In 1983 Airey (16) analyzed the hair mercury levels in 559 samples of human hair from thirty-two locations in thirteen countries, reporting the following mean hair mercury concentrations for subjects who ate fish 1-4 times each month [Note: micrograms per gram (mcg/g) is the same as parts per million (ppm)].

<table>
<thead>
<tr>
<th>Country</th>
<th>Mean (mcg/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>2.5 ppm</td>
</tr>
<tr>
<td>China</td>
<td>0.9 ppm</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>3.0 ppm</td>
</tr>
<tr>
<td>Japan</td>
<td>3.9 ppm</td>
</tr>
<tr>
<td>New Zealand</td>
<td>1.3 ppm</td>
</tr>
<tr>
<td>South Africa</td>
<td>1.9 ppm</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>2.4 ppm</td>
</tr>
<tr>
<td>Canada</td>
<td>1.2 ppm</td>
</tr>
<tr>
<td>West Germany</td>
<td>0.5 ppm</td>
</tr>
<tr>
<td>Italy</td>
<td>1.5 ppm</td>
</tr>
<tr>
<td>Monaco</td>
<td>1.7 ppm</td>
</tr>
<tr>
<td>Papua, New Guinea</td>
<td>1.8 ppm</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1.6 ppm</td>
</tr>
</tbody>
</table>

Airey subjected the samples to meticulous and stringent washing and preparation procedures, and analyzed them by laminar flow clean-room syringe injection AAS technique, which might explain the lower levels than reported in other studies.
In summary, it would seem that average hair mercury levels in general population groups fall in the range of 0.5-8.8 ppm, with the bulk being in the 1.2-4.2 ppm range. It should also be noted that an expert committee in Sweden has established an upper limit of 6.0 ppm (mcg/g) for hair mercury.

**HAIR MERCURY CORRELATIONS**

To establish the validity of measurements of hair mercury it is necessary to determine if these measurements correlate with exposure to mercury and/or mercury levels within the body. As previously stated, extensive reviews by Airey and the EPA led to conclusions that hair mercury levels do represent body burden of mercury. These conclusions are supported by more recent documentation.

Relation to Blood Mercury

Citing studies by Sexton and associates in 1978 and Kershaw and associates in 1980, Airey pointed out that the mercury concentrations in new growth of hair indicates blood mercury concentrations or body burden of mercury at the time of growth. (16) Airey also emphasized that mercury is excreted from blood into hair in both organic and inorganic forms. Hair mercury levels, therefore, will be reflective of blood levels of both forms of mercury.

In 1985, Gonzalez and associates stated "once mercury has been incorporated into the hair, its concentration does not change significantly, while mercury analysis of blood and urine can only reliably detect very recent exposures. Therefore, mercury analysis of sequential segments of human hair can provide an accurate representation of previous blood mercury levels." (15) It should be re-emphasized that this relationship does not pertain to chronic, low-level exposures to mercury vapor, which passes too rapidly into body tissues to reflect elevated blood mercury levels.

Gibson noted that trace element levels in hair are more concentrated than in blood and urine, thus facilitating analysis. (12) It may also be said that hair analysis, being noninvasive, would be more acceptable to patients and, most likely, less expensive.

In 1980, Phelps and associates analyzed samples of blood and head hair for organic and inorganic mercury from a population that consumed large amounts of fish contaminated with methylmercury. (17) Mercury levels in newly formed hair were found to reflect those in blood, with the concentrations in hair being approximately 300 times those in blood. There was a direct, linear relationship of organic and inorganic mercury levels in both blood and hair. In addition, the total mercury concentration and inorganic/organic ratio in hair remained constant with time. This important study demonstrated that both blood and hair mercury levels reflect an intake of methylmercury from food. It also suggests that a portion of the ingested methylmercury is converted within the body to inorganic mercury, or that there is some other nonoccupational factor that causes a temporal increase in the body burden of inorganic mercury (dental mercury fillings, perhaps?).

Relation to Diet

If hair mercury levels are shown to correlate with dietary intake of mercury, then problems with laboratory analysis notwithstanding, hair mercury analysis would have to be considered a valid diagnostic technique, at least for the evaluation of body burden from ingested mercury. Care and prudence in the analysis performance would obviate opposition to the procedure.

