SR 12

Senate Health, Education and Social Services Committee

Senator Paul Fischer, Chairman

Senator:

Included in this packet are:

PACKET A Back up supporting the Resolution

PACKET B Back up against the Resolution

Draft Committee Substitute of Resolution

40 other State

Senate Health, Education and Social Services Committee

Senator Paul Fischer, Chairman

PACKET B

LARGELY AGAINST THE RESOLUTION.

INCLUDED ARE:

1. LETTER FROM THE ALASKA DENTAL SOCIETY.
2. POSTION PAPERS SUPPORTING THE SAFETY OF DENTAL AMALGAM.
3. LETTER FROM THE DEPARTMENT OF HEALTH AND HUMAN SERVICES REGARDING AMALGAM
4. MICHIGAN DENTAL ASSOCIATION
5. AMERICAN DENTAL ASSOCIATION
6. THE NATIONAL BOARD OF HEALTH, Sweden.
7. OREGON HEALTH SCIENCES UNIVERSITY
8. CONCEPT PAPER/ DEPARTMENT OF HEALTH AND SOCIAL SERVICES, ALASKA

Implanting material in Montana

Abortion

452 - 5054

6-1387E ✓
Lauterbach
2/10/90

Original sponsor(s): SEN. RODEY

IN THE SENATE ~~BY THE HESS COMMITTEE~~

CS FOR SENATE RESOLUTION NO. 12 (HESS)

IN THE LEGISLATURE OF THE STATE OF ALASKA

SIXTEENTH LEGISLATURE - SECOND SESSION

Relating to the use of informed consent by dentists when they insert dental fillings.

BE IT RESOLVED BY THE SENATE:

WHEREAS it is a common dental practice in the state to use a variety of materials for dental fillings; and

WHEREAS some components of the fillings may infrequently cause allergic or adverse reactions in some persons; and

WHEREAS dental patients should have the right to choose which materials are used for their dental fillings; and

WHEREAS they often lack basic information that would help them make an informed choice;

BE IT RESOLVED that the Senate respectfully requests the Governor to direct the Board of Dental Examiners to report to the legislature by the 10th day of the First Session of the Seventeenth Alaska State Legislature its recommendations on whether dentists should inform their patients

(1) about the materials that are used for dental fillings;

(2) that there is a variety of materials that could be used for dental fillings; and

(3) that it is possible that alternative material can be used.

IN THE SENATE BY THE HESS COMMITTEE

CS FOR SENATE RESOLUTION NO. 12 (HESS)

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1st State

BE IT RESOLVED BY THE SENATE:

WHEREAS it is a common dental practice in the state to use a variety of materials for dental fillings; and

WHEREAS some components of the fillings may ~~infrequently~~ sometimes cause allergic or adverse reactions in some persons; and

WHEREAS dental patients should have the right to choose which materials are used for their dental fillings; and

WHEREAS they often lack basic information that would help them make an informed choice;

BE IT RESOLVED that the Senate respectfully requests the Governor to direct the Board of Dental Examiners to report to the legislature by the 10th day of the First Session of the Seventeenth Alaska State Legislature its recommendations on whether dentists should inform their patients

(1) about the materials, including mercury amalgam, that are used for dental fillings;

(2) that there is a variety of materials that could be used for dental fillings; and

(3) that it is possible that alternative material can be used.

Whereas Mercury amalgam materials are thought by some scientists to cause allergic or adverse reactions

Distributed to N. Carolina Legislators

RE: N.C. SENATE BILL #1171

COULD YOUR DENTAL FILLINGS BE POISONING YOU???

The following world-famous researchers would like to speak before the North Carolina Senate on this most critical issue.

--- No Fund Appropriations are Necessary ---

Dr. Matts Hanson, Ph.D., Sweden
Head of the Scandinavian Dental Patient Organization

Dr. Magnus Nylander, D.D.S., Ph.D., Sweden
Research showing the relationship of amalgam dental fillings to the mercury content in the human brain

Dr. Murray J. Vimy, D.M.D., F.A.G.D., Canada
Author, Assistant Professor, Faculty of Medicine, and Past President of the International Academy of Oral Medicine and Toxicology.
Head of the recent University of Calgary research done on the absorption of mercury in the body organs and tissues from mercury/amalgam dental fillings

Dr. Sam Ziff, Ph.D., U.S.A.
Author or coauthor of four books on the mercury/amalgam issue. President of the Foundation For Toxic-Free Dentistry. Research on the relationship between mercury/amalgam fillings and infertility and birth defects

Also to attend would be **Astronaut James Irwin**, who has had his amalgam fillings replaced for health reasons **and at least twenty** other M.D.'s and Dentists who have researched this issue.

-- We ask that you please allow these gentlemen the honor of speaking before you.

"All that is necessary for evil to triumph is for good men to do nothing."
--- British Statesman, Edmund Burke

DENTAL AMALGAM MERCURY SYNDROME

STATE OF ILLINOIS
EIGHTY-SIXTH GENERAL ASSEMBLY
HOUSE OF REPRESENTATIVES

House Resolution No. 1084

Offered by Representative Cowlishaw

WHEREAS, It is a common dental practice in Illinois to use an amalgam of materials for dental fillings; and

WHEREAS, This dental amalgam, thought by the public to be made only of silver, is actually 50% mercury; and

WHEREAS, Studies have shown that toxic mercury vapors can leak from fillings into the blood system and cause serious health problems, particularly in persons with allergies or chemical sensitivities; and

WHEREAS, Dental patients often lack information that would enable them to avoid having mercury used for their fillings; therefore be it

RESOLVED, BY THE HOUSE OF REPRESENTATIVES OF THE EIGHTY-SIXTH GENERAL ASSEMBLY OF THE STATE OF ILLINOIS, that this body hereby requests that the Illinois Department of Public Health review the studies that have examined the health risks of mercury in dental fillings and report to the General Assembly by March 1, 1990, its findings about such risks as well as its recommendations for providing a means by which dental patients may be informed of the findings and of the alternatives to mercury content in fillings when seeking dental treatment; and be it further

RESOLVED, That a copy of this preamble and resolution be presented to the Director of the Illinois Department of Public Health.

Adopted by the House of Representatives on November 1, 1989.

Michael J. Madigan

Michael J. Madigan, Speaker of the House

John O'Brien

John F. O'Brien, Clerk of the House

COLORADO

Proposed amendment to House Bill No. 1153, by Representative Tucker, A BILL FOR AN ACT CONCERNING CREATION OF THE DENTIST PEER HEALTH ASSISTANCE FUND, AND PROVIDING FOR THE FUNDING AND USE THEREOF.

Line 11 **Section IV** **Disclosure and Informed Consent.** The Dentist Peer Health Assistant Committee will direct all licensed practicing dentists to install and implement a form of Disclosure and Informed Consent which will address the following areas:

(1) educate the patient as to risk, to require detailed explanation of dental materials used in the patient's teeth and to make it a standard expectation that this information will be recorded in patient charts, and his own responsibility

(2) witnessed, understood and obtain a signed consent from the patient or legal guardian,

(3) Requires that all dentists will comply with Disclosure and Informed Consent and shall be advised that a failure to comply with requirements will be reported to the board and will result in disciplinary action.

February 13, 1989

RE: House Bill No. 1153
By Representative Tucker

A BILL FOR AN ACT CONCERNING CREATION OF THE DENTIST PEER HEALTH ASSISTANCE FUND, AND PROVIDING FOR THE FUNDING AND USE THEREOF.

Dear Legislator

The purpose of this letter is to inform you of the proposed amendment which is enclosed. The support of this amendment will have a positive affect on you and the people.

The people have had their civil rights violated in so much as they were not given the opportunity for informed disclosure of risks on their health and lives.

The dentists are censured. They cannot inform the patients of health risks through materials placed in the teeth.

According to the ADA, approximately 2-6 million people have extreme reactions to silver mercury fillings (amalgam) which consists of 50% mercury.

It would be to the benefit of the dentists and the general population if you add this amendment to House Bill No. 1153.

Thank you.

Shirley Brown, president
DAMS Inc. - victim support group
P.O. Box 19032 Denver, CO 80219
(303) 238-1673

— Call for a printed report if interested

Alaska Dental Society
3400 Spenard Road, Suite 10
Anchorage, Alaska 99503
(907) 277-4675

January 23, 1990

JAN 3 1990

Senator Paul Fischer
Senate
P.O Box V, Juneau, AK. 99811

Dear Senator Fischer:

We have recently become aware of Senate Resolution 12, questioning the use and safety of dental amalgam (the silver colored filling material commonly used to restore decayed or damaged teeth). It is our understanding all Alaska legislators have received a preponderance of paper supporting this question.

Enclosed are several reprints advocating the position of organized dentistry. Both the American Dental Association and the Alaska Dental Society feel unequivocally that dental amalgam is, in fact, safe.

Our combined members realize it is extremely important for you to understand the real facts concerning this very serious issue. We recognize much of the information you have received contains non-factual statements and anecdotal matter which cannot be substantiated.

Please know our concern. We will be offering additional details and personal comment/testimony at the appropriate time or as you may request by calling the Alaska Dental Society office in Anchorage.

Sincerely,

Phillip Moritz, DDS

Phillip V. Moritz, DDS
President
Alaska Dental Society

American
Dental
Association

211 East Chicago Avenue
Chicago, Illinois 60611
(312) 440-2500

ADA

January 4, 1990

The American Dental Association has never conducted a survey, the results of which concluded that "More than 70 percent would rather insert a composite-resin filling as the initial posterior restoration. More than a third believe that all silver alloy fillings should be removed and replaced with composites."

The above is misleading and not based upon results of any ADA survey. Moreover, neither Sweden nor Denmark have taken the action inferred in the article. No one can predict what may happen in the future but in conversation with Dr. Runo Cronstrom, President of the Swedish Dental Association, no such action is being contemplated in Sweden.

Sincerely yours,

John W. Stanford

John W. Stanford, Ph.D.
Secretary
Council on Dental Materials,
Instruments and Equipment

DEPARTMENT OF HEALTH & HUMAN SERVICES
PUBLIC HEALTH SERVICE

January 23, 1990

ALASKA AREA NATIVE HEALTH SERVICE
250 GAMBELL STREET
ANCHORAGE, ALASKA 99501

Martha Reinbold
Executive Secretary
Alaska Dental Society
3400 Spenard Road, Suite 10
Anchorage, Alaska 99503

Dear Martha,

Mercury has been used for more than 2,000 years in preparations such as diuretics, antibactericidal agents, laxatives, skin antiseptics and other ointments.

Since the late 1880's, mercury has been an important component of dental amalgams, being used in various forms and compositions. Reports estimate that dental amalgams compose nearly 75% of all single tooth restorations with this percentage remaining stable over the years. In fiscal year 1989, the dental programs which serve Alaska Natives placed nearly 10,000 one-surface amalgam restorations, nearly 10,000 two-surface amalgam restorations and nearly 4,000 three-surface amalgam restorations. Yet the safety of dental amalgams for both the dental patient and the dental professional has been questioned intermittently since the inception of the use of this material.

Exposure to mercury and mercury vapor has been recognized as a potential health hazard to dental personnel for many years. Exposure can occur either through direct skin contact with mercury or mercury-containing compounds or through the inhalation of mercury vapor. A mercury survey is annually conducted by the Environmental Health Branch of the Alaska Area Native Health Service in every dental clinic serving Alaska Natives. These surveys are conducted using a Jerome Model 411, Mercury Vapor Meter. There have been no readings which have exceeded 0.01 mg/m in the past six years. The threshold limit value (TLV) for mercury vapor recommended by the National Institute for Occupational Safety and Health(NIOSH) is 0.05 mg/m , based on a time-weighted average during an 8-hour day. The TLV is considered to be the concentration of mercury vapor which nearly all workers may be repeatedly exposed without adverse effects.

The potential hazards of mercury exposure in the dental environment are preventable by using proper mercury hygiene practices. Disposable capsules for mixing amalgam are used in all dental clinics serving Alaska Natives. Researchers have concluded that disposable capsules are preferable because their usage greatly reduces the risk of accidental mercury spills. All dental programs also store scrap amalgam in sealed containers under sulfur-containing solutions such as X-ray fixer.

The potential toxicity of mercury and advances in technology for measuring mercury vapor have revived the controversy over the safety of dental amalgam. Several studies have shown that measurable amounts of mercury vapor are released from amalgam restorations, particularly when the surface of the amalgam is subject to mechanical forces such as chewing or brushing. The absolute dose, frequency and duration of exposure remain a matter of speculation, as do the effects of confounding variables such as the age and composition of the dental amalgam.

Occupational exposure to mercury is a potential hazard for dental personnel, but is completely preventable with the implementation of proper mercury hygiene practices. There is no evidence in the scientific literature that the minute amounts of mercury vapor that may be released from amalgam restorations cause mercury poisoning. Allergic reactions to mercury and other constituents of amalgam have been documented, but are extremely rare. There have been no documented cases of this type of reaction in an Alaska Native. Dental amalgam has been used extensively for more than 100 years. It has an exemplary record of safety and benefit to the dental patient. Dental amalgam has been used extensively in the treatment of dental disease in Alaska Natives for the past 50 years with no reported untoward allergic reactions or mercury poisoning.

Sincerely,

David B. Jones, DDS, MPH

David B. Jones, DDS, MPH

cc: Dr. Joseph Cumming
1819 Roberts Road
Fairbanks, Alaska 99709

The University of Iowa

Iowa City, Iowa 52242

College of Dentistry
Department of Operative Dentistry

319/335-7207
Fax: 319/335-7155

January 29, 1990

Dr. J.R. Cumming
1819 Roberts Road
Fairbanks, AK 99709

Dear Dr. Cumming:

We have been studying mercury vapor emission from dental amalgam for several years at the College of Dentistry. The objective of our most recent research is to determine the amount of mercury exposure to dental patients who have amalgam restorations. I have enclosed a copy of a report of our most recent results that was published in the Journal of Dental Research in May of 1989.

We estimated that the ten subjects with an average of 14 surfaces of amalgam had a daily exposure of 1.3 μg Hg. The mean concentration of mercury in the blood attributable to amalgam was 1.1 ng/mL (1.1 parts per billion). The last three paragraphs of our article put these findings into perspective. The average daily intake of mercury from all sources of the U.S. population is 24.9 μg. Clinical evidence of toxicity begins to appear in only a few, very sensitive individuals at blood concentrations of 30 ng/mL. Most individuals show signs of mercury toxicity only when exposure to mercury is high enough to result in blood levels greater than 125 ng/mL. Consequently, the amount of exposure to mercury from dental amalgam is not sufficient to cause toxicity, even in the most sensitive individuals. The exposure to trace amounts of mercury from amalgam is well within the recommended guidelines of all regulatory agencies.

It should be noted that our study was conducted with subjects on fish-free diets in order to avoid confusion between mercury in blood due to fish and due to amalgam. Four of our subjects lost an average of 2.5 ng Hg/mL from the blood after beginning a fish-free diet. Eating only an occasional meal of fish was sufficient to maintain a mercury blood level of 5 ng/mL. This fish is not what would be called mercury contaminated, which results in far higher blood levels. Again, this puts in perspective the 1 ng Hg/mL that we attributed to the presence of amalgam.

Sincerely,

DBBoyer

Daniel B. Boyer, DDS, PhD
Professor of Operative Dentistry

DBB/my
Enclosure

OREGON
HEALTH SCIENCES UNIVERSITY
611 S.W. Campus Drive, Portland, Oregon 97201-3097 (503)279-8977

School of Dentistry
Department of Dental Materials Science

January 31, 1990

Dr. Philip Moritz, President
Al. St. D. Society
400 Willoughby Avenue
Suite 208
Juneau, AK 99801

Dear Dr. Moritz:

We are responding to a phone conversation between Dr. John Mitchem and Dr. Joe Cummings on January 25, 1990. Dr. Cummings asked if we could briefly state our position on the use of dental amalgam. Basically, we believe that:

1. Dental amalgam is still considered to be a highly viable restorative material. It remains the standard restorative for the initial restoration of posterior teeth when the strength of the remaining tooth structure is <u>not</u> in doubt. One exception might be the use of etched retained composites in very conservative occlusal pits and fissures.

2. Dental amalgam has withstood the "test of time" and has yet to be replaced by an equal or superior restorative.

3. A cause and effect relationship between Hg in dental amalgam and any systemic disease or disorder has not been established.

A brief review of the recent controversy may help to clarify the issue.

1. The recent literature.

   a. Svare (1981) reported that Hg was being released from amalgam restorations. He used a very sensitive, state-of-the-art Hg vapor analyzer. Prior to this time, it was generally thought that Hg was bound within the amalgam and did not escape.

   b. Abraham (1984) and Patterson (1985) further reported on the release of Hg from amalgam restorations in the mouth.

   c. Vimy and Lorscheider (1985) reported that amalgam restorations were releasing twice as much Hg as reported by Svare (30 vs 15 $\mu g/m^3$). In their discussion, they stated that patients with amalgam restorations were receiving more than a major percentage of the internationally accepted TLV's (Threshold Limit Value) for environmental Hg exposure.

2. What is the actual exposure?

   a. Mackert (1987) reviewed much of the recent literature on the subject and in particular, the Vimy and Lorscheider data. From careful analysis he concluded that these latter authors <u>over-estimated</u> the amount of Hg release by <u>16 times</u>. A second independent study in Sweden confirmed this.

b. The exposure, as determined by Mackert, when compared to the WHO standard and exposure from the environment is as follows.

	μgHg/day
Maximum allowable (WHO)	42
Normal exposure from food, air and water	25-30
Exposure with 12 or more occlusal surfaces of amalgam	2-3
Exposure with 4 or fewer occlusal surfaces of amalgam	0.5

In conclusion, it might be well to keep in mind that:

1. Dental personnel are exposed to more Hg than the average individual who is not industrially exposed to Hg. ADA urine screening tests report an average excretion of 12 to 15 μg/L for dental personnel vs 3 to 4 μg/L for the general populace. With this in mind, one should expect some evidence of an increased incidence of diseases and abnormalities related to Hg within the profession. There is no data to support this.

2. For the extremely rare case of a patient who is allergic to Hg, it has been suggested that he/she not receive amalgam and consider having existing restorations removed. However, how do we then isolate this patient from his/her environmental exposure to Hg?

3. This has become a very emotional issue. Emotion, at times, clouds reason and the controversy is moving from the scientific to the political arena.

4. The establishment of regulations to require dentists to obtain signed consent forms could easily create undue apprehension in patients. In addition, this would obviously bias patients and interfere with rational treatment planning by the dentist; and where would it stop? Other materials could be considered potentially toxic. Does this mean a required consent form for all restorative materials?

5. The <u>profession</u> would be the <u>first</u> group to suggest that the use of amalgam be discontinued <u>if</u> appropriate evidence suggested a possible harmful effect.

Sincerely,

John C. Mitchem, D.M.D., M.S.
Professor

Jack Ferracane, Ph.D.
Chairman of the Dept.

David B. Mahler, Ph.D.
Professor

cc: Dr. Joe Cummings

Bibliography

1. Svare, C.W., et al.: The effect of dental amalgam on mercury levels in expired air. J Dent Res 60:1668 1981.

2. Abraham, J.E.; Svare, C.W. and Frank, C.W.: The effect of dental amalgam restorations on blood mercury levels. J Dent Res 63:71 1984.

3. Patterson, J.E.; Weissberg, B.G. and Dennison, P.J.: Mercury in human breath from dental amalgam. Bull Environ Contam Toxicol 34:459 1985.

4. Vimy, M.J. and Lorscheider, F.L.: Intra-oral air mercury released from dental amalgam. J Dent Res 64:1069 1985.

5. Vimy, M.J. and Lorscheider, F.L.: Serial measurements of intra-oral air mercury: estimation of daily dose from dental amalgam. J Dent Res 64:1072 1985.

6. Mackert, J.F., Jr.: Factors affecting estimation of dental amalgam mercury exposure from measurements of mercury vapor levels in intraoral expired air. J Dent Res 66:1775 1987.

CONCEPT PAPER/Department of Health & Social Services

January 17, 1989

REGARDING MERCURY TOXICITY RELATED TO DENTAL FILLINGS:

The process of repairing dental caries involves replacing decayed tooth tissue with an artificial substitute. All of the materials used for this involve substances foreign to the body and have the potential to cause adverse or harmful reactions. The intensity of such reactions will vary in each person from no effect to severe, depending upon the individual's basic physiology, general state of health and prior history with the material.

Silver-mercury amalgam is the most commonly used dental filling material. Recent data indicate that small amounts of mercury in amalgam can dissociate from the parent compound as mercury vapor or abraded inorganic mercury which may then be absorbed through the oral pharyngeal and gastric mucosa.