The previously cited Phelps study (17) demonstrates the correlation between hair mercury levels and dietary mercury intake. Other studies firmly support this correlation. Kyle and Ghani compared mean hair
methylmercury levels in controls to fish eaters, finding almost two and one half times as much mercury in the hair of the fish eaters.(18) Inasmasu and associates demonstrated a correlation between hair mercury levels and consumption of canned tuna fish. The authors also cited four earlier studies that showed a correlation between hair mercury levels and fish intake.(19) In 1977, Harada and associates (20) examined the hair mercury content in seventy-one subjects in Ontario, Canada, and found a positive correlation between the mercury values in the hair and the quantity of fish in the diet. The highest hair mercury content was 80.3 ppm, with forty-four of the seventy-one subjects showing more than 20 ppm and twenty-three subjects more than 30 ppm.

Relation to Mercury Vapor Exposure

The early studies on occupational exposure to mercury vapor did not, unfortunately, include investigation of hair mercury levels. The investigators focused their attention on mercury levels in blood and, particularly, urine. The only occupational group routinely exposed to mercury vapor that has been evaluated for hair mercury levels is dental personnel.

An International Conference on Mercury Hazards in Dental Practice was held in 1981 in Glasgow, Scotland.(21) Several presentations addressed hair mercury levels in dental personnel.

Paper 9, by Dale and associates, compared dental personnel to the unexposed population, citing a mean of 0.75 ppm for the control group. Dental workers in general practice had a mean of 3.31 ppm and those in health service clinics had a mean of 1.54 ppm. Over 600 dental workers were surveyed and 20-25% exhibited hair mercury levels above normal. Levels of mercury in pubic hair were found to be significantly lower but still slightly higher than normal, suggesting that most of the hair contamination was exogenous.

Paper 15, by Sairenji and associates in Japan, surveyed fifty-eight male dentists employed at a dental school and fifty male dentists engaged in private practice in Tokyo. The hair mercury levels were found to be the same as in "normal Japanese," which the authors placed at a mean of 5.26 ppm. The authors cited three previous studies of hair mercury in dental personnel to be means of 10.8 ppm, 11.5 ppm, and 12.3 ppm. Of special interest was their finding that fully 30% of the mercury was lost from hair samples analyzed by NAA compared to samples that were treated with thioacetamide.

Paper 28, by Nishimura and Yamanaka, surveyed ninety-nine dentists in Japan by AAS. The mean hair-mercury level in the dentists was 8.64 ppm, compared to their citations of normal Japanese of 3.5 to 6.4 ppm. The authors further investigated the ability of hair to absorb mercury from the air and found this capability to be extremely low at the levels found in the air of the dental offices. They concluded that the higher levels of mercury found in the hair of dental personnel came from within the body or from touching the hair with hands contaminated with mercury. The authors also found that the waste water from almost all dental offices exceeded allowable limits, and further found that mercury levels in the soil around dental offices, and even around adjacent buildings, exceeded control sites.

In 1979, Lee and Sohn measured the mercury content in the head hair of eighty-seven Korean dental personnel and 210 control subjects with the following results: (1) The mean value of mercury content in dentists (8.57 ppm) was 3.3 times that of Seoul male citizens (2.57 ppm). The median of the former (5.92 ppm) was higher than that of the latter (2.39 ppm) by approximately 2.5 times. (2) The mean value of mercury content in dental nurses (5.79 ppm) was 2.8 times that of Seoul female citizens (2.11 ppm). The median of the former (4.62 ppm) was about 2.5 times that of the controls (1.86 ppm). (3) The mean value of mercury content in Seoul citizens was 2.29 ppm and the median was 1.98 ppm. (4) There was no correlation between the mercury content in the head hair of dentists and the length of dental surgery experience or the frequency of amalgam fillings per day. (5) The mercury content of Seoul citizens was higher in the male than in the female. (6) It appears more meaningful to employ median values than mean values when environmental pollution is considered.(22)
Francis and associates analyzed the inorganic mercury content of hair from dental and non-dental subjects in central Kentucky in 1982. They found no significant difference between the two groups. Sinclair and associates used NAA to measure the mercury in head hair from sixty-one dental students and dental faculty members and found "significant" increases. They attributed this to increased pressure of work, which might have resulted in decreased standards of mercury hygiene.

In 1986, Sikorski and associates analyzed fifteen women subjects exposed to metallic mercury at dental offices and eleven non-exposed control subjects. They found that the total mercury was significantly higher in both the scalp and pubic hair of the exposed women compared to the controls.

Relation to Dental Mercury Fillings

Only one study can be found that investigates the relationship between hair mercury levels and the presence of dental mercury fillings, that of Gonzalez and associates in 1985. The authors concluded that "no relationship exists between mercury levels and number of dental fillings." However, examination of the data provided by the study casts considerable doubt on the validity of that conclusion. Of the ninety-six subjects included in the study, sixty-two (64.6%) had no dental fillings at all. Of the remaining thirty-four subjects, eight (8.3%) had only one filling, nine (9.4%) had only two fillings, and seventeen (17.7%) had three fillings. None of the subjects had more than three fillings. Moreover, no information was provided as to the location of the fillings. Dental mercury fillings that are on the chewing (occlusal) surface of teeth will release more mercury than those not on chewing surfaces. The authors' conclusion is hardly justified by the data provided. The existence of high numbers of large dental mercury fillings in subjects is not an uncommon occurrence; the relationship of this situation to hair mercury levels remains uninvestigated and unanswered.

Relation to Pathology

Studies investigating the relationship between hair mercury levels and pathologic conditions are very sparse. This unfortunate circumstance is quite amazing in view of the strong evidence that hair mercury levels do correlate to the body burden of mercury, the knowledge of the severe toxicity of mercury, and the lack of other diagnostic tests for mercury poisoning, especially chronic mercury poisoning. Gonzalez and associates stated "perhaps what is more important than the possibility of a few people showing definite signs of mercury poisoning is the likelihood that a large proportion may be at risk from subclinical effects of mercury with regard to behavior, learning ability, fertility, and immunologic response, etc., which may result from prolonged exposure to low levels of mercury."

Airey said "it is now well known that methylmercury is deposited in and irreversibly destroys brain and nerve cells. It is less well known that subclinical accumulations may affect intelligence. People who are employed in buildings where mercury is used often show clinical and subclinical effects of mercury absorption, e.g. dentists; industrial workers; miners; and laboratory workers."

An example of how hair mercury analysis can be applied to Airey's point may be found in the papers from the Glasgow Conference. Paper 21, by Symington, is entitled "Clinical Features of Mercury Absorption." Symington reports on three dentists who were found to be occupationally poisoned by mercury where the office mercury vapor levels were well below the established standards. One of the dentists was treated with a daily dose of D-penicillamine for two weeks, which resulted in considerable clinical and biochemical improvement. During the period of treatment mercury levels in daily beard shavings fluctuated between 38 and 124 ppm, which reflected the release of the high body burden. The diagnosis of mercury poisoning was suggested by the dentist himself while being tested for other possible causes for his illness.
This reported case illustrates a very important application of post-challenge hair mercury analysis for the diagnosis and treatment of chronic mercury poisoning.

The previously cited study by Harada and associates in Ontario, Canada found fifteen of the seventy-one subjects with sensory neurologic disturbances and nine cases with visual disturbance. The cases with neurologica! symptoms showed higher mercury values in the hair than those subjects without symptoms, and were suspected of having mild methylmercury poisoning.(20)

In 1976, Clarkson and Amin-Zaki and associates reported the results of investigations of the methylmercury poisoning outbreak in Iraq. They found that hair and blood mercury levels correlated to exposure and were reflected by signs of mercury poisoning in mothers and severe brain damage in infants from prenatal exposure.(26,27)

The previously mentioned Sikorski study on fifteen women occupationally exposed to metallic mercury compared to eleven control women found a correlation between higher levels of mercury in scalp and pubic hair and lower blood serum levels of the IgG antibody.(25)

Considering the dynamic inference derived from these very few investigations, it is astounding that more attention and study has not been directed to this area. Moreover, low hair-zinc levels have been determined in mothers of infants born with spina bifida (28), in preschool children exhibiting anorexia and poor growth (29), and with the occurrence of diaper rash and hair loss in infants (30). Mercury is known to interfere with zinc and its metabolism.