The actual amount of mercury absorbed from amalgam is not known with certainty, nor have blood, urine or other diagnostic test levels been established for chronic low level mercury exposure.

There are a number of individual and small case studies suggesting that in some individuals replacement of silver-mercury amalgam fillings ameliorated chronic conditions such as fatigue, headaches, sinusitis and various neurologic symptoms which did not respond to conventional therapies. Most of these reports are anecdotal. A definitive case-controlled study has not yet been conducted. Such a study; statistically valid, controlled at all levels and performed by acknowledged scientific experts is

REGARDING MERCURY TOXICITY RELATED TO DENTAL FILLINGS

absolutely necessary in order to resolve the controversy which surrounds this issue. Until then it is impossible for the Alaska Division of Public Health to give a categorical warning against the use of silver-mercury amalgam.

Those persons who have a large number of amalgam fillings, who have experienced symptoms commensurate with chronic low level mercury exposure and who have tried traditional treatments may wish to consider replacement therapy. This is a personal decision which should be given thorough consideration. Even proponents of amalgam replacement admit that this treatment does not benefit all patients. It is also important to note that the long term physiological effects of other filling materials such as composites are less well known than that of silver-mercury amalgam. Since there are individuals who may be highly sensitive to the mercury in amalgam or to the organic chemicals in composites, it seems wise for dentists to inform their patients that these materials are being used and document any history of adverse effects from previous exposure.

It appears that the best solution for the public is not to be faced with the need to use and artificial substitute for decayed tooth tissue at all. Recent advances in preventative dental care and the documented reduction in numbers of dental caries in children are bringing us closer to that ideal. But until this ideal becomes a reality, the issue requires continued study by both health professionals and the public.

January 17, 1989

CONCEPT PAPER/Department of Health & Social Services

By Dr. Katherine Kelley, Director of Public Health
Department of Health & Social Services/State of Alaska

REGARDING MERCURY TOXICITY RELATED TO DENTAL FILLINGS

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OMNI MEDICAL CENTER

Robert Jay Rowen, M.D.
Diplomate, American Boards of Family Practice, Emergency Medicine, Chelation Therapy

"Biologic Alternatives to Drugs and Surgery"
907-344-7775

Sandra Denton, M.D.
Diplomate, American Boards of Emergency Medicine & Chelation Therapy

January 8, 1990

Senator Paul Fischer
Chairman, HESS Committee
Alaska Legislature, Room 510
P.O. Box V
Juneau, AK 99811

Dear Senator Fischer:

I request your support on Senate resolution #12 allowing the patient to have the freedom of choice in selecting their dental materials and to know what is being placed in their mouths. I have personally seen this effect hundreds of patients, and I strongly urge you to stand with us in making this change.

Thank you for your support.

Sincerely,

Sandra C. Denton, M.D.

SCD/fdl

Enclosure

Insurance Coverage

Request

Bob Stephenson
1837 No Way Lane
Fairbanks, Alaska 99701
455-6481 (h)
456-5156 (wk)
October 27, 1989

The Honorable Paul Fischer
P.O. Box 784
Soldotna, Alaska 99669

Dear Senator Fischer:

During the past two years or so I have been working with various people in state government in an effort to alert people to the dangers inherent in the use of mercury in dental amalgam fillings.

As you probably know, Senator Patrick Rodey has introduced Senate Resolution 12 (copy attached) pertaining to informed consent in the use of dental materials. I am writing to ask that you give this resolution your full support. The issue deserves the widest possible review, and the public clearly deserves to be informed about the scientifically established health risks associated with dental materials. I am sure that the Senate HESS committee could contribute substantially to the resolution of this unfortunate state of affairs by reviewing the facts and bringing the matter to the attention of other Senate members.

I recently forwarded to your office a few documents outlining the scientific basis for the concern, progress in other states, and some interesting developments here in Alaska. In addition, I can report that the issue is receiving widespread and serious attention in North Carolina with a hearing planned for this fall, and that Senator John Kelly of Michigan has agreed to sponsor an informed consent bill. National media coverage is in preparation for this fall.

I hope you will give serious consideration to this matter. Please feel free to contact me if you have questions or require further scientific or other documentation regarding this problem.

Sincerely,

Bob Stephenson

Bob Stephenson
RS/mnb

attachment

cc: Governor Steve Cowper
Senator Al Adams
Senator Jim Duncan
Senator Lloyd Jones
Senator Tim Kelly
Senator Patrick Rodey

Mary N. Boyd
P.O. Box 72666
Fairbanks, Alaska 99707
December 12, 1989

The Honorable Paul Fischer
Chair, Senate HESS Committee
Alaska Legislature
P.O. Box V
Juneau, Alaska 99811

Dear Senator Fischer:

I am writing to urge your support of Senate Resolution 12, regarding informed consent in the use of dental materials. I really haven't the words to express to you what I went through for more than twenty-five years in terms of my health and well-being due to having mercury poisoning, yes, filtered into my tissues from these damnable mercury/amalgam fillings. Whatever the American Dental Association line may be at this time, I am here to tell you that the only thing I changed was the removal of my mercury/amalgam fillings and their replacement with materials more compatible with my body chemistry . . . and guess what? I have experienced some dramatic positive changes in my health! Senator Fischer, whether or not you agree with the fact that mercury leaches and vaporizes out of this filling material do you not believe that the people of Alaska deserve, at the very least, to be informed of the ingredients of these filling materials?

Thank you, Senator, for your serious consideration of Senate Resolution 12.

Sincerely,

Mary N. Boyd

cc: Senator Al Adams
Senator Jim Duncan
Senator Lloyd Jones
Senator Tim Kelly
Senator Patrick Rodey, Resolution Sponsor

Senate Health, Education and Social Services Committee

Senator Paul Fischer, Chairman

PACKET A

SUPPORTS THE RESOLUTION AND THE NEED FOR INFORMED CONSENT.

1. ENVIRONMENTAL DENTAL ASSOCIATION NEWSLETTE

2. LEGISLATIVE ACTION FROM OTHER STATES:

   A. MICHIGAN

   B. NORTH CAROLINA

   C. COLORADO

3. ALASKA DEPARTMENT OF H&SS AMALGAM TOXICITY CONCEPT PAPER.

4. REPORTS IN SUPPORT.

Anti-mercury group lobbies in Michigan

Lansing, Mich.—By all accounts, Paul Stewart probably didn't have a clue.

In early August, as the dental supply company maintenance man worked in his father-in-law's basement reportedly smelting silver from dental amalgam, he was probably unaware of the odorless, yet lethal doses of mercury vapor he had unleashed throughout the suburban Detroit house.

By the end of the month, the 41-year-old Stewart, his wife, along with her father and grandmother, had died of mercury poisoning.

News of the tragedy spread quickly across Michigan, coinciding with a growing movement there calling for legislation requiring dentists to inform patients when they're using silver amalgam for fillings and to explain the alternatives.

"The group called DAMS [Dental Amalgam Mercury Syndrome] has hit the Michigan area pretty hard in the last three or four months," said William Burke, the Michigan Dental Association's assistant executive director for public affairs.

"They're getting newspaper and radio coverage, and they've been getting testimonials from people who say that once they had their amalgam removed all symptoms of all kinds of health problems ended. The claims have been pretty outrageous."

Moreover, representatives from DAMS have approached state Sen. John Kelly, who is considering introducing a bill this session that will require dentists to inform patients about the potential hazards of mercury poisoning.

"I know the dentists aren't real happy with the proposal," said Rosemarie Barone, Sen. Kelly's administrative assistant. "But the bill would not require anything other than for dentists to tell patients that a few people do have a reaction to silver mercury amalgam, and then to explain the alternatives and let the patients make up their mind."

Mr. Burke

Added Ms. Barone, "It's only a notification bill, and we feel it's really in the interests of both the dentists and patients in terms of liability."

Ms. Barone said the impetus for the legislation came from the DAMS organization, which sent Sen. Kelly's office petitions with 2,175 signatures supporting an informed consent bill.

"Those signatures were from all over the state of Michigan," she said. "And we know that they're collecting more signatures because other senators have called saying that they're getting petitions and they want to know about the bill. We know that there's substantial interest about this on the part of the people and legislators. ... [DAMS] is a very well organized group, so whoever is behind them knows what they're doing."

(OVER)

'They're getting newspaper and radio coverage ... the claims [they report] have been pretty outrageous.'

According to Carolyn Smith, president of the Michigan DAMS chapter, the 3-year-old organization has offices in 11 states: Alaska, California, Colorado, Florida, Illinois, Michigan, New Mexico, New York, North Carolina, Pennsylvania and Washington.

"We have two goals," continued Mrs. Smith. "The first is to dispense non-anecdotal information to both the lay person and the dental professional on the hazards of mercury as it's used in dental material. And we do this through contacts with the media, letter writing and on a one-on-one basis in small meetings.

The group's second goal, she said, is to press state legislatures to pass informed consent legislation. "We want people to be told that amalgam does contain a percentage of mercury, and that while some people can handle it, it can be toxic to others," said Mrs. Smith.

In response to DAMS' activities in Michigan, MDA representatives plan to meet with Sen. Kelly, and the association also has provided dentists with a package of materials to help them discuss the issue with patients.

"We've outlined," said Mr. Burke, "the questions patients most commonly ask, such as: 'What is dental amalgam?' 'How is it produced?' 'Why is it chosen over other fillings?' 'Is it safe?' And then we follow it up with a position paper from the ADA."

Included in the ADA material is the resolution on the use of mercury amalgam passed by the House of Delegates in 1986: "Resolved that based on current documented scientific research, the conclusions of conferences and symposiums on the biocompatibility of metallic restorative material, and upon joint reports of the Council on Dental Materials, Instruments and Equipment and the Council on Dental Therapeutics of the Association, the continued use of dental amalgam as a restorative material does not pose a health hazard to the non-allergic patient. ..."

Despite its efforts, DAMS has failed to get informed consent legislation passed in any state. Colorado Dental Association Executive Director Jeffrey Thompson reports that DAMS representatives have unsuccessfully approached both the state board of dental examiners and Colorado's Health, Environment, Welfare and Institutions Committee.

In North Carolina, a resolution "to study the effects of the use of toxic substances by the medical and dental professions on the health of persons exposed to such substances," died in committee at the end of the state's legislative session in August.

And in Alaska, a proposal requiring informed consent was introduced last May. No action has yet been taken. ■

—Daniel McCann

The mercury scare

If a dentist wants to remove your fillings because they contain mercury, watch your wallet.

"Just how concerned should I be?" the CU reporter asked. Dr. Joel Berger, a Queens, N.Y., dentist, paused a moment before answering. "If I were you," he said, "and I had that test at 8 o'clock this morning, I'd have called two of my friends and made sure I had those fillings out by 9 o'clock tonight."

Berger is a leading proponent of the notion that mercury-amalgam fillings are poisoning the populace—a notion now espoused by hundreds of dentists across the country. He has issued his warning on numerous New York City-area radio and television talk shows and was featured last September on the CBS Evening News, where he was shown measuring the mercury level in a patient's mouth. The CU reporter, without revealing his affiliation, had gone to Berger for a consultation. What was told to him is similar to what is being told to thousands of consumers by dentists who remove allegedly dangerous fillings and replace them with new ones.

One hundred million Americans have "silver" fillings. The fillings are actually alloys, or amalgams, of silver and several other metals. One of those metals is mercury, which makes up about half the filling. After the putty-like amalgam is inserted, it hardens in about one day.

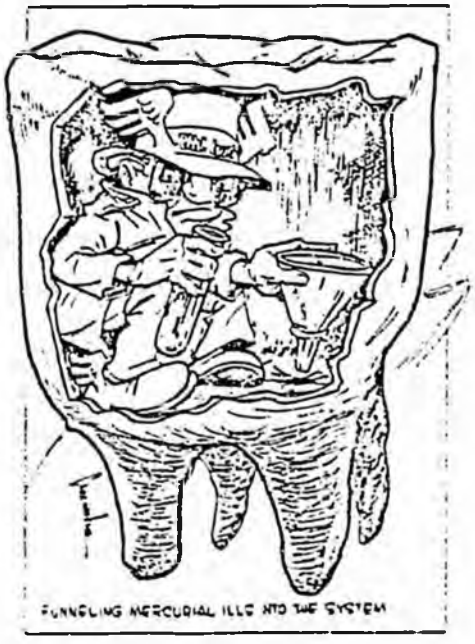
Until recently, researchers believed that the amalgam released mercury vapor only while it was hardening. But in 1979, University of Iowa researchers found that chewing can release minute amounts of mercury vapor from old fillings. That finding sparked the present controversy over amalgam safety.

It's been known for centuries that mercury is a potent poison when swallowed, inhaled, or absorbed through the skin. Exposure to high levels for a long time can damage the brain and nervous system. The classic example occurred in the 19th century, when makers of felt hats dipped material into mercuric-nitrate solution to make the felt easier to shape. In so doing the workers absorbed mercury through their skin and inhaled mercury vapor. Tremors, incoherent speech, difficulty in walking, and feeble-mindness resulted. The problem was immortalized in the phrase "mad as a hatter" and by the Mad Hatter in "Alice in Wonderland."

Exposure to smaller amounts of mercury vapor can cause less-drastic symptoms, including insomnia, anxiety, and minor tremors. Even today, mercury is a hazard for some workers—mainly those in thermometer factories and in plants that use mercury to make chlorine and caustic soda.

Can mercury in fillings cause those or other health problems? That's the key question in dentistry's newest controversy. "Anti-amalgam" dentists such as Berger contend that mercury fumes from amalgams can cause problems ranging from depression and multiple sclerosis to fatigue and irritability. Their solution: Drill out the amalgams and replace them with fillings made from other materials.

The American Dental Association (ADA), on the other hand, insists that amalgam fillings are safe. Only people allergic to mercury—probably less than 1 percent of the population—need avoid them, the ADA says.



Cartoons (above and at right) from Dr. Hal Huggins' book, "It's All in Your Head," an attack on mercury fillings.

Dentists don't make up amalgam containing mercury out of any special love for the stuff. They use it because it's strong and durable.

Chewing exerts tremendous force on the back teeth — mouthful after mouthful, meal after meal, day after day. An amalgam filling can withstand that force for a long time before breaking down. A mercury-amalgam filling usually lasts five to 10 years, and some of them last as long as 40 years.

The main alternatives to mercury-amalgam fillings are composite resin fillings, which were introduced about 20 years ago and are made mainly of plastics. When amalgam fillings are removed because of "mercury toxicity," composite fillings usually take their place.

Composites can be mixed to match the color of the tooth, and so are often used for front teeth, where cosmetic considerations are important. But composites have several drawbacks. They usually last no more than three years in back teeth; they're more expensive than amalgam; and teeth filled with composites are more susceptible to recurrent decay.

In 1984, the ADA's Council on Dental Materials provisionally approved the use of composites for back "baby" teeth. But for permanent back teeth, the ADA has so far withheld its endorsement.

Research is now in progress on composites that can be chemically bonded to teeth. Such composites could rival amalgam fillings in durability. But CU's dental consultants say that composites strong enough for use in back teeth probably won't be available for 5 to 10 years.

Gold inlays may also be used instead of amalgams. They're durable but cost a lot, both for the gold and the installation, for they must be pre-shaped to fit the cavity and then cemented into place. They're not a very practical alternative to amalgam fillings.

When the reporter had called Berger's office for a consultation, the secretary had asked "What are your problems?" It was the Monday after a rough weekend. "Fatigue and headaches," the reporter answered. She told him he needed to come in for the mercury toxicity test.

So there he was, with a rubber tube in his mouth. Berger held the tube there for about 10 seconds as it sucked a small amount of air into a mercury-vapor analyzer. The first measurement was reassuring: The digital readout said zero. Then Berger told the reporter to chew a stick of gum vigorously for 10 minutes. The measurement taken afterward was 32—which prompted Berger's "out by 9 P.M." recommendation.

Berger said that 32 meant a mercury-vapor level of 32 micrograms per cubic meter. Government regulations, he explained, require that workers cannot be exposed to an average mercury-vapor level of more than 50 micrograms per cubic meter of air during an eight-hour working day.

A worker exposed to the CU reporter's mercury level, Berger said, would be regarded as having a "borderline toxic" exposure. And he would be carefully monitored for five years for signs of mercury poisoning.

A saliva test produced more bad news. According to Berger, the reporter's "highly acidic" saliva was corroding his fillings and adding to the mercury vapor released during chewing.

The message was clear: The reporter's fillings were endangering his health. How much would it cost to take them out and put non-mercury ones in? Berger counted up the number of fillings—eight—and gave his answer: $580.

"Will removal of my fillings cure my fatigue and headaches?" the reporter asked. Berger said he couldn't promise that, since it would depend on the reporter's "unique physiological response" to mercury. But he said that many of his patients with the same problems had experienced relief once their fillings were out.

The mercury-vapor analyzer is a device customarily used in factories, where it measures the mercury levels in workplace air. Is it appropriate for dentists to use it, as increasing numbers of them are doing?

CU's dental consultants say that use of the mercury analyzer is a scare tactic to get patients to part with their fillings. Our consultants say that the device makes it easy for dentists to contend that mercury doses exceed occupational standards.

Vigorous chewing for 10 minutes creates heat and friction that maximize the release of mercury vapor. The analyzer senses the mercury contained in about one-half cup of air and multiplies it by 8000. That gives a readout corresponding to the mercury level in a cubic meter of air (about the amount inhaled in an hour). But for the patient, the exposure doesn't last for hours. It lasts only a few minutes during chewing—and only a fraction of the vapor may be inhaled.

Our consultants point out that most people don't inhale through their mouths when chewing. And most people breathe through the nose, so that inhaled air bypasses any mercury vapor that may be in their mouths.

In assessing mercury vapor's effect on health, the key question is: How much actually gets absorbed by the body's tissues? Dr. Thomas W. Clarkson of the University of Rochester School of Medicine is one of the world's leading authorities on mercury toxicity. He says that a mercury-vapor analyzer can't answer that question.

Clarkson told CU that a person's mercury exposure can best be assessed by measuring the mercury levels in blood and urine. The urine level provides the best measure of "body burden," or long-term exposure to mercury, while the blood level reflects recent exposure.

"I can promise one thing," Berger said. "Removal of your fillings will definitely lower your body burden of mercury."

Our reporter wondered: Just how heavy was his body's mercury burden? After all, he'd presumably been gulping mercury vapor ever since his first filling at age nine. And corrosive saliva had presumably been his constant companion.

Two hours after leaving Berger's office, he was in the office of CU's chief medical consultant. There he provided a blood sample and a urine specimen. He also had his saliva tested for acidity.

In two hours, his saliva had changed from "highly acidic" to neutral. The blood and urine samples were analyzed for mercury by a leading biomedical laboratory. For urine, the level was six micrograms per liter. Normal, according to the lab, is anything up to 20 micrograms per liter. The blood level was also well within the normal range.

The reporter notified Clarkson of his test results. Clarkson's advice: "Hold onto your $580."

Almost everyone, Clarkson said, has detectable levels of mercury in the urine and blood. The main source of mercury in most people's bodies is the food they eat, seafood in particular. Clarkson expressed surprise that the CU reporter, who eats tuna at lunch most days, had such modest mercury levels in his blood and urine.

If dental amalgams really were poisoning people, Clarkson pointed out, the mercury levels in the general population (where fillings are commonplace) would rival those found among workers exposed to mercury. That's far from the case. In

one study of 1107 people (mainly in the U.S.), 95 percent had urine levels of mercury lower than 20 micrograms. Adverse health effects appear when the level reaches about 150 micrograms or more, Clarkson said.

CU's dental consultants point out that replacing mercury fillings may cost more than money. Re-invading a tooth—drilling out amalgam and installing a replacement—can increase tooth sensitivity and weaken the tooth. Also, studies show that drilling out amalgam can produce brief but significant increases in mercury levels in the mouth.

According to CU's consultants, if anyone faces a health hazard from mercury fillings, it's dentists and their assistants. The average dentist handles between two and three pounds of mercury every year. Skin contact can result in absorption. Careless use and accidental spills can produce significant levels of mercury vapor in the air.

Surveys have shown that as many as 10 percent of dental offices have mercury-vapor levels that exceed 50 micrograms per cubic meter of air—the upper limit that the National Institute for Occupational Safety and Health considers safe for eight-hour exposures in the workplace.

Despite their higher exposures, dental personnel aren't being poisoned. Since 1982, the ADA has sponsored a mercury-testing service that measures urine-mercury levels in dentists and in people who work in dentists' offices. While average levels are about four times higher than in the general population, they are still well within the acceptable range.