HAIR MERCURY LEVELS OF MOTHER AND INFANT DURING PREGNANCY

This paper examines the high incidence of birth defects that still occur in the UK and suggests that it might be possible to reduce this by preparing prospective mothers for parenthood prior to conception. One test in particular is suggested as having a part to play in this preconception screening -- that being the hair metal analysis. Such a screening test is useful in identifying both excesses of toxic metals and deficiencies of essential metals.(31)

This dynamic statement by Barlow and associates dramatizes an important consideration for all prospective parents. Our children are very dear to us. Can a simple, inexpensive, and noninvasive test help reduce risks to our offspring and enhance their chance for a better life? The price of this insurance policy is certainly infinitesimal, especially compared to the price of potential consequences. Will hair mercury analysis be a valid part of this consideration?

As previously discussed, Clarkson and Amin-Zaki and associates have demonstrated that hair mercury levels correlate with brain damage found in infants of mothers exposed to methylmercury.(26,27) It is fairly well established that exposure to both methylmercury and mercury vapor present a definite threat to the fetus. Other investigations have determined that mercury in the blood of pregnant women will actually concentrate to higher levels in the fetal blood, resulting in even a greater exposure and threat to the fetus.

In 1976, Creason and associates wrote "there have been numerous reports of abortion or fetal malformation due to excessive exposures of the expectant mother to mercury and other trace elements."(32) Their study investigated the levels of sixteen trace elements in maternal venous blood, cord blood, placenta, and maternal scalp and pubic hair. The maternal scalp hair sample and geometric means were 2.2 ppm and 1.4 ppm, and the maternal pubic hair sample and geometric means were 3.8 ppm and 0.7 ppm. The levels of mercury in the cord blood were higher than in the maternal blood and even higher in the placenta.
Fujita and Takabatake, in 1977, sampled blood and hair of mother-neonate pairs and mother’s breast milk of thirty-four subjects. They found that the maternal samples showed generally lower total mercury levels than those of the babies. A significant correlation was found in the concentration of total mercury between the newborn babies’ hair and maternal blood, and also between the neonatal hair and neonatal blood. In their investigation of the methylmercury poisoning outbreak in Iraq, Amin-Zaki and associates found that mercury in the milk of nursing mothers averaged 8.6% of the simultaneous blood level. Gonzalez and associates measured the hair mercury levels of nursing infants and their mothers and found the correlation to be extremely significant.

SUMMARY

Barlow and associates probably said it best in their 1985 study:

The technique of hair analysis has received a good deal of criticism by many people. Perhaps one of the main reasons for this is that the significance of the analysis has not been fully appreciated. The present authors would suggest that the analysis of hair for its metal content is a useful technique for the primary screening of individuals and selected populations for the assessment of body burdens of metals. Often in reported work relating to hair analysis the concept of "normal ranges" is used, however this concept is rather artificial in that the actual levels of metal found will depend on the method of sample preparation and the analysis technique used. Also with the majority of biological variables there is no well defined boundary between what is normal and what is abnormal. Thus, it is perhaps better to make use of "reference levels" and then it can be said with more confidence that if a particular value falls within the reference range the subject under investigation is more likely not to be abnormal than normal whilst the converse applies to a value outside the reference range.

These comments, of course, refer to the evaluation of all trace minerals found in hair analysis. The existence of contrary opinions such as that of Barrett notwithstanding, it is quite apparent that the vast weight of scientific evidence favors the validity of hair analysis for trace mineral evaluation. The utilization of this procedure can certainly be supported with scientific documentation, providing that judicious care is exercised regarding technique and laboratory procedures.

Regarding analysis for mercury specifically, the cited documentation clearly indicates that hair mercury levels do reflect exposure to and body burden of all forms of mercury. It should be emphasized that consideration should be given to the exclusion of mercury contamination of the hair from sources outside of the body, without the elimination of that mercury within the hair in the process.