According to CU's dental consultants, a major reason some dentists are jumping on the anti-amalgam bandwagon can be summed up in one word: fluorides.

Largely because of fluoridated drinking water and flouride toothpastes, the incidence of tooth decay over the past 20 years has dropped by some 50 percent. So some dentists are suffering from a large cavity in their practice. Taking out and replacing amalgam fillings helps to fill their financial hole.

In CU's view, dentists who purport to treat health problems by ripping out fillings are putting their own economic interests ahead of their patients' welfare. Amalgams have been used for more than 150 years. Except for a few people with a genuine allergy to mercury, CU knows of no one who's been harmed by them. There's little danger of the U.S. becoming a nation of Mad Hatters. ■

"Have you felt draggy, listless and even fatigued when you wake up? Have you felt depressed, irritable and jumpy, and lashed out at people for no good reason? Have you worried yourself sick because thoughts of suicide keep floating into your conscious mind? For many of my patients, the culprit is mercury toxicity."

So writes Dr. Hal Huggins, a 48-year-old Colorado Springs dentist and the leader of the anti-amalgam movement. Huggins claims at least 20 percent of people with amalgam fillings are "mercury toxic"—and the American Dental Association "is covering up the fact" because of its fear of lawsuits.

Huggins gets his own message out through books, articles, tapes, and lectures. He told CU that he has spoken to between 4000 and 5000 dentists, 1500 of whom have attended his seminars on mercury toxicity. Each day, he says, his office fields about 250 letters and phone calls from concerned members of the public.

Huggins says that he hasn't practiced dentistry for 2½ years. Instead, he's involved in "diagnosis and treatment planning." A three-to-four-hour consultation with Huggins costs about $1500. Or for $300, patients can get a consultation through the mail after completing an extensive computerized questionnaire.

Huggins reports that he mainly treats patients with multiple sclerosis—about 150 so far. He said that 80 percent of them have experienced "substantial improvement."

In 1983, such claims prompted the National Multiple Sclerosis Society to issue a memo to all its chapters. In it, the society said that there was no evidence that multiple sclerosis was related to dental amalgams, and that "this therapeutic claim . . . involves economic implications, in terms of expense to the patient and great profit to the dentist."

"The suicidal patient," Huggins has written, "is very special to us." He told CU that his success with suicidal patients is "better than 50 percent." For some of these depressed people, he said, "it just takes a couple of weeks and it's gone."

Huggins claims that in addition to multiple sclerosis and depression, mercury toxicity causes many other conditions, including epilepsy, leukemia, Hodgkin's disease, arthritis, mononucleosis, and premenstrual syndrome.

Huggins describes his treatment successes in his 1985 book "It's All in Your Head." That book has prompted the Colorado Attorney General's office to investigate whether he is practicing medicine without a license.

Not surprisingly, Huggins prescribes amalgam removal as part of the treatment process. But fillings, he says, must be removed in the proper sequence. That's where the *Amalgameter*, a Huggins invention, comes in.

The *Amalgameter* supposedly reads the "electrical current" in each filling and determines if the current is "positive" or "negative." Huggins claims that highly negative fillings (which supposedly cause the worst diseases) must be removed first; otherwise, amalgam removal probably won't help the patient.

Huggins formed Tox Supply Inc. to market the *Amalgameter* (cost: $350) to other dentists. Last November, the U.S. Food and Drug Administration informed Huggins that the *Amalgameter's* promotion and distribution involved "serious violations of the Federal Food, Drug and Cosmetic Act." The FDA contends that "there is no scientific basis for the removal of dental amalgams for the purposes claimed."

Huggins sold Tox Supply in 1984. The FDA says he "continues to promote the *Amalgameter* for use as a medical device." Huggins denies it.

When people are "mercury toxic," amalgam removal is not enough, according to Huggins. He also recommends special nutritional supplements "to get rid of the body's stored mercury." Huggins markets the supplements through his company, Matrix Minerals Inc. Two of them, *X-IT* and *Eater's Digest*, prompted a warning from the FDA last November. The FDA contends that both products are "unapproved new drugs" whose labeling is "false and misleading."

Huggins claims to have been studying mercury toxicity since 1973. But when CU asked him for evidence that amalgam fillings can harm people, Huggins acknowledged that he has no clinical studies.

His evidence, he says, is contained in the 600 case studies stored in his computer. They have provided "a massive amount" of data that "all points in the same direction." Huggins told CU, "As soon as I take my course in statistics, I will start putting together the information."

In addition to Hal Huggins and Joel Berger (see page 150), some other prominent anti-amalgamists include:

Michael F. Ziff, an Orlando, Fla., dentist. Ziff travels around the country giving courses to dentists on mercury toxicity. He claims to have "completed research on over 400 articles on mercury toxicity."

Ziff boasts a B.S. degree in nutrition from Donsbach University. Critics describe Donsbach University as a diploma mill, with B.S. degrees selling for about $2000. (See CONSUMER REPORTS, May 1985).

Sam Ziff, Michael Ziff's father, is the author of the book "Silver Dental Fillings: The Toxic Time Bomb." With his son Michael, he has coauthored a booklet, "The Hazards of Silver/Mercury Dental Fillings," which anti-amalgam dentists give away to their patients. Sam Ziff also has a degree from Donsbach University, in his case a Ph.D., which sells for about $6000.

Roy Kupsinel, M.D., of Oviedo, Florida. Kupsinel publishes "Health Consciousness — a holistic magazine," which prints numerous articles opposing mercury-amalgam fillings. He markets *Amalgameters* and has written "A Patient's Guide to Mercury Amalgam Toxicity." He also publishes the rebelliously titled Journal of the American Quack Association.

*by P.L. Fan, PhD

Safety of amalgam

Current analysis of scientific information indicates that amalgam restorations are safe

The trituration of mercury with an alloy for dental amalgam produces results in an amalgam restorative material that has a long-proven clinical performance record.

The formation of mercury-silver (gamma one) and mercury-tin (gamma two) phases are described in detail in dental materials textbooks. With the use of sensitive analytical instrumentation, investigators have reported that there were detectable nanogram amounts of mercury vapor in expired air of subjects after chewing.

This has stimulated extensive investigations and review of the safety of dental amalgam. This paper summarizes the positions on the safety of dental amalgam. It also discusses the Food and Drug Administration regulations on medical and dental devices used for diagnostic purposes.

Literature reviews

In 1982 a review by Bauer and First concluded that, "The use of mercury in dental amalgam is relatively safe. The potential for mercurial poisoning exists. However, its occurrence is negligible.

"Of concern to the dental patient and personnel is the occurrence of mercurial hypersensitivity, the allergic response to mercury in amalgam restorations and from restorative procedures. Since the allergic reaction is self-limiting, it may be necessary for the dentist only to be aware of its symptoms for an adequate diagnosis and palliative treatment."[1]

In 1987, Enwonwu, in a critical review of the literature on the potential hazards of use of mercury in dentistry, concluded that "while there is consistent evidence indicating release of mercury vapor from the restorations during chewing, tooth brushing, and other oral activities, proof of a casual link of this specific source of the heavy metal to any major human health problem is lacking."[2]

ADA

In 1983, the American Dental Association published a summary of scientific information then available.[3] It stated:

"There is no recorded scientific evidence of mercury vapor toxicity resulting from (10 ng/min) of mercury vapor. Further, none of these measured amounts of released mercury have been documented as being associated with various diseases or medical conditions, or both.

"Furthermore, and it is most significant to note that there is no documented scientific evidence to suggest that dentists and dental office personnel, who are exposed to much greater amounts of mercury vapor, have a greater incidence of certain medical conditions or higher mortality rates as compared with the general population."

The report also stated "the association wishes to emphasize that, except in individuals sensitive to mercury, there is no reason why a patient should seek to have amalgam restorations (silver fillings) removed. Indeed, the effect of such a procedure and further restorative operations could be detrimental to the patient's oral health, including the unnecessary loss of teeth, and cannot be justified."

Another report from the ADA[4] in 1984 considered the utilization and safety of patch testing for sensitivity to mercury and concluded that "patch tests for mercury. . . are not to be used indiscriminately for all patients. . . the validity of the patch test results and the suggested interpretation of the monitored patient reactions have not been well documented."

The report also stated that "a medical history of the patient and consideration of the benefit-to-risk should be included in the professional judgment on the use of patch tests. The decision rests with the dentist.

When a patch test is indicated, the informed consent of the patient should be obtained. Patch tests should only be performed by a professional trained in the administration and interpretation of these tests. Referral to physicians, such as allergists or dermatologists, who specialize in this testing is strongly recommended."

The ADA House of Delegates in 1986 passed a resolution on the use of amalgam as restorative material.[5] The resolution stated:

"Resolved that based on current documented scientific research, the conclusions of conferences and symposiums on the biocompatibility of metallic restorative material, and upon joint reports of the Council on Dental Materials, Instruments and Equipment and the Council on Dental Therapeutics of the Association, the continued use of dental amalgam as a restorative material does not pose a health hazard to the non-allergic patient, and be it further resolved that to advocate to a patient or the public the removal of clinically serviceable dental amalgam restorations solely to substitute a material that does not contain mercury is unwarranted and violates the ADA Principles

*Dr. Fan is associate secretary, American Dental Association's Council on Dental Materials, Instruments and Equipment.

of Ethics and Code of Professional Conduct, and be it further resolved that in those instances where state dental boards initiate proceedings on this question that the ADA cooperate in such proceedings by making available scientific personnel as expert witnesses."

NIDR

The National Institute of Dental Research (NIDR), in 1984, sponsored a workshop on biocompatibility of metals in dentistry.[6-8] The goal was to review existing scientific evidence and literature about metals used in dentistry and to pinpoint areas of interest or concern that warrant further research. The question as to whether the small levels of mercury released from amalgam surfaces can pose a possible risk for patients with amalgam restorations was also considered.

The summary on the workshop stated:

"Studies have demonstrated that patients are exposed to mercury vapor when amalgams are placed as a restoration, when existing amalgams are removed, and during chewing.

"Some studies suggest that blood levels of mercury are elevated in patients during these procedures and that the levels are correlated with the number of amalgams and the occluding surface area. Other studies have shown no difference in blood levels in patients with and without amalgam restorations. Additional studies in this area are required to more accurately assess the possible risk to patients.

"Health hazards of blood mercury levels associated with dental amalgams have not been documented. It is difficult, therefore, to interpret the relevance of blood and urine levels of mercury that are observed after placement or removal of amalgams, and chewing on amalgam surfaces. In addition, the distribution of mercury into body tissues is highly variable and there appears to be little correlation between levels in urine, blood or hair, and toxic effects."

The summary also addressed the consideration of rare occurrences of possible allergic reaction to mercury and states that "although cases of allergy to mercury have been reported in the literature, the prevalence of mercury allergy is estimated to be less than 1 percent.

"In patients with a history or clinical symptoms (or both) of mercury allergy, patch testing may be indicated to confirm the allergy. Because of the infrequency of reports of mercury allergy, it is not recommended that patients be tested routinely for sensitivity.

"When patch testing is indicated, it is recommended that the patient be referred to a professional trained in the administration and interpretation of the test."

The conclusion of the workshop is stated in the summary: "On the basis of the information presented in this workshop, there is no documented evidence for recommending the discontinuation of the use of dental amalgams as a restorative material in dentistry. Additionally, the removal of dental amalgam can be recommended only in those patients who have a true hypersensitivity to mercury or other constituents."

USPHS

The United States Public Health Service (USPHS), in 1984, issued a statement on the safety of dental amalgam.[11] The statement, signed by the Assistant Surgeon General, Dr. Robert E. Mecklenburg, put forth the position that "Research on dental amalgam, as well as the total range of dental restorative materials used in the United States and accepted by the U.S. Food and Drug Administration and the American Dental Association's Council on Dental Materials, indicates no potential harm to the vast majority of dental patients receiving amalgam fillings.

"Additionally, no evidence exists to indicate that the health of individuals occupationally exposed to dental amalgams (dentists, dental hygienists, dental assistants) is compromised where approved materials and methods are conscientiously employed.

"As with any substance, the rare possibility of individual allergy does exist. However, individuals suspected of having such allergies may receive skin tests and, where necessary appropriate dental treatment alternatives can then be selected.

"Individuals should not seek replacement of amalgam fillings with alternate materials based on a fear of harm. To do so would result in unnecessary expenditures. Providers of dental care should be familiar with accurate scientific literature as well as the actions and recommendations of representative professional organizations, such as the American Dental Association, regarding dental restorative materials, and should not discontinue appropriate use of dental amalgam."

NMSS

The use of amalgam as a restorative material has been implicated by some as the cause of a number of medical problems such as neurological diseases and more specifically, multiple sclerosis (MS).

In response to this specific implication, the National Multiple Sclerosis Society (NMSS) issued a memorandum in 1983 to refute this implication.[12] The memorandum said:

"A review of the literature reveals that the question of mercury toxicity from silver fillings was raised in Europe in the mid-1960s by a Swiss neurologist, Ernst Baasch. However, later publications from the same area and during the same decade show the seemingly contradictory recommendation for the use of mercury as part of a salve compound to treat MS cutaneously.

"(This indicates the complex and inconclusive nature of these claims, and the difficulties faced when evaluating the theories which abound, concerning the causes of, and treatments for, multiple sclerosis.)

"There has been a related suggestion that a combination of gold and silver fillings in contact with saliva can create an 'electrogalvanic current' which adversely affects the cells of the body, causing neurological dysfunction. This claim is also questionable, as there are vast numbers of people with mixed dental metals, and there is no documentation of any adverse effects.

"Although the claim that removal of silver amalgam and replacement with alternative dental materials will alleviate the symptoms or cure neurological disease is based partly on the known toxicity of heavy metals, the toxic effects of mercury absorption occur only when this agent is in the form of elementary mercury vapor or as mercury compound dusts. The 'occasional incidental swallowing of metallic mercury is without harm' (Merck Index, 1976).

"If indeed there was a connection between silver amalgam dental fillings and multiple sclerosis, one might observe a much higher incidence of MS among the professional dental community, as well as

Continued on Page 36

among those who assist dentists. These individuals deal with mercury in its more elemental form and theoretically are exposed to greater risk.

"There is no indication that a higher incidence of MS exists among this specialized group. In addition, the incidence of multiple sclerosis has been documented in the literature long before modern techniques of dentistry were developed and thus it would be impossible to implicate dental amalgam in any of those cases.

"Several other factors need to be seriously appraised in relation to this therapeutic claim. First, there is a placebo response as high as 70 percent in patients with multiple sclerosis which makes defining the basis for improvement in any individual patient impossible unless subject of rigorously controlled trials.

"Second, while the effect of stress on the clinical course of multiple sclerosis can never be predicted in any specific instance, it is the consensus of experienced physicians that avoidance of unnecessary physical or emotional stress is an important consideration in maintaining optimal function. Such stress includes unnecessary surgery and anesthesia.

"Finally, this therapeutic claim for multiple sclerosis involves economic implications, in terms of expense to the patient and great profit to the dentist.

"In evaluating this treatment, patients should recognize all of these issues and are advised to consult their physician before pursuing this dental therapy. It is the advice of the National Medical Advisory Board that replacement of silver amalgam fillings cannot be recommended for the treatment of multiple sclerosis."

Consumers Union

The Consumers Union investigated "the mercury scare" and reported its findings in a 1986 article.[13]

Its reporter visited a dental office and after undergoing a saliva test and a test for mercury vapor emission after chewing, was advised to have the fillings out by 9 o'clock that night at a cost of $580. The reporter then visited the office of Consumer Union's chief medical consultant and provided a blood sample and a urine sample for mercury testing.

The acidity of the saliva was also tested. The reporter also consulted with Dr. Clarkson of the University of Rochester School of Medicine, who is one of the world's leading authorities on mercury toxicity.

When the reporter notified Dr. Clarkson of the test results, the advice from Dr. Clarkson was that the reporter should hold on to his $580. The Consumers Union's view is stated in the article as "dentists who purport to treat health problems by ripping out fillings are putting their own economic interests ahead of their patients' welfare.

"Amalgam has been used for more than 150 years. Except for a few people with a genuine allergy to mercury, Consumers Union knows of no one who has been harmed by them. There is little danger of the U.S. becoming a nation of Mad Hatters."

FDA

The use of mercury vapor analysers or galvanic current meters as diagnostic devices for toxicity or allergy would place these items under the categories of medical and dental devices.

Government regulations require that medical and dental devices need to be approved for marketing before they are commercially available. The agency responsible for approving these devices is the Center for Devices and Radiological Health, Food and Drug Administration.

This agency can remove unapproved medical and dental devices from the market. This has been the case for an amalgameter.

Conclusions

The current analysis of scientific information indicates that amalgam restorations are safe. Exceptions may be the rare individuals who are allergic to mercury.

The incidence of mercury allergy is so rare that a percentage number cannot be assigned to its occurrence in the general public. Routine allergic testing to mercury should not be performed. If an allergy test is to be considered, the administration and interpretation by a professional trained in these areas are recommended.

There is no scientific basis to consider mercury from amalgam restoration is a causative factor for medical problems, especially neurologic diseases such as multiple sclerosis.

Apart from demonstrated allergic reactions, there is no reason for patients to have amalgam restorations removed. The practitioner should be aware that diagnostic systems are regulated by the Food and Drug Administration.

References

1. *Bauer, J.G., and First, H.A.: "The toxicity of mercury in dental amalgams." CDAJ. 10(6):47-61, 1982.*
2. *Svare, C.O.: "Potential health hazard of use of mercury in dentistry: critical review of the literature." Environmental Res. 42:257-274, 1987.*
3. *Council on Dental Materials, Instruments and Equipment; and Council on Dental Therapeutics: "Safety of dental amalgam." JADA. 106:519-520, 1983.*
4. *Council on Dental Materials, Instruments and Equipment; and Council on Dental Therapeutics: "Patch tests for sensitivity to mercury or ... ." JADA. 108:381, 1984.*
5. *American Dental Association, Transactions 127th Annual Session, Miami Beach, Florida, 1986, p. 536-537.*
6. *National Institute of Dental Research: "Workshop: biocompatibility of metals in dentistry." JADA. 109:469-471, 1984.*
7. *Mitchell, E.W.: "The biocompatibility of metals in dentistry." CDAJ. 12(10):17-19, 1984.*
8. *Autian, J.: "Carcinogenic potential of metals." CDAJ. 12(10):23-33, 1984.*
9. *Cooley, R.L.; and Young, J.M.: "Detection and diagnosis of biocompatibility of mercury." CDAJ. 12(10):36-43, 1984.*
10. *Svare, C.W.: "Dental amalgam related mercury exposure." CDAJ. 12(10):54-60, 1984.*
11. *U.S. Public Health Service Statement on the Safety of Dental Amalgam. April 30, 1984.*
12. *National Multiple Sclerosis Society, Patient Services Department Memorandum No. 115-83, Silver amalgam fillings and multiple sclerosis.*
13. *Consumers Union: "The mercury scare." Consumers Report. 51:150-152, 1986.*

Reprint requests to:
P.L. Fan, PhD
Associate Secretary
Council on Dental Materials, Instruments and Equipment
American Dental Association
211 E. Chicago Ave.
Chicago, IL 60611

Mercury has been used for a variety of medicinal purposes for centuries. Exposure to mercury can occur from environmental, dietary, and occupational sources. Since the beginning of the early 1800s, intermittent controversy has surrounded the use of mercury in dental amalgam restorations. At the center of this controversy are questions concerning the amounts and effects of mercury exposure to dental patients and personnel. This report reviews recent scientific literature on the safety and use of mercury in dentistry.

The use of mercury in dentistry: a critical review of the recent literature

Dan C. Langan, DDS
P. L. Fan, PhD
Alice A. Hoos

Mercury has been used for more than 2,000 years in preparations such as diuretics, antibacterial agents, laxatives, skin antiseptics, and other ointments. Presently, workers in more than 60 industries are occupationally exposed to mercury. These industries include factories producing chlorine, caustic soda, insecticides, and fungicides, as well as those involved in the manufacture of neon lights, paper, paint, and jewelry, and in the practice of dentistry.[1]

Since the 1800s, mercury has been an important component of dental amalgams, being used in various forms and compositions. In 1984, it was estimated that 85% of posterior restorations placed in the United States were amalgams.[2] Previous reports estimated that 75% of all single tooth restorations were amalgam restorations and that this percentage had remained stable for many years.[3] In 1979, a survey[4] conducted by the American Dental Association's Bureau of Economic and Behavioral Research estimated that in the United States annually, nearly 57 million one-surface and 53 million two-surface amalgam restorations are placed.

Yet, the safety of dental amalgams for both the dental patient and the dental professional has been questioned intermittently since the inception of the use of this material. Many articles and reports have appeared in dental journals and the lay press concerning the properties and safety of dental amalgams.[5-9]

History (Amalgam Wars)

Controversy is not new for amalgams. The foundations for the earliest recorded "Amalgam War" were laid around 1833. The Crawcour brothers, then exiled from France for dental practice irregularities, started a thriving practice in New York City using a silver coin-mercury mixture called "royal mineral succedaneum." Because their treatment was inexpensive and painless (they did not bother to remove decay), patients flocked to the Crawcours' office. Many dentists abandoned the traditional gold foil technique of the day[10] in favor of this more lucrative technique.

After a few years of the unscrupulous and inept work of the Crawcours and their followers, disastrous side effects started to appear. In 1843, the American Society of Dental Surgeons condemned the use of all filling materials other than gold, thereby igniting the first Amalgam War.[10]

The society went further and requested members to sign a pledge refusing to use amalgams. Members could stay in good grace by signing the following: "I hereby certify it to be my opinion and firm conviction that any amalgam whatever . . . is unfit for the plugging of teeth or fangs and I pledge myself never under any circumstances to make use of it in my practice as a dental surgeon, and furthermore, as a member of the American Association of Dental Surgeons, I do subscribe and unite with them in this protest against the use of the same" (Goldwater, 1972).[11]

The question of amalgam composition was finally settled in 1895 by Dr. G. V. Black of Northwestern University, who after years of scientific research on amalgams, demonstrated the proper quantitative and qualitative mixture of mercury in amalgam to make an effective restorative material.

The work of Black served as a basis for modern concepts and practices in the use of amalgam restorations and led to later standardization in the manufacture of amalgams. Specifications for mercury to be used in making dental amalgam were drawn up and promulgated jointly by the American Dental Association and the U.S. Bureau of Standards in 1932.[11]

The second Amalgam War was started by a German chemist, Professor A. Stock, in the mid-1920s when Stock claimed to have evidence showing that mercury could be absorbed from dental amalgams and that this led to serious health problems. Stock also expressed concern for the health of dentists, stating that nearly all dentists had excess mercury in their urine. He reported that the mercury levels in urine of seven patients with amalgams ranged from 0.1 to 4.0 μg/L, but failed to record any urine mercury levels before restorations were placed. Stock's work was later questioned; even Stock, in 1934, repudiated his earlier analyses. Regardless, this marks the beginning of a controversy that continues.[11]

The controversy remained dormant until the late 1970s when it was reignited by published reports — entirely unsubstantiated by scientific or medical evidence — that linked mercury release from amalgams to severe and debilitating cardiovascular, psychiatric, neurological, and immunologic diseases.[9-12] It was advocated that all amalgams be removed and that the biochemical condition of the body be determined. Electrical current from amalgams was to be measured "to determine the sequence of negative to positive electrical currents." This was essential, it was claimed, because the removal of the amalgams in the wrong sequence and without concomitant biochemical treatment would worsen the patient's condition. One proponent of this technique suggested that negatively charged amalgam restorations should be removed first for the greatest health benefit, whereas removal of positively charged amalgam restorations would not have an immediate health effect.[13]

The following dramatic health history also was reported.[12] A 17-year-old girl, withdrawn, totally lacking in energy, even suicidal, sought treatment. When she became ill, she began to hyperventilate, and "started withdrawing from life," and eventually dropped out of school. She was sent to psychiatrists, internists, and cardiologists without results, and became progressively sicker. A detailed case history recorded by a dentist disclosed that her symptoms had begun 6 months earlier, after the placing of several amalgam restorations. A mercury evaluation and biochemical tests were done. The amalgam restorations were removed and within days all symptoms cleared. The patient has been reported to have returned to school and is now leading a normal, productive life. These reports made their way into the professional and lay press, causing concern among patients and the dental profession. A few dentists even started advocating the removal of dental amalgam restorations. It seemed to some that a third Amalgam War had started.

This report presents a critical review of the literature on mercury and dental amalgams, concentrating on material and research after 1980 when an excellent review appeared.[5] Many fundamental aspects of mercury metabolism and toxicity have been well established and this report has relied on current reviews to complete these sections rather than original research articles, most of which were published before 1980. Subjects covered in this paper include mercury exposure of dental personnel during dental practice; mercury vapor release from amalgams; mercury metabolism and its distribution in body tissues (such as hair, blood, nerve tissue, and urine); allergy to mercury (including patch testing and the mechanism of mercury allergy); and possible linkages between diseases and dental exposure to mercury.

Chemical forms and sources of mercury

Chemical forms of mercury

Mercury exists in three major chemical forms, which determine the toxicity of the metal. These forms are: elemental mercury (mercury vapor), inorganic mercury or salts of mercury, and organic mercury (organomercurials).

Elemental mercury is the most volatile of the three and exposure to it is usually occupational. Chronic exposure can result from mercury in the ambient air after accidental spills, improper handling of mercury, and poorly ventilated work rooms or laboratories. Mercury vapor can have toxic effects and can be an occupational hazard in dentistry.[14] Inorganic mercury or mercury salts can exist as monovalent mercurous or divalent mercuric salts. Mercury salts can be irritating and acutely toxic. The organomercurials or organic mercury compounds used today contain mercury with one covalent bond on the carbon atom. This is a heterogenous group of compounds with the ability to produce various toxic effects. The alkylmercury salts are the most toxic, with methylmercury being the most common form of these salts. Organic mercury compounds are not a hazard in dentistry but can be an environmental hazard.[14]

Mercury in the environment and food chain

Mercury is a naturally occurring element with 30,000 to 150,000 tons being released into the atmosphere by the degassing of the earth's crust and the oceans. Additionally, 20,000 tons of mercury are released into the environment through the combustion of fossil fuels and other industrial activities. Ten tons of mercury are produced annually for industrial use.[15]

Unfortunately, environmental pollution has increasingly contaminated water, air, and soil. This contamination results from the use of mercury in agricultural fungicides, industrial pollution, and an increased burning of fossil fuels containing mercury. However, the use of mercury containing fungicides is now banned by many nations.

Mercury enters the food chain by inadequate and improper disposal of wastes into oceans, lakes, and streams where microorganisms methylate inorganic mercury to the more toxic methylmercury. Methylmercury is then rapidly taken up by plankton algae and is concentrated in fish via consumption of these organisms. Predatory and larger fish concentrate more mercury than smaller feeder fish. From the aquatic environment, methylmercury becomes incorporated in the terrestrial environment by species feeding on the aquatic organisms. Factors influencing the amount of methylmercury in fish are: mercury content in water and bottom sediment; acidity and oxidation-reduction potential of the water; species, age, and size of fish.

A survey of 34 countries was conducted to establish the levels of mercury contamination in food and to determine if these levels presented a health problem. The results from each country were reported in the form of median and 90th percentile levels. The highest median values were reported for shark (1,800 μg/kg) and swordfish (1,500 μg/kg). For tuna, the highest median level for any country was 1,500 μg/kg, but the majority of sample values was in the range of 100 to 500 μg/kg.[16]

In 1972, the Joint Food and Agriculture Organization/World Health Organization (WHO) Expert Committee on food additives established a provisional tolerable weekly intake of 0.3 mg of total Hg per person with not more than 0.2 mg being methylmercury.[16]

The earliest indication that methylmercury was an environmental hazard came from two episodes in Minamata Bay and Niigata, Japan, from 1953 to 1960. In Minamata, 121 people were poisoned with methylmercury, 46 of whom died. In Niigata, 47 cases were identified with six deaths. Adults and children consuming the contaminated fish suffered a degenerative neurological disease with paresthesia, ataxia, hearing and visual changes, and dysarthria. After the contamination, 6% of births resulted in cerebral palsy. In both the Minamata and Niigata epidemics, there was a relationship between the nature of the disease and fish intake. In both episodes, the fish were contaminated by mercury from discharges from factories using mercuric chloride catalysts in the manufacture of vinyl chloride and acetaldehyde.[17]

Major incidents of human poisoning

also occurred from the inadvertent consumption of mercury-treated seed grain in Iraq, Pakistan, Ghana, and Guatemala. The most catastrophic outbreak occurred in Iraq in 1972. Iraq, having imported large quantities of seed treated with methylmercury fungicide, distributed the grain for planting. Despite official warnings, the grain was ground into flour and made into bread. As a result, 6,530 victims were hospitalized and 500 died.[18,19]

Mercury exposure from other sources

Mercury exposure can result from many commercial products. Mercurous chloride or calomel, the best-known mercury compound, is still used in some face creams as an antiseptic. Mercury exposure also can result from exposure to antiseptic agents such as merbromin, tincture of mercresin, and merthiolate. Exposure may occur from the use of mercury-containing medicaments, such as diuretics and ointments.[8] Cases of rash and skin reactions have been reported[20] from mercuric contact after breaking clinical thermometers.

Recently, neuropsychiatric symptoms were reported in a sphygmomanometer repairman who used poor mercury hygiene.[21] Also, two cases of acrodynia — following the accidental home spill of mercury from the repair of a manometer and barometer — have been reported in young children.[22,23]

Occupational exposure to mercury

Mercury vapor levels in dental offices

Exposure to mercury and mercury vapor has been recognized as a potential health hazard to dental personnel for many years. Exposure can occur either through direct skin contact with mercury or mercury-containing compounds, or through the inhalation of mercury vapor. Inhalation of mercury vapor is the primary route of exposure: approximately 80% of inhaled mercury is absorbed through the lungs.[24] At 25 C, the equilibrium vapor concentration of mercury is calculated to be 20 mg/m^3.[24,25] The vapor pressure of mercury increases rapidly with increases in temperature. The threshold limit value (TLV) for mercury vapor recommended by the National Institute for Occupational Safety and Health (NIOSH) is 50 μg/m^3, based on a time-weighted average during an 8-hour day.[26,27] The TLV is considered to be the concentration of mercury vapor to which nearly all workers may be repeatedly exposed without adverse effects.[25]

Many recent surveys[24, 27-32] have been undertaken to determine the cause and extent of mercury vapor contamination in dental offices. Comparisons between surveys are difficult because of the variety of sites tested and sampling techniques used. A recent study of 528 dental offices in North Carolina — in which ambient air mercury vapor concentrations were recorded in 1,064 rooms — found that 108 rooms (10.2%) had mercury vapor concentrations greater than 50 μg/m^3, and 44 rooms (4.1%) had levels reported as equal to 50 μg/m^3.[28] Canadian studies in Manitoba[29] and the Atlantic regions[24] found mercury vapor concentrations in the ambient air above the TLV in 11.4% and 3.2% of offices respectively. However, in the latter study some areas, such as the area used for trituration, 15.7% had mercury vapor concentrations equal to or exceeding 50 μg/m^3. Similar studies in Texas[27] and New York[30] found that 10% and approximately 6%, respectively, had ambient air mercury vapor levels exceeding the TLV, whereas an Iowa study[31] noted that 16% of the offices surveyed had mercury vapor measurements above the TLV in one or more locations. In general, recent studies support earlier reports, concluding that at least 10% of dental offices have mercury vapor concentrations higher then the 50 μg/m^3 level recommended by NIOSH.[25]

The potential hazards of mercury exposure in the dental environment are preventable by using proper mercury hygiene practices.

Sources of mercury exposure

Sources of mercury contamination in the dental environment include mercury spills, expression of excess mercury from amalgam, leakage from dispensers, improper storage of scrap amalgam, leakage from amalgam capsules during trituration, mercury vaporization from contaminated instruments placed in sterilizers, grinding of amalgam during removal of restorations, and amalgam condensation with ultrasonic condensers.

Mercury spills and the subsequent accumulation of mercury in carpeting or cracks in the flooring material are a major source of mercury contamination. Studies have found little or no difference in ambient air concentrations of mercury vapor between offices with carpeting and those with hard floor coverings.[24,28,30] Each kind of flooring poses unique problems with regard to spilled mercury. Mercury spilled on hard surfaces tends to be dispersed more widely and divided into smaller droplets, whereas mercury spilled on carpets is contained to a smaller area. Cleanup of mercury on seamless vinyl or linoleum floors is relatively easy to accomplish, but complete decontamination of carpets is difficult except for removal of the carpet.[25,28,28]

Much attention has been focused on mercury vapor leakage from disposable and reusable amalgam capsules.[33-37] Both types of capsules are possible sources of mercury vapor during trituration with neither having a proved superiority. However, researchers have concluded that disposable capsules are preferable because their usage greatly reduces the risk of accidental mercury spills.[33] Contaminated capsules of either type should be reassembled after use, if possible, and stored or disposed of properly in an airtight container or plastic bag to prevent mercury vaporization.[34]

Other possibly contaminated dental office equipment and furnishings of concern as indirect sources of mercury include contaminated amalgamators, sterilizers, cabinets and countertops, cuspidors, drains, filters in heating or cooling systems, waste containers, capsule storage areas, and drapes.[24,38-40]

Mercury hygiene procedures

The potential hazards of mercury exposure in the dental environment are preventable by using proper mercury hygiene practices. Recognizing the importance of mercury hygiene, the ADA Council on Dental Materials, Instruments, and Equipment has periodically published recommendations in dental mercury hygiene.[25] In addition, several authors have investigated the effectiveness of various hygiene procedures and commercially available products for prevention and decontamination.

Effective techniques for cleanup of an

spilled mercury include using a wash-bottle trap connected to suction systems for removing visible droplets of mercury. Other devices for recovering mercury include handheld pumps, aspirator bulbs, or plastic syringes. Sponges are generally much less effective for mercury cleanup.[41,42] Adhesive tape, tin foil, or a fresh mix of dental amalgam can remove droplets of mercury and have been suggested.[28,43] Powdered sulfur and other chemical products that react with the surface of mercury droplets will suppress vaporization only when the mercury is undisturbed. Reagents that combine with mercury may facilitate cleanup. Commercially available spill cleanup kits that contain a combination of these devices and materials have proved useful.[28,41,42]

A "no-touch" technique should be used for handling amalgam.[28] Using precapsulated alloys eliminates many potential sources of mercury vapor and minimizes the possibility of accidental spillage. Offices using precapsulated alloys have lower mercury vapor levels.[24,27,30,41,45] Expressing excess mercury from amalgam should be avoided.[28,29] Amalgamator arms and capsules should be covered during trituration.[24,28,36]

Researchers recommend that scrap amalgam be stored in sealed containers under sulfur-containing solutions such as used X-ray fixer solution, or a commercial mercury vapor suppressor which has been proved effective.[28,44,45] Mercury and amalgam should be stored away from heat sources. Contaminated instruments should be thoroughly cleaned before sterilization.[46] Disposable items contaminated with mercury should be discarded in properly sealed containers.[34]

During removal of amalgam restorations, the use of a water spray and high-volume evacuation greatly reduces mercury vapor levels.[47,48] Good ventilation with rapid fresh air exchanges and an outside exhaust is extremely important to prevent inhalation of mercury vapor in high concentration by dental personnel.[28] Although not a substitute for good mercury hygiene, air filters with chemical absorbants (usually iodized charcoal) can reduce mercury vapor levels.[42,49,50]

Investigators have tested several devices for monitoring mercury vapor and concluded that some of these devices may be valuable adjuncts for assessing the effectiveness of mercury hygiene procedures.[28,42] Biologic monitoring through periodic urine analysis for mercury is a recommended method for assessing the exposure of dental office personnel.[28] Also, these periodic checkups are excellent for indirect evaluation of the effectiveness of the mercury hygiene in an office.

Mercury exposure from amalgam

Mercury vapor from amalgam

Measurable amounts of mercury vapor have been reported in the expired air of patients with or without amalgam restorations.[31-38] In persons with amalgam restorations, increases in the amount of mercury vapor were observed after chewing[31-35] and brushing; the degree to which this vapor is inhaled is not known.[36] Negligible changes were observed in subjects without amalgams. The levels of mercury vapor reported in different studies varied greatly, as did the methods of measurement. The chewing before measurement also varied and ranged from 3 minutes at 120 cycles/min to 10 minutes without a defined frequency. Interpretation and extrapolation of the data are also not uniform, making comparisons between studies difficult.

In a study reported in 1979,[31] seven patients were instructed to exhale ten times into a collector tube filled with silver wool. The silver wool was then heated to release mercury vapor, which was measured by ultraviolet absorption. After chewing, the amount of mercury collected ranged from 64 to 244 ng per ten exhalations.

In a study of eight subjects without amalgams (amalgamless group), and 40 subjects with amalgams, the mercury concentrations of expired air samples were measured by collecting 2.7 L of expired air in a plastic bag and passing it through a gold foil mercury vapor analyzer. The mean average mercury concentrations before chewing were 0.26 $\mu g/m^3$ for the amalgamless group and 0.88 $\mu g/m^3$ for the amalgam group. After vigorous chewing for 10 minutes, the mean mercury concentrations were 0.13 $\mu g/m^3$ for the amalgamless group and 13.74 $\mu g/m^3$ for the amalgam group.[32] A similar approach was used in another study of 15 subjects without amalgams, and 54 subjects with amalgams. Before chewing, the mean mercury concentrations were 0.05 $\mu g/m^3$ for the amalgamless group and 0.29 $\mu g/m^3$ for the amalgam group. After chewing, the mercury levels were 0.05 $\mu g/m^3$ for the amalgamless subjects and 1.35 $\mu g/m^3$ for the amalgam group.[34]

As expired air is a mixture of air from the mouth and the entire respiratory tract, a later study flushed air through the mouth for 15 seconds in an attempt to measure mercury concentrations in the mouth only. The rate of air flush was reported to have little influence on the amount of mercury vapor measured. A 15-second air flush was analyzed with a gold foil mercury vapor analyzer in a group of 14 amalgamless subjects, and 47 subjects with amalgams. Before chewing, the mercury levels were 1.13 ng/15 sec for the amalgamless group and 2.24 ng/15 sec for the amalgam group. After chewing, the mercury levels were 1.06 ng/15 sec for amalgamless subjects and 18.97 ng/15 sec for the amalgam subjects.[34]

In another study[35] using a gold foil mercury vapor analyzer, the collection tube was moved rapidly and continuously around the open mouth for 10 or 20 seconds at a flow rate of 0.75 L/min. Before chewing, the mean mercury concentrations were 0.54 $\mu g/m^3$ for the amalgamless group and 4.91 $\mu g/m^3$ for the amalgam group. After chewing, the mercury concentrations were 0.72 $\mu g/m^3$ for amalgamless subjects and 29.10 $\mu g/m^3$ for subjects with amalgams. The mercury level decreased as a function of time after cessation of chewing. From the results, attempts were made to estimate the daily dose of mercury according a subject's number of occlusal amalgam surfaces. The estimated daily dose for all subjects (one to 16 occlusal surfaces) was 19.85 μg. For the subgroups of subjects with less than four, or greater than 12 occlusal surfaces, the estimates were 8.10 μg and 29.24 μg, respectively. An attempt to estimate the body burden of mercury using a computer model was reported in 1986.[37] The investigations included that the computer simulation remains to be confirmed by experimental data.

The effect of brushing on the level of mercury in expired air has also been assessed. Measurements were made by collecting breath samples exhaled from the mouth at approximately 22 L/min into a tube filled with gold trimmings. The mercury was then measured using a photoacoustic mercury detector.[36] A mean value of 8.2 ng/L was found after brushing compared to 3.1 ng/L before brushing for 172 subjects with amalgam restorations. The mean mercury level in the expired air of five subjects without amalgam restorations was 0.06 ng/L. These results are shown in Table 1.

The validity of measuring mercury vapor concentrations in a small volume sample and extrapolating the results to much larger volumes is questionable. The amount of mercury vapor available for re-

lease from a finite source — such as the surface of an amalgam restoration — may limit the concentration which can be reached in a volume as large as the total volume of air inhaled by an individual over a number of years. Furthermore, the assumption that these extrapolated values are comparable to situations in the industrial work environment involving consistent exposure to elevated mercury vapor concentrations is also questionable.

It has been shown that small but measurable elevations exist (lasting about 10 minutes) in the level of mercury in the expired air of patients as the result of amalgam removal.[55] This kind of exposure to mercury can be reduced with the use of certain techniques, such as wet cutting, high vacuum evacuation, and a rubber dam. An in vitro simulation of amalgam removal demonstrated that with the use of water spray, exposure to mercury vapor and particulate amalgam seems negligible. In a study simulating operatory procedures, the measured mercury vapor in the breathing zone and in the exhaled air of dentists removing amalgams was similarly reduced when water spray and vacuum evacuation were used.[56]

Table 1 ■ Summary of reports of mercury vapor released from dental amalgam restorations.