What is the significance of the mercury levels found in human hair? There can be no doubt that mercury is hazardous to human health, and most particularly to the developing child. Moreover, it is well established that the effects of mercury on the embryo/fetus are neurological and developmental and therefore not recognizable by mere visual observation at birth. The EPA states that the minimal amount of exposure to mercury vapor that humans can be exposed to without incurring harm is unknown. Since the significant exposure to mercury from dental amalgam fillings is from the vapor form, and since mercury has no known beneficial biologic function, it may be argued that hair mercury levels should not exceed a reference range derived from subjects without dental amalgam fillings or exogenous exposure to mercury. Unfortunately, no such reference range has been established at this time. It is our hope that this review might stimulate efforts from reputable scientists to establish valid parameters for biological references.
derived from subjects free of chronic exposure to mercury from dental amalgam fillings. These parameters should cover the entire range of tests and not be limited to only mercury levels in hair, blood, and urine.

Finally, we would like to refer once more to statements from the 1985 study by Barlow and associates. (31) That group pointed out that in 1977 in the United Kingdom a total of 10,892 malformed babies were born alive. (This is not including babies born with developmental or neurological defects that would not be recognizable until a later time.) This figure represents 20 per 1000 live births. Various reports suggest that between six and ten per cent of all children born have some degree of handicap by the age of five years and that possibly 20-50 per cent of such handicaps arose in the peri-natal period. In addition it has been suggested that many of these handicaps, be they mental or physical, might be preventable. If the utilization of the simple, inexpensive and noninvasive hair analysis, along with the elimination of chronic mercury exposure from dental amalgam fillings, prevents even a fraction of these handicaps, the service to mankind would be inestimable.

REFERENCES

1. Workshop on Biocompatibility of Metals in Dentistry, July 11-13, 1984. Sponsored by the NIDR and hosted by ADA. Transcript provided by the ADA.


***********

REVIEWS/ABSTRACTS


ABSTRACT: Three adult vervet monkeys received occlusal fillings in all first and second molars. Total weight of the amalgam fillings for each animal varied from 0.8-1.2 grams. After one year, the monkeys were anaesthetized and killed by transcardial perfusion with buffered glutaraldehyde. Tissue from different organs including kidney, liver, adrenals, pituitary and spinal ganglia were removed and tissue blocks embedded in Epon. Semithin sections were then analysed by autoradiography (J. Histochem. Cytochem. 33:219-228 1985). This technique demonstrates small amount of silver and mercury. When sections are exposed to potassium cyanide before autoradiography, exogenous silver will be removed from the section (Histochem. J. 18:109-114, 1986). It is therefore possible to distinguish between accumulations of the two metals. From the present study, it was found that the kidney, liver, adrenal, pituitary and spinal ganglia contained intracellular accumulations of mercury located primarily in lysosomes. Tissue from three monkeys without amalgam tooth fillings were devoid of mercury and silver.

ABSTRACT: The present study investigated the relationship between mercury levels in children and their performance on an individual intelligence test. Hair mercury levels in 59 children were correlated with their performance on the Wechsler Intelligence Scale for Children (Revised). Low mercury levels correlated significantly and negatively with full scale, verbal, and performance IQ and six subtest scores of the intelligence test. A continuing reexamination of mercury exposure is needed because mercury levels previously thought harmless and routinely encountered in the environment may be associated with intellectual decrements.

****


ABSTRACT. Nerve conduction velocity (NCV) of the median motore, median sensory, and sural nerves was assessed in 16 workers chronically exposed to various inorganic mercury compounds. Exposed workers were compared with an unexposed control group using t test analyses. Slowing of the median motor nerve NCV was found, which was correlated with both increased levels of mercury in blood and urine, and with increased number of neurologic symptoms. Sensitive evaluation of neural function was found to be practical and informative for investigating mercury toxicity. Such evaluation can help determine safe mercury levels at the workplace.

**************************

FORUM


****


****

The International Academy of Oral Medicine and Toxicology will hold its 1988 mid-year meeting in Denver, Colorado at the Hyatt Regency on April 16-17. Meeting chairperson is Don Swartz, D.D.S. (303) 773-8262. The annual meeting of the Academy will be held in Chicago, Illinois at the Oak Brook Hills Hotel & Conference Center on September 16-18, 1988. Meeting chairperson is Marcia Basciano, D.D.S. (312) 953-2808. More detailed information will be provided in the next issue of Bio-Probe.