Investigator	Chewing or brushing	Mercury vapor levels Without amalgam	Amalgam	Units
Abraham and others (1984)	Before	1.13	2.24	ng·15 sec
	After	1.06	18.97	
Svare and others (1981)	Before	0.26	0.88	$\mu g \cdot m^3$
	After	0.13	13.74	
Vimy and Lorscheider (1985)	Before	0.54	4.91	$\mu g \cdot m^3$
	After	0.72	29.10	
Patterson and others (1985)	Before	0.06	5.1	ng·L
	After		8.2	
Ott and others (1984)	Before	0.05	0.29	$\mu g \cdot m^3$
	After	0.05	1.35	

Corrosion of amalgam

The reaction of amalgam with chemical species in the surrounding liquid produces soluble and insoluble corrosion products. Simulations of mercury dissolution from amalgams have been reported for in vitro studies[39-42] using distilled water, isotonic saline solution, and saliva as liquid media. The mercury dissolution from dental amalgam into mixed saliva in vitro was reported to have a mean value of 0.853 ± 0.423 ppm.[39] One study[43] showed that the cumulative dissolution of mercury after 6 months ranged from 0.001 to 0.003 μg/mL in water, and 0.003 to 0.088 μg/mL in 0.5% sodium chloride. The dissolution of mercury from three types of amalgam after 7 days in 0.9% sodium chloride solution ranged from 0.50 to 2.21 $\mu g/cm^2$.[42]

The effects of organic acids, chlorides, sulfites, and ammonia on the corrosion and dissolution of amalgam have also been reported. After immersion in chemical solutions for 6 months, the amounts of mercury dissolved from amalgam samples were 0.05 to 0.09 μg/mL for acetic acid, 0.01 to 0.10 μg/mL for formic acid, 1.30 to 2.64 μg/mL for lactic acid, and 0.02 to 0.04 μg/mL for succinic acid.[44] The corresponding values for sodium chloride, sodium sulfide, and ammonia solutions were 0.04 to 0.17 μg/mL, 0.23 to 21.19 μg/mL, and 6.24 to 7.39 μg/mL, respectively.[45]

The in vitro test results of mercury dissolution from amalgam in simulated oral environments have been reviewed.[46] For the first 24 hours, mercury dissolution in most cases ranged from 0.5 to 5 $\mu g/cm^2$, with one study reporting higher values.[47] The dissolution rates decreased sharply with time.[48,49] Long-term dissolution rates after 10 or more days ranged from 0.01 to 0.5 $\mu g/cm^2$ per day. It was concluded that over the long term, dissolution of mercury from amalgam into saliva is insufficient to cause concern.[46]

The in vitro corrosion rate of dental amalgam was increased if the amalgam surface was subjected to abrasion.[50] The observed increase was attributed to the disruption of the protective passive surface layer, and repassivation is relatively slow. The release of mercury from an amalgam during cyclic loading to simulate chewing and under static conditions has also been studied in vitro.[51] Amalgam particles accounted for most of the mercury loss of about 10 $\mu g/cm^2$ during a cyclic loading of 20-minute duration. The amount of ionic mercury released was estimated to be 3 $\mu g/cm^2$ or about 18 μg daily for a person with 20 amalgam surfaces, which is less than half of the provisional tolerable intake (43 μg/day or 300 μg/week) established by WHO.[18]

The elemental contents of a 6-year-old copper admix amalgam restoration, after 6 years of clinical service, have been compared with the calculated values based on phase composition.[52] The percent of mercury in the gamma one phase of the restoration was 72.8 ± 2.3 compared with a calculated value of 73.6. The microstructures of amalgams corroded in vitro and in vivo were also compared, and it was concluded that the changes in microstructure were similar. The microstructure changes appear to be consistent with the amount of corrosion products released into saline solutions in vitro.

The corrosion of an amalgam may be affected when the amalgam is in contact with a dissimilar metal forming a galvanic cell. The release of mercury from amalgam was studied in vitro with amalgam in contact with gold,[53] gold and base-metal casting alloys,[54] and amalgams of different composition.[55] The total amount of mercury released into solution ranged from 62 to 1,650 $\mu g/cm^2$ after a 35-week period. When amalgam was in contact with gold, the amount of mercury released was greater in the early periods of the study, but the values for amalgams with or without contact with gold were similar for longer periods. When different amalgams were in contact, the accumulated mercury released during the 35 weeks ranged from 122 to 176 μg. The differences in values were dependent on the sample configurations as well as the types of amalgam.

Particulate exposure from amalgam

Amalgam particles embedded in oral tissues may manifest clinically as pigmented macules that are referred to as "amalgam tattoos." The localized tissue reactions to implanted amalgam have been reviewed.[56,57] Amalgam particles are present in the tissue in two forms: very fine,

discrete, round, black, or dark brown granules of 1.0 μm or less in size, or as irregular, dark, solid fragments of various larger sizes. The embedded particles usually elicit no reaction, although in some cases a mild to moderate chronic inflammatory response occurs. This response may result in the formation of a foreign-body granuloma with macrophages and multinucleated giant cells.

The pigmented areas may possibly increase in size and intensity of color from the continuous disintegration of the amalgam particles and migration of the breakdown products. In addition to the localized tissue reactions, the release, distribution, and excretion of mercury from implanted amalgam have been studied in guinea pigs.[75-81] It has been observed that larger amalgam particles become enclosed in fibrous tissue and that there is limited breakdown and corrosion on the particle surfaces. Finely powdered amalgam is phagocytized by macrophages and giant cells. Further investigation disclosed dissolution and redistribution of mercury from the gamma one and gamma two phases of amalgam into body tissues. Elevated mercury concentrations were detected in several tissues—including blood, kidney, and liver—with the highest concentration in the renal cortex. Microanalysis and implantation of individual constituent phases of dental amalgam have demonstrated that mercury and tin are completely removed from experimental amalgam tattoos. Tattoos always result from the persistence of minute particles of silver and sulfur associated with basal lamina and connective tissue.[79]

The ingestion of amalgam particles and subsequent dissolution in the gastrointestinal environment have been studied in rats. Particles of 7-day-old amalgam were administered gastrointestinally, and the animal tissues were analyzed 20 hours later. The highest levels of mercury were found in the kidneys (about 0.01 to 0.1 μg/g wet tissue) and in blood (about 0.005 to 0.1 μg/g). The values varied among the various kinds of amalgam studied.[82]

Absorption, biotransformation, distribution, and elimination of mercury

The metabolism of mercury is dependent on the chemical form of mercury and the route of exposure. Only those forms of mercury encountered by dental personnel or dental patients will be considered in this report.

Metal ions including the mercuric ion (Hg^{++}) may be released from amalgam restorations because of corrosion. The quantities of such ions released are extremely minute. Exposure to the Hg^{++} ion in the form of mercuric salts results in gastrointestinal absorption of 10% or less of the ingested mercuric ions.[14,15] For these reasons, it is unlikely that exposure to ionic mercury has any significant role in exposure of dental patients to mercury. One possible exception is that mercuric ions, as well as other forms of mercury, may act as allergens leading to allergic reactions.

There is no direct exposure of personnel or of patients to organic mercury in dentistry. On the basis of in vitro studies, some investigators have speculated that mercury released from amalgam in particulate or ionic form may undergo biological methylation by bacteria present in either the mouth or the intestine.[83] A recent in vitro study[84] has shown that methylmercury can be formed by common oral streptococci in a nutrient broth containing mercury from pulverized amalgam. However, the study investigators caution against extrapolation of these results to in vivo situations without further investigation.

A study that compared one group of dentists who are occupationally exposed to inorganic mercury with another control group not occupationally exposed to inorganic mercury found that the dentists' blood levels of inorganic mercury were significantly higher. However, no significant difference existed in the blood concentrations of organic mercury between the two groups.[85] These findings suggest that in vivo biotransformation of inorganic mercury to methylmercury probably does not occur to any significant degree.

There is evidence[23] that elemental mercury can penetrate the skin, but quantitative data are lacking. Ingested elemental mercury is very poorly absorbed from the gastrointestinal tract and not considered particularly toxic.[14,23] In contrast, elemental mercury vapor readily crosses cell membranes because of its high diffusibility and lipid solubility.[13,23] About 75% to 80% of inhaled mercury vapor is absorbed across alveolar membranes into the bloodstream.[13] Mercury vapor dissolved in the blood is transported to other tissues and absorbed by those tissues, including the brain.[13,23] However, mercury vapor has a limited lifetime in the body as it is rapidly oxidized to divalent mercuric ion (Hg^{+}—Hg^{++}) by the action of catalase in erythrocytes and in cells of other tissues.

The mercuric ion does not easily cross cell membranes, either from blood to tissue or from tissue to blood.[23] Reduction of Hg^{++} also occurs, but the extent of this reaction is unclear. The mercuric ion is believed to be largely bound to sulfhydryl groups on proteins and has limited mobility in the body.[15]

The accumulation of mercury, after exposure to mercury vapor, is dependent on the dose, frequency, and duration of exposure, as well as metabolic factors related to the individual.

The accumulation of mercury, after exposure to mercury vapor, is dependent on the dose, frequency, and duration of exposure, as well as a number of metabolic factors related to the exposed individual.[13] The retention time of mercury in organs varies considerably, with biologic half-times ranging from a few days to months.[13,23] The organs with the longest retention times are the brain, kidneys, and testicles.[13] The kidneys are the main organ of accumulation.[86] In cases of chronic low level exposure, the critical organ is the brain.[83]

The elimination of mercury from the body occurs primarily by the excretion of Hg^{++} via the urine and feces.[14,23] Exhalation of mercury vapor has been demonstrated in humans after inhalation exposure but is thought to account for only a small portion (7%) of total mercury elimination.[13,83] Perspiration may also have a role in the excretion of mercury under certain conditions.[86] Overall, based on the limited data available, it is believed that the majority of inorganic mercury accumulated in the body has a biologic half-life of about 50 to 60 days.[13,23,86]

All forms of mercury cross the placenta to varying degrees. The results of animal experiments indicate that elemental and organic mercury cross the placenta to a greater extent than inorganic mercury.[87] Several studies[88] have reported that the mean total mercury concentration of fetal

Table 2 ■ Mercury concentrations associated with time-weighted-average air concentrations of mercury that cause the earliest effects in the most sensitive adults with long-term exposure to mercury vapor.*

Blood (μg/100 mg)	Urine (μg/L)	Air (μg/m³)	Earliest effects
3.5	150	50	Nonspecific symptoms
7-14	300-600	100-200	Tremor

*Adapted from Goyer, 1996.[17]

cord blood is 13% to 24% higher than in maternal blood. Of these studies, one that analyzed organic and inorganic mercury in fetal cord blood and maternal blood indicated that higher methylmercury concentrations in fetal cord blood are primarily responsible for the difference. The mean values of total mercury in fetal cord blood and maternal blood, respectively, range from 1.2 parts per billion (ppb) and 1.0 ppb (from a study in rural Iowa) to 20.0 ppb and 16.8 ppb (from a study in Japan).[89] Based on these findings, researchers have suggested that diet is an important factor in explaining the variability of the mercury concentrations reported.[89] The relationship of occupational exposure to mercury in dentistry and pregnancy outcome was examined in a study of 30,272 female dental assistants and the wives of 29,514 dentists. The subjects were divided into low exposure and high exposure groups based upon the number of amalgam procedures they or their spouses performed. The study found that there was no difference in the rate of spontaneous abortions or congenital abnormalities between the low-exposure group and the high-exposure group in either the dental assistants or the wives of dentists.[90]

Biologic monitoring for mercury exposure

Methods and relationship to exposure

Biologic monitoring of mercury concentrations in blood, urine, and hair has failed to produce an exact relationship between these parameters, organ concentrations, and toxicity.[91] It is necessary to exercise caution when reviewing reports of the concentration of mercury in biologic samples since methodologies vary and some past studies have lacked adequate controls. On a group basis, a linear correlation seems to exist between average time-weighted atmospheric air concentrations of mercury vapor and average urinary mercury concentrations.[78] Because of high individual variations and daily fluctuations, serial monitoring is recommended to increase the reliability of blood and urinary concentrations as a measure of exposure for individuals.[83,86] Blood levels reflect very recent exposure since mercury in blood has a short half-life, estimated to be about 3 days. Urinary monitoring is recommended for assessing long-term steady-state exposure.[86] A correlation has been shown between levels of mercury in urine and blood; however, this correlation cannot be assumed to be linear over a wide range of concentrations, and an exact quotient between mercury concentration in urine and blood cannot be given.[13]

The range of concentrations of mercury in urine and blood in the general population (not excessively or occupationally exposed to mercury) is 0 to 20 μg/L[91,92] and 0 to 1.0 μg/100 mL,[83,93] respectively. On a group basis, blood and urinary mercury concentrations of 3.5 μg/100 mL and 150 μg/L, respectively, are associated with an average air mercury level of 0.05 mg/m³.[83] These concentrations, 3.5 μg Hg/100 mL[83] for blood and 150 μg/L[17] for urine, also are estimated to be the minimal concentrations associated with clinical effects (Table 2). However, group occupational exposure data have indicated that detectable health effects—measured as an increase in tremor frequency of the forearm when loaded with a 15-lb weight — may rise significantly when urinary mercury concentrations exceed 50 μg/L.[13] As stated, because of the number of variables affecting toxicity, clinical symptoms or degree of effect cannot be predicted precisely by biologic monitoring. However, because urine samples reflect exposure (which in turn leads to the accumulation of mercury in the CNS, and as a consequence, adverse health effects), these parameters do provide useful information for the prevention of toxicity.[13] The monitoring of urinary mercury is the current method for evaluating exposure on a group basis in industry.[86]

Analysis of sequential segments of human head hair has been advocated for the determination of longitudinal exposure to methylmercury. Hair reflects the blood concentrations of methylmercury at the time of formation.[86,94-98] Because of the differences in metabolism of the different chemical forms of mercury, long-term exposure to methylmercury can be assessed by analysis of hair, although long-term exposure to mercury vapor is better assessed by urine analysis.[86] Hair analysis for mercury vapor exposure is not considered valid because mercury vapor may directly contaminate the hair and not reflect mercury metabolized into the hair. In addition, other exogenous sources of mercury such as hands, gloves, equipment, and some hair treatments containing mercury may also directly contaminate the hair.

The legitimate use of hair analysis by qualified researchers should not be confused with the misuse of hair analysis to assess nutritional status or diagnose toxicity to various trace elements. This misuse and misinterpretation of hair analyses has been the subject of several recent articles.[97-101] A recent study,[98] in which hair samples from two healthy teenagers were submitted to 13 commercial laboratories performing hair analysis, found that the reported levels of trace elements varied considerably between identical samples sent to the same laboratory and from laboratory to laboratory. In the words of the study investigator: ". . . most reports contained computerized interpretations that were voluminous, bizarre, and potentially frightening to patients."[97] Other researchers[98] have noted that such reports often suggest "nutritional imbalances" and "toxic levels" of certain elements and then proceed to market dietary supplements, vitamins, and chelating agents to consumers.[98]

Monitoring to assess occupational mercury exposure

Monitoring of air for mercury vapor levels in dental offices is important for maintaining a safe working environment, but because exposure and absorption are affected by a number of individual specific variables, the absorbed mercury level can be determined only by biological monitoring of body fluids and tissues.[25] Several recent studies have reported the mercury concentrations of urine,[29,102] blood,[25,83,103,104] and hair samples[29,93,99] collected from dental personnel. In a 9-year study during which urine specimens were col-

lected from 4,272 dentists, it was found that 1% of the dentists had urinary mercury concentrations greater than 20 μg/L, which is considered the upper limit of the normal range. The mean urinary mercury concentration was 14.2 μg/L with a range of 0 to 356 μg/L. Among the factors significantly related to urinary mercury concentrations were the type of practice, hours practiced per week, type of amalgam capsules used, and the number of amalgams placed per week.[102]

In a study of 205 dentists, the mean whole blood concentration of mercury was found to be 0.61 μg/100 mL as opposed to 0.40 μg/100 mL for a group of 24 control subjects not occupationally exposed to mercury.[33] In another study of 23 dentists, who had been in active practice for at least 20 years, a serum mercury concentration of 1.13 μg/100 mL was found compared to a serum concentration of 0.72 μg/100 mL in a group of control subjects.[33] In a Korean study of 35 dentists, the mean blood mercury concentration was reported to be 21.62 μg/100 mL.[104] The Korean study did not measure blood concentrations in a control group, but cited another Korean study that found a mean blood concentration of 25.3 μg/100 mL in a group of persons not occupationally exposed to mercury. These data suggest that other sources of mercury, such as dietary sources, may have a much greater effect on blood mercury concentration than occupational exposure.

Although recognizing the limitations of hair analysis, several studies have reported the hair mercury values from dental personnel, and one such study is noted here to indicate the magnitude of the levels reported. In a British study[38] of 150 dentists, 43 dental surgery assistants, and 28 control subjects, the range of hair mercury levels was 0.5 to 64 ppm for the dental personnel and 0.35 to 2.7 ppm in the control subjects. Fourteen percent of the dental personnel had hair mercury levels greater than 10 ppm. It was also reported that one dentist with a hair mercury concentration of 40 ppm had been forced to give up his dental practice because of the gradual development of ataxia and a cerebellar speech defect. The investigators noted that those dentists with the highest hair mercury levels expressed the least concern in obtaining the results of the analysis. Similarly, Canadian researchers, who surveyed mercury vapor levels, noted that only 10% of the dental personnel had been tested for mercury levels in the body and suggested that further emphasis be placed on this subject in the education of dentists, hygienists, and assistants.[24]

In addition to monitoring of body fluids and hair, an attempt has been made to measure the mercury content of tissues of dentists in situ using an X-ray fluorescence technique. Evaluation of the technique in vitro with samples irradiated for 20 minutes produced results that compared well with a chemical assay; however, the in situ tissue measurements were made with an X-ray exposure time of only 1 minute. Furthermore, the technique is limited to measuring mercury in the superficial layers of tissues only. The mercury content of the superficial layers of the head and wrist was determined in situ for 298 dentists using this technique. Of the 298 subjects studied, 84 had detectable mercury levels (defined as greater than 20 μg/g) in the superficial tissues of the head and 32 subjects had detectable levels in the wrist.[105] To equate these measurements with mercury body burden would appear unwarranted as the researchers note that the mercury content of tissues such as the kidney and liver could not be measured with this technique because of the thickness of the overlying tissue. The implication that "head" mercury levels are indicative of brain mercury concentrations has not been proved. In a follow-up of this study, 23 dentists whose mercury levels ranked within the top 20% of the study population, and 22 control dentists whose levels were designated undetectable, were assessed by neurophysiological and neuropsychological tests. Polyneuropathies, defined as reduced motor or sensory conduction velocities or response amplitudes in two or more nerves, were found in seven dentists, all in the elevated mercury group. The elevated mercury group was also reported to have more visuographic alterations as detected by the neuropsychological tests and higher distress levels measured from self reports of symptoms on a checklist.[106]

A necropsy report of seven cases—three of whom were dentists and four control subjects with no known occupational exposure to mercury—measured the mercury content of tissues from the occipital cortex and pituitary glands. The occipital cortex levels ranged from 5 to 14 ng/g wet weight for the dentists and from 5 to 21 ng/g wet weight for the control subjects. In contrast, the pituitary gland levels for the dentists ranged from 135 to 349 ng/g wet weight, whereas these levels for the controls ranged from 5 to 97 ng/g wet weight. The control subject with the highest pituitary gland level had several amalgam restorations removed during the last year of life. The results of this control subject and those from the three dentists suggest that inhalation of mercury vapor may lead to high mercury concentrations in the pituitary gland.[107]

Monitoring to assess mercury exposure from amalgam

Although numerous reports on the concentrations of mercury in the urine of subjects with occupational exposure to mercury exist, similar information on subjects without such exposure is limited. One study[108] of such nonexposed subjects reported that the mean urine mercury values were 1.66 μg/L for 25 subjects with amalgam restorations, and 1.54 μg/L for 19 subjects without amalgam restorations. In the same study, the mean values for subjects with occupational mercury exposure were 3.99 μg/L for 43 subjects with amalgam restorations, and 2.4 μg/L for 15 subjects without amalgam restorations. The concentrations of mercury in the urine of subjects before and after amalgam placements have also been reported.[60] The concentrations of mercury in urine were observed to rise for 24 hours after amalgam placement, but returned to pretreatment levels after 7 days.

In a group of 73 Norwegian schoolchildren, with a mean age of 12, the mean creatinine-adjusted concentration of mercury in urine was 0.58 nmol Hg/mmol creatinine. A significant positive correlation (R=.35) was found between the concentrations of mercury in urine and the extent of amalgam restorations as assessed on a point scale that took into account the number and size of restorations in each child. However, no correlation was found between the extent of amalgam restorations and illness or allergy. The authors concluded that the very small amounts of mercury found did not warrant reevaluation of the use of amalgam as a dental restorative material.[109]

The concentrations of mercury in blood have been compared between subject groups with or without amalgam restorations. In one comparison the mean value of mercury in blood for 47 subjects with amalgam restorations was 0.07 μg/100 mL with a range of 0 to .33 μg/100 mL, whereas the mean value for 14 subjects without amalgam restorations was .03 μg/100 mL, with a range of 0 to 0.1 μg/100 mL.[34] Another study[34] showed the mean value for 54 subjects with amalgam restorations was 0.06 μg/100 mL with a range of 0.012 to 0.18 μg/100 mL, while the mean value for 15 subjects without amalgam was

Table 3 ■ Mercury concentrations of subjects with and without amalgam restorations.

Investigator	Sample		Occupational exposure
	Urine levels (μg/L)		
	Amalgam	Without amalgam	
Kroncke and others (1981)	1.66	1.54	No
Kroncke and others (1981)	3.99	2.4	Yes
	Blood levels (μg/100 mL)		
	Amalgam	Without amalgam	
Kroncke and others (1981)	0.18	0.19	No
	0.21	0.24	Yes
Abraham and others (1984)	0.07	0.03	No
Ott and others (1984)	0.06	0.08	No

0.08 μg/100 mL with a range of 0.016 to 0.33 μg/100 mL.[33] Yet another study[198] reported that for subjects without occupational contact with mercury, the mean values for 23 subjects with amalgam restorations were 0.18 μg/100 mL while the mean value for 16 subjects without amalgam restorations was 0.19 μg/100 mL. The mean values for subjects with occupational mercury exposure were 0.21 μg/100 mL for 41 subjects with amalgam restorations and 0.24 μg/100 mL for 14 subjects without amalgam restorations. The results of the foregoing studies are summarized in Table 3.

The concentrations of mercury in saliva have been reported in several studies. One such study[80] found geometric mean values of 1.91 ppb for 141 subjects in central Tokyo and 1.01 ppb for 37 subjects in a suburban location. The same study also reported that the mean concentrations of mercury in saliva were 2.11 ppb for 133 subjects with amalgam restorations and 0.88 ppb for 65 subjects without amalgam restorations. The study estimated that the daily ingestion of mercury in saliva would be 1.5 μg and would be increased by 2.1 μg by the presence of amalgam restorations. These estimates correspond to 1/30 of the total mercury intake from food for a person without amalgam restorations and 1/3 of the intake of a person with amalgam restorations.

In another investigation of the mercury concentration in saliva, no significant differences were demonstrated between subjects with occupational exposure (dental office personnel) and subjects with amalgam restorations without occupational exposure.[81] Other investigators comparing the mercury levels in saliva reported a mean level of 30.8 ppb for subjects with four or more amalgam restorations which was 16 times the mean value of 1.9 ppb for subjects without amalgam restorations.[110] A study[33] that assessed the effect of chewing reported that the mean mercury levels in saliva for subjects with amalgam restorations was 4.90 μg/L (range 0.60 to 143.0) before chewing and 12.95 μg/L (range 0.30 to 193.8) after chewing. The corresponding values for subjects without amalgam restorations were 0.30 μg/L (range 0.10 to 2.70) and 0.4 μg/L (range 0.1 to 0.5), respectively. An evaluation of 12 subjects for various metal ions in saliva showed that only one had a mercury concentration above the detection limit of 2.0 ppb. The study concluded that there is no support for the theory that increased oral galvanic action influences the saliva concentration of mercury or ions of other elements contained in amalgams.[111]

The mercury content of nerve tissue from the head and peripheral nerves was determined in an autopsy study of two men whose dental status was recorded. The mercury levels ranged from 0.03 to 130 μg/g dry weight. In the same report, an experiment was conducted on dogs to assess the effect of amalgam restorations on the mercury levels of nerve tissues. The mercury content of nerve tissues in both humans and dogs differed widely from one nerve to another with no apparent relationship to the number, type, or location of amalgam restorations.[112] Another study[113] that attempted to relate mercury in the central nervous system to dental amalgam restorations reported that, for 15 human subjects, the mean mercury level (wet weight) in the occipital cortex was 12.4 ng/g with a range of 4.8 to 28.7 ng/g. The mean level in cerebellar cortex was 11.2 ng/g with a range of 3.0 to 33.8 ng/g; and the mean level in the semilunar ganglion was 5.0 ng/g with a range of 1.5 to 14.8 ng/g. The investigators also reported a statistically significant correlation between the total mercury level in the occipital cortex and the number of dental amalgam restorations. In contrast to these values, a computer simulation model of mercury exposure from amalgam that assumed long-term preferential accumulation of mercury in the brain projected a concentration of mercury in the brain of 4.0 μg/g wet tissue.[37]

Data on the brain level of mercury that causes toxicity are scarce. It has been reported[15] that in two confirmed cases of mercury toxicity from long-term mercury vapor exposure, the brain mercury concentrations ranged from 6 to 9 μg/g, but in one other case of chronic calomel intake the concentrations ranged between 4 to 5 μg/g. These three cases represent the lowest levels reported. Other autopsy studies have reported higher levels of mercury in the brain.

Mercury toxicity

The toxic effects of elemental mercury are produced after it has been oxidized to mercuric ion, which has a strong affinity for the sulfhydryl groups of proteins.[114] The mercuric ion also combines with other ligands, such as the phosphoryl, carboxyl, amide, and amine groups.[13] Within cells, mercuric ions act as potent nonspecific enzyme inhibitors and denaturants of protein, thus interfering with cellular metabolism and function.[13,114] The mercuric ion has also been shown to alter membrane function and transport, including the release and uptake of neurotransmitters in the brain.[13,34] Although little is known about the exact distribution of mercury in the brain, it does appear to be nonuniform, with preferential accumulation in certain cells.[15,114]

Chronic exposure to mercury vapor produces a form of toxicity that is dominated by neurological effects.[14] Early nonspecific signs of mercury exposure have been termed the asthenic-vegative syndrome or micromercurialism and include such symptoms as weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. With increasing exposure, the characteristic mercurial tremor appears as fine trembling of muscles interrupted by coarse shaking movements.[15] The tremor begins with intention tremors of muscles involved in fine motor

functions—such as those in the fingers, eyelids, and lips—and progresses to a generalized tremor involving the entire body and violent chronic spasms of the extremities.[15-17] Concurrent with the development of tremors, psychological and behavioral changes occur.[15] Symptoms may include increased excitability, loss of memory, insomnia, severe depression, irritability, excessive shyness, and confusion. Other reported symptoms[7,8] include ataxia, speech disorders, reflex abnormalities, visual disturbances, and impaired nerve conduction. Oral symptoms of mercury intoxication include gingivitis, excessive salivation, metallic taste, and loosening of teeth.[15-17] The triad consisting of increased excitability, tremors, and gingivitis has been recognized as the major manifestation of mercury poisoning from inhalation of mercury vapor.[17]

In all cases of suspected mercury poisoning, treatment begins with immediate termination of exposure. In some cases, the symptoms of mercury exposure are reversible when exposure is eliminated. Blood and 24-hour concentrations of mercury in urine are generally measured as soon as possible and are used to monitor the effectiveness of treatment.[91] The affinity of mercury for thiols provides the basis for treatment with chelating agents.[14] Dimercaprol, penicillamine, and N-acetyl-D,L-penicillamine are most commonly recommended for the treatment of chronic mercury vapor exposure.[14,91,113] A recent report has suggested that 2,3-dimercapto-propane-1-sulfonate may also be a safe and effective agent.[116]

Mercury allergy

Mechanisms of mercury allergy

Recent studies reporting mercury release from amalgam, either as mercury vapor or mercury ions in saliva, have focused increased attention on the incidence and effects of mercury hypersensitivity. The literature[8,11,17,118] indicates that considerable confusion exists about the misuse of the term hypersensitivity as it applies to mercury in dental amalgam. Mercury hypersensitivity is an allergic response mediated by the immune system. It is a type IV or cell-mediated response that is usually delayed because of the time required for effector cells to accumulate and produce symptoms at the site of the reaction. The reaction is the result of the release of lymphokines from sensitized T-cells stimulated by contact with the antigen. The release of lymphokines results in an inflammatory response and localized tissue damage. Mercury, like most substances that induce contact allergies, is an incomplete antigen or hapten. It must combine with proteins in the skin or mucous membranes to form a hapten-protein conjugate that is the complete antigen.[119] As in other allergic reactions, prior exposure to the antigen, that is, sensitization, is necessary before a secondary response that results in symptoms can occur. Although the reasons are not clear, it is known that there is a much lower rate of sensitization to most compounds when exposure is through mucous membranes than when it is through the skin, and this appears to be true for mercury.[120]

The method for confirming allergy to mercury involves the proper use and interpretation of a patch test.[121] Many difficulties are associated with the use of patch tests, including the fact that many of the compounds used for testing are irritants or have been used in excessive concentrations, producing false-positive results.[120] It should also be noted that allergy to certain mercury-containing compounds does not necessarily indicate a true allergy to mercury, and a patient with allergy to one form of mercury may or may not cross-react to other forms of mercury.[120] A patch test is judged positive on the basis of the evaluation of cutaneous signs such as erythema, edema, vesicles, and papules, and not on systemic changes, such as pulse rate and blood pressure, as suggested by some opponents of amalgam usage.[117,118] The North American Contact Dermatitis Group has recommended that 1% ammoniated mercury in petrolatum be used in the patch test for mercury allergy.[122] Some European investigators[115,123] use 0.5% metallic mercury in petrolatum. Patch testing with mercuric chloride is considered extremely unreliable because of the high number of irritant reactions that occur.[115]

The method for confirming allergy to mercury involves the proper use and interpretation of a patch test.

Occupational contact dermatitis

Occupational exposure to mercury is known to cause contact dermatitis; however, case reports of mercury allergy among dental personnel are extremely rare.[25,124] In a recent case report[124] on a 44-year-old male who had been a dentist for 2 years, the symptoms were erythema, vesicles, and itching of the fingers spreading to the palms and back of the hands. The patient also showed positive patch tests to 1% ammoniated mercury in petrolatum and 0.5% metallic mercury in petrolatum. The symptoms cleared within 1 week after using topical steroids and stopping work. This would appear to be a typical case of occupational contact dermatitis. Contact with mercury or mercury-containing compounds is easily avoided in dental practice with the use of gloves and "no-touch" techniques for amalgam preparation.

The incidence of mercury allergy among dental personnel has been reported most recently in a study[125] that tested dental students at the University of Texas. The study showed that positive patch test reactions to a 0.1% mercuric chloride solution increased from 2.0% in freshmen (students tested before entry into dental school) to 10.8% in senior dental students. The students were also tested for positive reactions to a patch test of a 5% mixture of powdered amalgam and anhydrous lanolin. The results of the latter test showed that only five of the 396 students tested (1.3%) exhibited a positive reaction and that there was no increase in the incidence of sensitization from freshmen (one case) to seniors (0 cases). Considering the concentration and the unreliability of mercuric chloride in patch testing, the results of the powdered amalgam patch test may be more indicative of the actual incidence of sensitization among dental personnel.

Allergic reactions to amalgam restorations

In a comprehensive review, French researchers[119] cite 41 published clinical cases of allergy to dental amalgam restorations from 1905 to 1986. The authors acknowledge that in four of the 41 cases, it was

difficult to be certain that an allergic reaction to amalgam was the principal cause of the symptoms reported. They also recognized that six additional cases have been mentioned in the literature but were not included in their review because there was insufficient information available. Since 1980, there have been five cases reported; all but two were covered in the French review.[20,126-128]

A study of the 41 cases disclosed some of the characteristic manifestations of allergic reactions to amalgam restorations. In 37 of the 41 cases, allergy to mercury or mercury and another metal was present. In the other four cases, two were considered to be caused by allergy to silver and two by allergy to copper.

Women seem to be affected more often than men, as 30 of the cases involved females. Cutaneous signs and symptoms were predominant, occurring in 38 of the 41 cases. The most common symptoms were dermatitis, eczema, urticaria, erythema, edema, and itching, occurring primarily on the face, neck, limbs, and upper torso. The symptoms usually appear 24 to 48 hours after the placement of an amalgam restoration. Oral manifestations were seen in 17 of the 41 cases and were described as gingivostomatitis. Other oral symptoms included burning sensations, hypersalivation, dry mouth, alterations of taste, and erosive lesions. Less frequently reported (six of 41) were general symptoms, usually malaise or fever. In 20 of the cases, the symptoms resolved after removal of the amalgam restorations, usually within a few days to 2 weeks, whereas in eight cases, the symptoms resolved spontaneously without amalgam removal.[119]

Two of the recent reports of allergic reactions to mercury deserve closer scrutiny because of the spread of symptoms over large areas of the body. A Japanese study[20] reported 15 cases of patients with a generalized rash that they termed "mercury exanthem" and described as diffuse symmetrical erythema predominantly on major flexural areas of the body. Other common symptoms included V-shaped erythematous areas on both upper anteromedial thighs, pyrexia, malaise, mild itching, and, in some cases, burning sensations. Severe cases exhibited miliary pustules and/or purpura on erythematous skin. Almost all of the cases occurred 1 to 2 days after exposure to mercury from a broken clinical thermometer. One case was thought to be definitely related to dental treatment, and one other case had a history of both the placement of a dental restoration and the breaking of a thermometer. In both these latter cases, the patients showed positive patch tests to phenylmercuric nitrate, ammoniated mercury, and mercuric chloride. Previous sensitization was thought to have occurred from prior exposure to mercurochrome. It was pointed out that there is probably a higher frequency of sensitization to mercurials in the Japanese population as a result of extensive use of mercurochrome. A similar case was reported[127] in Great Britain involving a 36-year-old man who experienced widespread erythematous eruptions with a similar flexural distribution followed by an eczematous process. The reaction occurred after receiving dental treatments. Patch testing showed a positive reaction to ammoniated mercury. These cases seem to demonstrate that systemic absorption of mercury can precipitate a widespread or systemic contact dermatitis. Another type of reaction that has been reported to be the result of mercury allergy are lesions that were diagnosed as oral lichen planus.

Oral lichen planus and allergy to amalgam restorations

Oral lichen planus occurs in reticular, papular, plaquelike, bullous, erosive, and atrophic forms, characterized by white striae (Wickham's striae) in netlike or lacy patterns or radiating outward from the edge of the lesion. Histologically the lesions show "saw-toothed," rete ridges, a bandlike subepithelial infiltration of lymphocytes, degeneration of the basal cell layer, and hyperparakeratosis. Although the cause of oral lichen planus is unknown, some recent reports have suggested that some cases may be caused or aggravated by an allergy to mercury from dental amalgams.[129-131] Another possibility is that mercury allergy may develop secondarily in patients with oral lichen planus because of the greater penetration of mercury ions into subepithelial layers when the integrity of the oral mucosa is compromised. The incidence of mercury allergy associated with oral lichen planus varies greatly in the literature reviewed. In a study of 67 patients with oral lichen planus, 64 of whom had amalgam restorations, 11 patients (16%) were positive to at least one mercury-containing compound in a patch test series of four mercury compounds. In contrast, four of 50 patients (8%) in a reference group, who were tested because of suspected contact dermatitis but did not have oral lichen planus, showed a positive patch test reaction to mercury.[129] Another study[132] reported that 18 of 29 patients (62%) with oral lichen planus showed a positive patch test to 0.5% metallic mercury in petrolatum versus 3.2% positive in a group of control patients without lichen planus.

In a third group of 52 patients with erosive lichen planus topographically related to amalgam restorations, 18 patients (34%) were reported to have an allergy to mercury as indicated by patch testing.[133] Although these studies convincingly demonstrate an association between positive patch tests for mercury allergy and some cases of oral lichen planus, the frequency of this occurrence is still uncertain.

Researchers have investigated the effect of amalgam removal on the clinical course of oral lichen planus. In the study that found a 62% frequency of mercury allergy, amalgam restorations were removed from four patients and replaced with gold or composite materials. In three of these cases, the lesions healed completely within an observation period of 1 year, and considerable improvement was reported in the fourth case.[132] In the group of 52 patients previously mentioned (34% allergic to mercury), the amalgam restorations of 18 patients were replaced by other materials such as gold, porcelain, or composite resin. In 16 of these 18 patients, complete remission of the lesions was observed within 1 to 12 months after replacement of the amalgam restorations. Of the two remaining cases, partial remission was seen in one case after 4 months, and in the other case, no clinical change occurred after 2 years. Of 23 cases in which no replacement of amalgams was performed, two showed spontaneous remission, and 21 showed only minor fluctuations in clinical course and symptoms.[133] It should be noted that six of the cases in which complete remission of lichen planus occurred after removal of amalgam restorations did not test positive for mercury allergy.

In another report, 31 of 48 patients with histologically verified oral lichen planus were patch tested for allergic reactions to a battery of 30 substances that the researchers selected to indicate allergies to dental materials. Twelve patients (39%) tested positive for allergy to one or more of the substances. Eight of the patients (26%) tested positive to mercury in the form of 0.1% mercurous bichloride ($HgCl_2$) or 0.1% merthiolate. The dental restorations and/or prostheses of eight of the patients were replaced with alternative restorative materials to eliminate the allergens discovered. The allergen replaced

was mercury in six of the cases, copper in one case, and hydroquinone in one other case. In six of these eight patients, the oral lichen planus lesions showed regression and in the other two patients the lesions disappeared completely.[134] These results suggest that allergic reactions to a variety of substances may be of significance in cases of oral lichen planus.

These cases of remission after replacement of amalgam restorations with alternative restorative materials support the theory that mercury allergy may be a causative or aggravating factor in certain cases of oral lichen planus. As it is unlikely that a single agent is responsible for all lesions currently classified as oral lichen planus the term "oral lichenoid reaction" proposed by Lind and others[133] is probably more appropriate for describing these lesions.

Discussion

Exposure to mercury compounds can occur from manufactured mercurials and a wide variety of other sources including environmental, dietary, and occupational. There are many well-documented cases of mercury toxicity from these sources. Mercury toxicity is dependent on the chemical form and dose of mercury to which an individual is exposed. In dentistry, elemental mercury vapor is the only chemical form of mercury encountered in sufficient quantities to be of possible concern with regard to toxicity.

Occupational exposure has been well documented among dentists and dental assistants. Recent investigations have shown that a significant portion of dental personnel are being exposed to mercury vapor levels in excess of recommended safety limits. Biologic monitoring has confirmed that some dental personnel have mercury concentrations in blood, urine, and tissues above the normal range of the general population. However, even at these higher levels of exposure, symptoms of toxicity are rare. Many sources of mercury exposure in the dental office have been identified and correlated with blood and urine mercury concentrations. Excess exposure to mercury vapor is completely preventable through the implementation of proper mercury hygiene practices that have been widely disseminated to the profession.

The potential toxicity of mercury and advances in technology for measuring mercury vapor have revived the controversy over the safety of dental amalgam. Several studies have shown that measurable amounts of mercury vapor are released from amalgam restorations, particularly when the surface of the amalgam is subject to mechanical forces such as chewing or brushing. The critical issues that need to be considered are the amount of mercury released, the amount of mercury absorbed, and the effect of this exposure on the patient's health.

A wide range of experimental values have been reported for the amount of mercury vapor released from amalgam following mechanical stimulation (Table 1). The measurements of mercury released from amalgam are influenced by experimental design and subject to a variety of interpretations and extrapolations. As an example, a series of 13 mercury vapor measurements of 10- or 20-second duration, made at 5-minute intervals, has been extrapolated to calculate cumulative exposure for 10 years. The absolute dose, frequency, and duration of exposure remain a matter of speculation, as do the effects of confounding variables such as the age and composition of the dental amalgam.

Because exposure parameters cannot be precisely defined, the amount of mercury absorbed and its concentration in body tissues and fluids may be better indicators for assessing potential toxicity. Exposure prevention programs in industry and clinical management of cases of mercury toxicity have long relied on biologic monitoring. Although each of the methods of biologic monitoring has recognized limitations as precise indicators of mercury toxicity, these methods provide a good indicator of the absorbed dose and can be used to compare the relative magnitude of exposure from various sources of mercury. The blood and urine mercury concentrations of subjects with dental amalgams indicate that the magnitude of the absorbed dose of mercury from this source is substantially less than the lowest mercury concentrations reported to cause adverse health effects (Table 2). In addition, an autopsy study that measured mercury concentrations in the brain tissues of patients with amalgams found mean levels of 12.4 ng/g, 11.2 ng/g, and 5.0 ng/g in the occipital cortex, cerebellar cortex, and semilunar ganglion, respectively. The maximum brain tissue level found in any subject was 33.8 ng/g. This amount is 100 times less than the 4.0 μg/g (4,000 ng/g) predicted by some investigators on the basis of intraoral measurements of mercury vapor. The concentrations of mercury measured in urine, blood, and nerve tissues emphasize the need to exercise caution in extrapolating mercury exposure, on the basis of brief measurements of mercury vapor in the mouth, following stimulation by chewing or brushing.

The final issue that needs to be addressed is the question of symptoms of mercury toxicity reported in patients with dental amalgams. To date, no studies or case reports have appeared in refereed scientific journals to support the assertion that dental amalgams are the cause of recognized symptoms of mercury toxicity. Opponents of amalgam usage have relied upon their own anecdotal reports that cite symptoms such as backache and heart palpitations to support their conclusions.

In contrast, mercury allergy manifested as an allergic reaction to amalgam restorations has been documented. A comprehensive review of allergic reactions to dental amalgams published in 1986 found 41 cases and noted the possibility of six additional cases. Recent reports would add two more cases for a total of 49 cases, excluding possible cases that appear as oral lichen planus. Considering that a 1979 survey estimated that 110,000,000 one- and two-surface amalgams are placed in 1 year in the United States alone, it is obvious that allergic reactions to amalgam restorations are an exceedingly rare phenomenon.

When allergic reactions to amalgam do occur, the symptoms are consistent with a type IV allergic response mediated by the immune system. Symptoms are usually localized and most frequently include dermatitis, eczema, urticaria, erythema, edema, and itching. The most commonly reported oral symptoms are gingivostomatitis, burning sensations, alterations of taste or salivary flow, and erosive lesions adjacent to the amalgam restoration. Suspected cases should be confirmed by appropriate tests performed by professionals trained in the administration and interpretation of these tests, such as allergists or dermatologists.

Recent reports have indicated that certain cases of oral lichen planus may be caused or aggravated by mercury allergy. The possibility that mercury allergy may develop secondarily to oral lichen planus has also been suggested. In the studies of oral lichen planus reviewed, a total of 6 cases were cited that demonstrated mercury allergy, as evidenced by a positive patch test to mercury-containing compounds, or remission of the oral lichen planus following amalgam removal. Other allergens, such as copper, were also noted in a few cases of remission.

These studies provide sufficient ev

dence to warrant further investigation of the possible relationship between mercury allergy and oral lichen planus. However, even when these cases are combined with the other cases of allergic reactions to amalgam restorations, the incidence of adverse effects from amalgams is minuscule, considering the number of patients who have such restorations.

Conclusions

Occupational exposure to mercury is a potential hazard for dental personnel, but is completely preventable with the implementation of proper mercury hygiene practices. There is no evidence in the scientific literature that the minute amounts of mercury vapor that may be released from amalgam restorations cause mercury poisoning. Allergic reactions to mercury and other constituents of amalgam have been documented, but are exceedingly rare. The association between allergies and oral lichen planus requires further investigation. Finally, dental amalgam, which has been used extensively for more than 100 years, has an exemplary record of safety and benefit to the dental patient.

JADA

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Dr. Langan is assistant secretary, Council on Dental Therapeutics. Dr. Fan is associate secretary, Council on Dental Materials, Instruments, and Equipment; and Ms. Hoos is technical information assistant, Council on Dental Therapeutics, American Dental Association, Chicago. Address requests for reprints to Dr. Langan.

1. Louria, D.B. Trace metal poisoning. In Wyngaarden, J.B., and Smith, L.H., eds. Cecil textbook of medicine. Philadelphia, W. B. Saunders, 1985, pp 2307-2315.

2. Vanherle, G., and Smith, D.C. Posterior composite resin dental restorative materials. Minnesota Mining and Manufacturing, 1985, p 16.

3. Rupp, N.W. Clinical use of some dental materials. Amalgams. J Indiana Dent Assoc 52(8):432-434, 1973.

4. Bureau of Economic and Behavioral Research. Survey. Chicago, American Dental Association, 1979.

5. Bauer, J.G., and First, H.A. The toxicity of mercury in dental amalgams. CDA J 10(6):47-61, 1982.

6. Craig, R.G. Biocompatibility of mercury derivatives. Dent Mater 2(3):91-96, 1986.

7. Bauer, J.G. Action of mercury exposure in dental exposures to mercury. Oper Dent 10(3):104-113, 1985.

8. Anonymous. The mercury scare. Consumer Reports 51(3):150-152, 1986.

9. Pinto, O.F., and Huggins, H.A. Mercury poisoning in America. J Int Acad Prevent Med 3(2):42-58, 1976.

10. Bird, D.J. The amalgam war: an historical review. NY State Dent J 38(1):5-8, 1972.

11. Goldwater, L.J. Mercury, a history of quicksilver. Baltimore, York Press, 1972, pp 279-287.

12. Huggins, H.A. Mercury — a factor in mental disease? Can mercury-silver amalgams cause psychiatric symptoms? Oral Health 73(12):42-45, 1983.

13. Huggins, H.A. Amalgam in motion. Dent Assist 54(3):10-13, 1985.

14. Klaassen, C.D. Heavy metal and heavy-metal antagonists. In Gilman, A.G., and others, eds. Goodman and Gilman's pharmacological basis of therapeutics, ed 7. New York, MacMillan Publishing Co, 1985, pp 1605-1627.

15. Berlin, M. Mercury. In Friberg, L., Norberg, G.E., and Volk, V., eds. Handbook on the toxicology of metals, vol. 2, ed 2. Specific metals. Elsevier, NY, 1986, pp 387-445.

16. Anonymous. Mercury in fish. Bull WHO 64(5):634, 1986.

17. Elhassani, S.B. The many faces of methylmercury poisoning. J Toxicol Clin Toxicol 19(8):875-906, 1982-83.

18. Bakir, F., and others. Methylmercury poisoning in Iraq: an interuniversity report. Science 181(4096):230-241, 1973.

19. Bakir, F., and others. Clinical and epidemiological aspects of methylmercury poisoning. Postgrad Med J 56(655):1-10, 1980.

20. Nakayama, H., and others. Mercury exanthem. Contact Dermatitis 9(5):411-417, 1983.

21. Wide, C. Mercury hazards arising from the repair of sphygomomanometers. Br Med J 293(6559):1409-1410, 1986.

22. Foulds, D.M.; Copeland, K.C., and Franks, R.C. Mercury poisoning and acrodynia. Am J Dis Child 141(2):124-125, 1987.

23. Curtis, H.A., and others. Mercury as a health hazard. Arch Dis Child 62(3):293-295, 1987.

24. Jones, D.W.; Sutow, E.J., and Milne, E.L. Survey of mercury vapour in dental offices in Atlantic Canada. Can Dent Assoc J 49(6):378-395, 1983.

25. Rao, G.S., and Hefferren, J.J. Toxicity of mercury. In Smith, D.C., and Williams, D.F., eds. Biocompatibility of Dental Materials, vol 3, Biocompatibility of dental restorative materials. Boca Raton, FL, CRC Press, 1982, pp 19-40.

26. Council on Dental Materials, Instruments, and Equipment. Recommendations in dental mercury hygiene. JADA 109(10):617-619, 1984.

27. Ochoa, R., and Miller, R.W. Report on independent survey taken of Austin dental offices for mercury contamination. Tex Dent J 100(1):6-9, 1983.

28. Kantor, L., and Woodcock, C. Mercury vapor in the dental office — does carpeting make a difference? JADA 103(9):402-407, 1981.

29. Skuba, A. Survey for mercury vapour in Manitoba dental offices. J Can Dent Assoc 50(7):517-522, 1984.

30. Chopp, G.F., and Kaufman, E.G. Mercury vapor related to manipulation of amalgam and to floor surface. Oper Dent 8(1):23-27, 1983.

31. Schulein, T.M.; Reinhardt, J.W.; and Chan, K.C. Survey of Des Moines area dental offices for mercury vapor. Iowa Dent J 70(1):35-36, 1984.

32. Rowdhouse, R.H.; Férg, M.R.; and Knox, R.P. Mercury in dental offices. J Can Dent Assoc 51(2):156-158, 1985.

33. Wilson, S.J., and Wilson, H.J. Mercury leakage from disposable capsules. Br Dent J 153:144-148, 1982.

34. Cooley, R.L., and Lubow, R.M. Mercury-vapor leakage from disposable capsules. Gen Dent 32(3):218-221, 1984.

35. Brown, J.W.; Hosein, H.R.; and Horwood, J.H. Mercury leakage during amalgam trituration. J Can Dent Assoc 50(3):234-236, 1984.

36. Carter, J.M., and Marier, R.P. Mercury emission from capsules during trituration. Oper Dent 7:2:42-47, 1982.

37. Capelouzo, C.B., and von der Lehr, W.N. Mercury leakage during trituration: an evaluation of disposable capsules. Oper Dent 9(2):69-71, 1984.

39. Cooley, R.L.; Stilley, J.; and Lubow, R.M. Mercury vapor emitted from disposable capsules placed in trash containers. Gen Dent 32(6):498-500, 1985.

40. Mercury leakage from some disposable amalgam capsules during transport. Aust Dent J 27(1):47-48, 1982.

41. Cooley, R.L., and Barkmeier, W.W. Techniques and devices for recovering mercury and preventing contamination. Gen Dent 30(1):36-41, 1982.

42. Eames, W.B., and Palmertree, C.O. Twelve dental mercury devices: an evaluation of methods of monitoring, containment, and removal of mercury. Oper Dent 5(1):72-81, 1980.

43. Grajower, R.; Mann, J.; and Lewenstein, I. Mercury contamination removed with tin foil. Oper Dent 9(3):101-104, 1984.

44. Burgess, V.B., and Mackinson, O.F. Mercury vapour associated with amalgam capsule and waste storage. Aust Dent J 28(6):352-354, 1983.

45. Cooley, R.L.; Barkmeier, W.; and Lubow, R.L. Evaluation of ability of various agents to suppress mercury vaporization. Clin Prevent Dent 7(1):29-32, 1985.

46. Cooley, R.L.; Stilley, J.; and Lubow, R.M. Mercury vapor produced during sterilization of amalgam-contaminated instruments. J Prosthet Dent 53(3):304-308, 1985.

47. Reinhardt, J.W., and Schulein, T.M. Mercury vaporization during amalgam removal. J Prosthet Dent 50(1):62-64, 1983.

48. Richards, J.M., and Warren, P.J. Mercury vapor released during the removal of old amalgam restorations. Br Dent J 159(7):231-232, 1985.

49. Koski, R.E.; Kantor, J.; and Gough, E.J. Controlling mercury vapor within the dental operatory. CDA J 9(6):33-39, 1981.

50. Brown, D. The decontamination of a mercury-polluted room with iodised-charcoal filter fans. Br Dent J 156(12):453-454, 1984.

51. Gay, D.D.; Cox, R.D.; and Reinhardt, J.W. Chewing releases mercury from fillings. Lancet 1(8123):985-986, 1979.

52. Svare, C.W., and others. The effect of dental amalgams on mercury levels in expired air. J Dent Res 60(9):1668-1671, 1981.

53. Ott, K.H.R., and others. Mercury burden due to amalgam fillings. Dtsch Zahnarztl Z 39(3):199-205, 1984.

54. Abraham, J.E., Svare, C.W., and Frank, C.W. The effect of dental amalgam restorations on blood mercury levels. J Dent Res 63(1):71-73, 1984.

55. Vimy, M.J., and Lorscheider, F.L. Intra-oral mercury released from dental amalgams. J Dent Res 64(8):1069-1071, 1985.

56. Patterson, J.E.; Weissberg, B.G., and Dennison, P.J. Mercury in human breath from dental amalgams. Bull Environ Contam Toxicol 34(4):459-468, 1985.

57. Vimy, M.J.; Lorscheider, F.L., and Lorscheider, F.L. Estimation of mercury body burden from dental amalgam: computer simulation of a metabolic compartment model. J Dent Res 65(12):1415-1419, 1986.

58. Reinhardt, J.W., and others. Exhaled mercury following an insertion of amalgam restorations. J Prosthet Dent 49(5):632-636, 1983.

59. Takaku, S. Studies on mercury concentration in saliva with references to mercury dissolution from dental amalgams into saliva. Shikwa Gakuho 82(3):385-406, 1982.

60. Takaku, S. Mercury dissolution from dental amalgam into saliva. Bull Tokyo Dent Coll 26(3):137-152, 1985.

61. Kuc, B., and others. Investigations on mercury release from amalgam fillings. Czas Stomatol 34(7):671-675, 1981.

62. Okabe, T., and others. Dissolution of mercury

Safety of dental amalgam—an update

Council on Dental Materials, Instruments, and Equipment
Council on Dental Therapeutics

The Council on Dental Materials, Instruments, and Equipment and the Council on Dental Therapeutics reported in 1985[1] that based on scientific information amalgam is safe. The councils further emphasized that, except in individuals allergic to mercury, there is no reason why a patient should seek to have amalgam restorations removed. The councils also reported in 1984[2] that the need for patch tests for allergy is a professional judgment, and when patch tests are indicated, they should be performed by a professional trained in the administration and interpretation of these tests. Referral to physicians such as allergists or dermatologists, who specialize in this testing, is strongly recommended.

Investigations of mercury vapor from amalgam[3-9] and mercury concentrations in blood,[5,6,10] urine,[10,11] and other biological specimens[12-15] (such as nerve tissues of subjects with amalgam restorations), report that small quantities of mercury are released from amalgams. Quantification of in vivo mercury vapor release from amalgam based on direct measurement with a mercury vapor analyzer is questionable and a variety of analytic techniques and interpretations have been reported.[9] Nevertheless, the quantities reported are small in comparison with mercury from other sources such as diet, and are far less than the quantities required to induce symptoms of mercury poisoning.[16] Dental health care workers having occupational exposure to mercury vapor have higher mean values of mercury in blood[17,18] and urine[19,20] than the general population; however, these levels have not been shown to cause symptoms of mercury poisoning in dental health care workers who practice good hygiene in use of dental mercury.

Allergic reactions to amalgam restorations are extremely rare. When such reactions do occur, they are most frequently characterized by signs and symptoms that are similar to those seen in other contact allergies such as dermatitis, urticaria, erythema, and edema. Oral symptoms are usually described as gingivostomatitis.[21] In some cases where allergy to mercury was determined, previous exposures to other sources of mercury such as Mercurochrome or skin contact with metallic mercury were noted. Occupational exposure to mercury is known to cause contact dermatitis; however, case reports of mercury allergy among dental health care workers are also extremely rare.[22]

The method for confirming allergy to mercury involves the proper use and interpretation of a patch test.[2] Many difficulties are associated with the use of patch tests, including the fact that many of the compounds used for testing are irritants or have been used in excessive concentrations, producing false-positive results.[23] It should also be noted that allergy to certain mercury-containing compounds does not necessarily indicate a true allergy to mercury, and a patient with allergy to one form of mercury may or may not cross-react to other forms of mercury.[22] A patch test is judged positive on the basis of the evaluation of cutaneous signs such as erythema, edema, vesicles, and papules, and not on systemic changes, such as pulse rate and blood pressure.[24,25]

Galvanic currents have been shown to be of similar magnitude and distribution in patients with and without symptoms attributed to galvanic corrosion in the mouth.[26] The clinical recording of electrochemical variables such as potentials, currents, or charge transfers cannot be accomplished by using common instruments.[26] Even with special measuring instruments of the type constructed and used in well-controlled studies, the magnitude of the recorded values has not been related to the presence or severity of symptoms allegedly caused by galvanic corrosion in the mouth. These kinds of measurements should not be the sole basis for a decision regarding the substitution of one type of restorative material for another. There is no basis for the use of galvanic current measurements as diagnostic tools for neither allergy nor toxicity.

There are several reviews of literature on mercury and amalgam.[16,22,27-31] On the basis of these reviews and current information, amalgam is safe for patients not allergic to mercury, and the occurrence of mercury allergy is extremely rare. The long history of amalgam successfully used for more than 150 years, and the number of amalgam restorations placed with no documented toxicity support the safety of amalgam. The councils have reviewed extant scientific information and reaffirm the Association's[32] position that amalgam is safe for patients not allergic to mercury. There is no reason, based on toxicological consideration, why a nonallergic patient should seek to have serviceable amalgam restorations removed. There is insufficient evidence to justify claims that mercury from amalgam restorations has an adverse effect on the health of the patients.

JADA

This report was approved by the councils in April 1989. Address requests for reprints to the Council on Dental Materials, Instruments, and Equipment.

1. Council on Dental Materials, Instruments, and Equipment and Council on Dental Therapeutics. Safety of dental amalgam. JADA 1985;106:519-20.

2. Council on Dental Materials, Instruments, and Equipment and Council on Dental Therapeutics. Patch tests for sensitivity to mercury or nickel. JADA 1984;108:581.

3. Gay DD, Cox RD, Reinhardt JW. Chewing releases mercury from fillings. Lancet 1979;8123:985-6.

4. Svare CW, et al. The effect of dental amalgams on mercury levels in expired air. J Dent Res 1981;60:1668-71.

5. Ott KHR, et al. Mercury burden due to amalgam fillings. Dtsch Zahnarztl Z 1984;39:199-205.

6. Abraham JE, Svare CW, Frank CW. The effect

of dental amalgam restorations on blood mercury levels. J Dent Res 1984;63:71-3.

7. Vimy MJ, Lorscheider FL. Intra-oral mercury released from dental amalgams. J Dent Res 1985;64:1069-71.

8. Patterson JE, Weissberg BG, Dennison PJ. Mercury in human breath from dental amalgams. Bull Environ Contam Toxicol 1985;34:459-68.

9. Berglund A. Determination of the rate of release of intra-oral mercury vapor from amalgam. J Dent Res 1988;67:1235-42.

10. Kroncke A, et al. Uber die quecksilberkonzentrationen in blut und urin von personen mit und ohne amalgamfullungen. Dtsch Zahnarztl Z 1981;36:69-74.

11. Olstad ML, et al. Correlation between amalgam restorations and mercury concentrations in urine. J Dent Res 1987;66:1179-82.

12. Nilner K, Akerman S, Klinze B. Effect of dental amalgam restorations on the mercury content of nerve tissues. Acta Odontol Scand 1985;43:303-7.

13. Friberg L, et al. Kvicksivler i centrala nervsystemet i relation till amalgamfyllningar. Lakartidningen 1986;83:519-22.

14. Nylander M, Friberg L, Lind B. Mercury concentrations in the human brain and kidneys in relation to exposure from dental amalgam from dental amalgam fillings. Swed Dent J 1987;11:179-87.

15. Eggleston DW, Nylander M. Correlation of dental amalgam with mercury in brain tissue. J Prosthet Dent 1987;58:704-7.

16. Eley BM, Cox SW. Mercury from dental amalgam fillings in patients. Br Dent J 1987;163:221-6.

17. Chang SB, Siew C, Gruninger SE. Examination of blood levels of mercurials in practicing dentists using cold-vapor atomic absorption spectrometry. J Anal Toxicol 1987;11:149-53.

18. Siew C, Chang SB, Gruninger S. Additional threat? CDA J 1987;15:18-21.

19. Naleway C, et al. Urinary mercury levels in US dentists, 1975-1983: review of health assessment program. JADA 1985;111:37-42.

20. Langan DC, Steffek AJ, Naleway CA. Mercury hygiene practices. CDA J 1987;15:24-9.

21. Vernon C, Hildebrand HF, Martin P. Amalgames dentaires et allergie. J Biol Buccale 1986;14:83-100.

22. Langan DC, Fan PL, Hoos AA. The use of mercury in dentistry: a critical review of the recent literature. JADA 1987;115:867-80.

23. Burrows D. Hypersensitivity to mercury, nickel, and chromium in relation to dental materials. Int Dent J 1986;36:30-4.

24. Mackert JR. Hypersensitivity to mercury from dental amalgam. J Am Acad Dermatol 1985;12:877-80.

25. Fisher AA. The misuse of the patch test to determine "hypersensitivity" to mercury amalgam dental fillings. Cutis 1985;35:110, 112, 117.

26. Council on Dental Materials, Instruments, and Equipment. American Dental Association status report on the occurrence of galvanic corrosion in the mouth and its potential effects. JADA 1987;115:783-7.

27. Mjor IA. The safe and effective use of dental amalgam. Int Dent J 1987;37:147-51.

28. Enwonwu CO. Potential health hazard of use of mercury in dentistry: critical review of the literature. Environmental Res 1987;42:257-74.

29. Ely BM, Cox SW. 'Mercury poisoning' from dental amalgam—an evaluation of the evidence. J Dent 1988;16:90-5.

30. Dodes JE. Amalgam toxicity: a review of the literature. Oper Dent 1988;13:52-6.

31. Reinhardt JW. Risk assessment of mercury exposure from dental amalgams. J Public Health Dent 1988;48:172-7.

32. American Dental Association. Trans 1986;536-57.

ANSI/ADA specification no. 66* for dental glass ionomer cements

Council on Dental Materials, Instruments, and Equipment

American Dental Association specification no. 66 for dental glass ionomer cements has been approved by the Council on Dental Materials, Instruments, and Equipment of the American Dental Association. This and other specifications for dental materials, instruments, and equipment are being formulated by subcommittees of the Accredited Standards Committee MD156 for Dental Materials, Instruments, and Equipment. The council acts as administrative sponsor of that committee, which has representation from all interests in the United States in the standardization of materials, instruments, and equipment in dentistry. The council has adopted the specifications, showing professional recognition of their usefulness in dentistry, and has forwarded them to the American National Standards Institute with a recommendation that the specifications be approved as American National Standards. Approval of ADA specification no. 66 as an American National Standard was granted by the American National Standards Institute on Jan 25, 1989. This standard becomes effective Jan 25, 1990.

The council thanks the subcommittee members and organizations with which they were affiliated at the time the specification was developed: John M. Powers (chairman), University of Michigan, Ann Arbor; B. Keith Moore (secretary), Indiana University, Indianapolis; Emery Dougherty, Dentsply Intl, York, PA; Richard Norman, Southern Illinois University, Alton; and V. B. Dhuru, Marquette University, Milwaukee.

This standard specifies requirements for dental glass ionomer cements produced by the reaction between a powder of acid-soluble, aluminosilicate glass and an aqueous solution of a polymer (alkenoic acid). Glass ionomer cements prepared by the addition of water to a mixture of dry acid and aluminosilicate glass are also covered by this standard. The glass ionomer cements covered by this standard may be used as luting cements, restorative materials, or as pit and fissure fillers or sealers.

This standard does not cover glass ionomer cements used as liners or bases. The desirable properties to be tested for liners and bases are being investigated at this time. When suitable test methods have been developed and verified, this classification will be added as a revision or addendum.

This specification is essentially identical to ISO Standard 7489, dental glass polyalkenoate cements, prepared by technical committee, ISO/TC106, dentistry, of the International Organization for Standardization (ISO). In accordance with the desire to have ISO and ANSI/ADA specifications as similar as possible, this ISO standard was circulated to the ASC MD156 subcommittee for glass ionomer cements for acceptance as the ANSI/ADA specification no. 66. The subcommittee approved the ISO standard with one exception, the specification differs from ISO 7489 in reference to the name of dental glass polyalkenoate cements. The specification title and all references made within the body refer to dental glass polyalkenoate cements as glass ionomer cements.

*ANSI/ADA specification no. 66-1989. Approved Jan 25, 1989.

JADA

Copies of this and other ANSI/ADA specifications are available from the American National Standards Institute, 1430 Broadway, New York, 10018.

Your Money

By Barbara Gilder Quint

Seven Slick Swindles

You can outsmart a con artist. Just be wise to the newest rip-offs around.

RIP-OFF No. 1: THE DENTAL FILLING DEAL

Silver dental fillings contain a small amount of mercury, an element that, if absorbed in large enough quantities, can cause insomnia, feeble-mindedness, tremors and brain damage. The American Dental Association (ADA) reports that unscrupulous dentists across the country are preying on the fears of new patients who have recently moved to town.

Here's how the scam works: After thoroughly inspecting your fillings, the dentist will offer to measure your mercury level in order to "determine whether an allergy exists." He then reports that tests show you are indeed allergic to mercury, and he strongly recommends that he replace your present silver fillings with new ones made of composite resin—an expensive procedure.

Yet the ADA says that very few people (less than 1% of the population) suffer any ill effects from the mercury found in silver dental fillings. "Scientific studies have been conducted on these types of fillings for over a hundred years, and there is no sound evidence that links silver fillings to any general medical disorders," says Suzanne Richter, a spokesperson for the ADA. In fact, the association points out that it's possible to get more mercury from eating swordfish than from these dental fillings. And other leading health experts advise that even if you do suspect you're allergic to mercury, you should consult a dermatologist or an allergist . . . *not* a dentist.

Barbara Gilder Quint, a writer on financial matters, is a contributing editor to FAMILY CIRCLE.

RIP-OFF No. 2: THE "$29 AIRFARE" SCAM

Last March, Jane Adams* of Cincinnati, Ohio, received a telephone call offering her a real bargain—a round-trip airline ticket to Hawaii for only $29. Jane charged it to her credit card, and a certificate eventually arrived in the mail.

When Jane began arranging her trip, she was told she could use the certificate only if she booked the flight *and a hotel* through a specified travel agency. She then discovered that the hotel rates were outrageously high: The agency was adding the true airfare onto the hotel price and quoting that figure as the hotel rate. The *total* cost—hotel plus airfare—was higher than what Jane would have paid had she planned the trip on her own.

From March 1986 to September 1987, some 700,000 certificates were sold, and people who tried to get refunds were generally unsuccessful. The Illinois company that sold the certificates has been stopped by a court order from making further sales, but similar deals have cropped up elsewhere. *Don't* fall for a bargain vacation offer until you've asked for written details and references.

RIP-OFF No. 3: THE "GOLD AT 50% OFF" CON

When Catherine Reed of San Diego, California, was first offered a chance to buy gold at 50% off the current market price, she was skeptical. The sales representative claimed his company was selling "gold-bearing ore"; once Catherine purchased the ore, he promised, pure gold would be extracted from it and delivered to her. Then the sales rep quickly followed up by sending an assay report guaranteeing the amount of gold in "her" pile of ore. Convinced, Catherine put up $5,000.

The catch was that the assay report was a fake. G. W. McDonald, assistant commissioner in the enforcement division for the California Department of Corporations, found that in a similar deal, a test of the ore showed it contained only one-tenth of the gold promised. In another case the promoters neglected to mention that the assay report was 100 years old! What Catherine was actually buying was nothing more than a pile of dirt. *(Continued)*

Laura Cornell

*Victims' names have been changed to protect their privacy

DEPARTMENT OF HEALTH & HUMAN SERVICES

The Chief Dental Officer of the
Public Health Service
Rockville, MD 20857

April 30, 1984

U.S. Public Health Service Statement on
the Safety of Dental Amalgam

Recently, claims have been made that dental amalgams (silver fillings), which have been used by the dental profession safely and effectively both in the United States and abroad for a century and a half, are potentially harmful to individuals. Concern has been raised by a few individuals that the mercury component of amalgam fillings, which also contain silver, copper, tin and sometimes zinc, may remain unreacted in the amalgam and release vapors that are toxic to the human body.

Research on dental amalgam, as well as the total range of dental restorative materials used in the United States and accepted by the U.S. Food and Drug Administration and the American Dental Association's Council on Dental Materials, indicates no potential harm to the vast majority of dental patients receiving amalgam fillings. Additionally, no evidence exists to indicate that the health of individuals occupationally exposed to dental amalgams (dentists, dental hygienists, dental assistants) is compromised where approved materials and methods are conscientiously employed. As with any substance, the rare possibility of individual allergy does exist. However, individuals suspected of having such allergies may receive skin tests and, where necessary, appropriate dental treatment alternatives can then be selected.

Individuals should not seek replacement of amalgam fillings with alternate materials based on a fear of harm. To do so would result in unnecessary expenditures. Providers of dental care should be familiar with accurate scientific literature as well as the actions and recommendations of representative professional organizations, such as the American Dental Association, regarding dental restorative materials, and should not discontinue appropriate use of dental amalgam. Continuing evaluation of dental amalgam is being conducted by the U.S. Public Health Service (National Institutes of Health and the Food and Drug Administration) and the American Dental Association. Workshops to provide continuing evaluation and to clearly determine the state-of-the-art and further research directions for biomaterials in dentistry are planned for the summer of 1984 and during 1985.

Robert E. Mecklenburg, D.D.S., M.P.H.
Assistant Surgeon General

Dental Dialogue

Subject: Dental Amalgam

Important and current information to help you communicate with patients and the public.

Michigan Dental Association
Department of Public Affairs

September 1989
Volume 1 Number 1

September 1989

Welcome to the first in a series of Dental Dialogues. The Michigan Dental Association Public Affairs Department will bring you the latest information on current topics of interest on a quarterly basis. Additionally, when urgent issues arise---such as this-- you will receive special bulletins on a timely basis. Please keep this information on file for future reference.

This first Dental Dialogue is devoted to the topic of dental amalgam. Once again the issue of the safety of mercury amalgams has been raised, this time in news reports in the Detroit-area. "Silver (Mercury) Fillings, Your Health Under Siege," a public forum sponsored by the International Academy of Oral Medicine and Toxicology will be September 15-16 in Troy. It can be anticipated that questions will be raised by the news media, possibly throughout the state, and by patients in the dental office.

The following materials are provided to update you on the issue and to make it easier for you to communicate with your patients:

1. Dental Amalgam Questions and Answers

   Suggested Uses: Answer patient questions; duplicate and make available to patients; use information for office newsletter; background for interview if contacted by local media.

2. ADA Position Paper on the "Safety of Amalgam," by P.L. Fan, Ph.D., associate secretary, ADA Council on Dental Materials, Instruments and Equipment.

   This paper provides a concise review of current literature, as well as the position of the ADA, National Institute of Dental Research (NIDR), U.S. Public Health Service (USPHS), National Multiple Sclerosis Society (NMSS), Consumers Union and the FDA.

Comments and Suggestions

If you have ideas for future topics, or suggestions on how to make Dental Dialogue more beneficial to you, please contact Mr. Tom Kochheiser, director of public relations, at 517/372-9070, ext. 122. Your input is valuable and always welcome.

DENTAL AMALGAM QUESTIONS AND ANSWERS

Dental amalgam is one of the most effective and widely used tooth restoration materials. Even with its widespread use and excellent safety record, some people still have misconceptions about dental amalgam. To provide you with accurate information, some of the most frequently asked questions about dental amalgam are presented.

What Is Dental Amalgam?

Dental amalgam is a silver-colored filling material commonly used to restore decayed or damaged teeth. First developed in France in the early 1800's, amalgam became accepted for use in the United States a short time later and still is popular today. Dental amalgam currently is used in about 75% of all single-tooth fillings.

How Is Amalgam Produced?

Dental amalgam is produced by mixing one or more metals such as silver, tin and copper with mercury to form a compound. The mercury reacts with these metals, causing them to harden into place in the cavity which the dentist has cleared of decay. The amalgam forms an effective dental restorative material, or filling.

Does Anyone Evaluate The Safety & Effectiveness Of Dental Amalgams?

Yes. More than 50 years ago, the American Dental Association established a certification program to help dentists choose from among the safest and most effective brands. Currently, more than 100 brands of amalgam have been certified for dentists' use.

Why Is Amalgam Often Chosen Over Other Filling Materials?

In most cases, dental amalgam is the preferred filling material for use in the biting surfaces of the back teeth. It is less expensive than a cast restoration, such as gold inlay; and it is more durable than current composite resins (tooth-colored plastics), which have not yet demonstrated their long-term use in the molars and bicuspids of adults due to the inability of this material to withstand the intense pressures of chewing.

Is Dental Amalgam Safe?

Yes. Scientific studies of dental amalgam in tooth restoration have been carefully conducted for more than 100 years. There is no scientifically sound evidence linking amalgam fillings to any general medical disorder. Quite the contrary, amalgam restorations continue to be shown safe for the vast majority of dental patients. If there were any proven health hazard, dentists would immediately stop using amalgam.

Is the Mercury Portion of Amalgam Also Safe?

Yes. After more than a century of thorough testing, no scientifically reliable study has found the mercury component of amalgam to present a threat to the general health of

dental patients. Indeed, for the great majority of patients, the benefits of using amalgam fillings far outweigh any risks. This is because mercury is made virtually harmless when it combines with the other metals used to produce amalgam.

In fact, mercury in small quantities is found throughout the human body. It enters the body primarily through the foods we eat, as well as through the air we breathe and through our drinking water. Eventually, the body rids itself of mercury through the urine, but there is always a very low level of mercury present in the human system. The average mercury level found in the general public is more than 100 times lower than the level at which harmful effects are usually reported.

The mercury we receive each day from these nondental sources far exceeds the miniscule amount released from dental fillings.

Is Amalgam Appropriate For Use With All Dental Patients?

Amalgam restorations are appropriate for the vast majority of people. In extremely rare cases, some individuals are allergic to amalgam. However, an allergic reaction to amalgam is so uncommon that it involves less than one percent of the general population.

Sometimes, in rare cases of sensitivity to amalgam, the sensitive patient will experience localized symptoms of allergy in the form of inflammation or rash. Many times, this reaction is only temporary and will subside on its own within 2-3 weeks.

Usually patients who are truly allergic to amalgam have a medical or family history of allergies to metals. To guard against the remote possibility that a patient may be allergic to amalgam, dentists maintain a complete medical history for each of their patients. If there is an allergy, some other restorative material will be used.

Wouldn't It Be Best To Replace Amalgam Fillings With Another Restorative Material?

No. This procedure is not as simple as it appears, and it carries the risk of unnecessary damage to healthy tooth structure. It also can be quite expensive. Unless a patient is truly allergic to dental amalgam, dental researchers caution concerned patients not to have their amalgam restorations replaced.

Amalgam restorations are made to last for many years. By following the proper oral hygiene routine at home and by visiting your dentist regularly, you can make your amalgam fillings last for a long time. One-hundred and fifty years of experience with dental amalgam have proved it to be a safe and essential means of meeting patients' dental care needs.

Fischer

LEGISLATION & LAW

Amalgam and Lawsuits; What are the Chances?

One of the more complex issues surrounding amalgam is over the potential of mass tort litigation. Should patients sue dentists? If they did, how successful would they be? We interviewed two attorneys and asked them their opinion. Dr. Berger is a dentist who received his law degree in December of 1989. Vasilios B. Choulos is the senior partner of the San Francisco-based firm, Choulos, Choulos and Wyle.

"I would not want to be a dentist today placing amalgam," stated Berger. This comment was based on his prediction that lawsuits stemming from the use of amalgam would dominate the courts in the 1990's.

Berger couched his prediction with the following argument:

"On a scientific basis, there is no disagreement that mercury is coming out of the fillings and going into the body. In law, any change in structure or form of the body is a harm, and is actionable."

He then outlined three potential targets:

1. Individual liability against the dentist who places the amalgam.
2. Against the same dentist for being the actual manufacturer of the amalgam (the material doesn't become an amalgam until the dentist mixes the alloy with mercury).
3. Against the dental supply houses and the dental manufacturers for being the manufacturers and suppliers of the component parts, knowing the use the doctor was going to put it.

However, San Francisco attorney Vasilios Choulos[1] cautions any lawsuits stemming from the placement of amalgam involving the dentist, would be difficult to win. He feels the best approach, is the latter target, the manufacturer.

In his words, *"This most probably would not come under a drug concept; it is simply a product. If you can show that a product is defective, then you have strict liability."*

Choulos believes this would be easier to pursue, however, he cautioned that it too, would be difficult, since it would involve numerous attorneys and a vast amount of money.

Whatever the outcome of the legal approach, we feel that continued research and public awareness will add to the chances of success for any such actions. ■

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[1]Co-author of "Toxic Health Risks of Dental Amalgam." Vasilios B. Choulos, Esq. and Michael A. Weiner, Ph.D. — San Francisco Barrister, June 1985.

The Environmental Dental Association Newsletter is published quarterly for the benefit of its members. The purpose of the EDA is to inform the dental/medical community of events and educational opportunities that are helping to provide the transition for dentistry to become a more environmentally conscious profession. Members are encouraged to inform us of noteworthy news in the area of less hazardous dentistry. Related press releases and meeting announcements are welcome. Address all correspondence to: Newsletter Dept., The Environmental Dental Association, 9974 Scripps Ranch Blvd., Suite #36, San Diego, CA 92131.
For membership information, write or call (619) 689-8124.

INFORMED CONSENT

Vol. 1, No. 1 — The Environmental Dental Association Newsletter — Winter 1990

Joyal W. Taylor, D.D.S.
President

This is the first edition of the newsletter for members of the Environmental Dental Association (EDA).

The EDA is a non-profit organization whose purpose is to raise the awareness level of the dental/medical community concerning hazardous side effects of specific dental materials and procedures.

Membership is composed of dentists, physicians, lawyers, biochemists, researchers, and other professionals concerned about the potential side effects of dental materials and procedures. The Board of Advisors is composed of representatives from many professional disciplines. EDA president and newsletter editor is Joyal W. Taylor, D.D.S., author of: *The Complete Guide to Mercury Toxicity from Dental Fillings.* ■

THE GOAL OF THE EDA IS TO TRANSFORM DENTISTRY INTO AN ENVIRONMENTALLY CONSCIOUS PROFESSION

A valuable benefit of membership is the quarterly EDA Newsletter, *Informed Consent* which is dedicated to informing the dental/medical community as well as the general public.

Each of its pages addresses a major concern. Example: "Speaking Out" — events happening close to home, media and educational opportunities; "Global Perspectives" — significant research and events happening around the world; and "Legislation and Law," focusing on what's happening in the legal arena. ■

The *EDA Newsletter* informs the membership of events and educational opportunities that are helping to promote this transition.

Coming in future issues of the EDA Newsletter:

- Interviews with leading authorities in the non-toxic movement.
- Safety concerns with nickel, composites, fluoride, etc.
- Protocol for amalgam removal.
- Updates regarding *"Informed Consent"* legislation surrounding the use of mercury in amalgams. ■

MEMBERS RECEIVE:

1. Subscription to The EDA Newsletter.
2. Immediate notification of significant events.
3. Copies of noteworthy media articles.
4. Discounts on meetings, seminars, and workshops sponsored by the EDA.
5. Discounts on books, booklets, cassette tapes, VHS tapes, and other literature distributed by the EDA.
6. Listing with the EDA's Referral Service. Toll-free Number (800) 388-8124. ■

CONTENTS

"SPEAKING OUT"

PORTLAND MEDIA TOUR

Dr. Taylor recently completed a two day media tour of Portland, Oregon. Appearing on many local television and radio programs, he informed the public of the possible health hazards of amalgam.

AM Northwest featured Dr. Taylor in a special segment on mercury toxicity.

KATU-AM NORTHWEST

The program had the largest audience per capita of any television morning show in the United States. As a result of his appearance on the program. the EDA's Mercury Information Number was deluged with calls. Viewers wanted information on dentists in the Portland area that did not use mercury and who understood protocol.

KATU-AM NORTHWEST

The local NBC affiliate invited Dr. Taylor on several programs. Their morning news featured an interview with Taylor as he explained the concept of informed consent legislation.

KGW-NEWS

KGW-NEWS

Later the same day, the station taped Dr. Taylor in a segment for PM Magazine. The producer has submitted the story as a network feature to other affiliate stations throughout the United States.

PM MAGAZINE

The Oregon Dental Association declined debate. They did issue a position paper stating, *"Dental amalgam . . . presents no known general health threat to dental patients."*

Concluding, *"This misinformation is a great disservice and a cruel hoax that only serves to confuse and needlessly alarm the public."*

Prior to the tour, press kits were sent to several senators and members of the Oregon legislature. Additional media coverage is now being planned for Portland in early 1990. The purpose of the next tour is to target informed consent legislation in Oregon. ■

Doctors interested in sponsoring similar coverage in their area, may contact David Collins at (503) 783-2212.

GLOBAL PERSPECTIVE

NEW RESEARCH REAFFIRMS:

MERCURY FROM AMALGAMS ACCUMULATES IN FETUS AS WELL AS MOTHER

September 1
Calgary, Canada
Initial results of research involving radioactively tagged mercury amalgams placed in pregnant sheep showed *eight times more mercury in the mother's milk than in her blood.* The research team composed of doctors from the University of Calgary Medical School used radioactive mercury to prevent misidentification with other sources of mercury accumulation.

Amalgams were placed in five sheep on the 112th day of pregnancy. After three days radioactive mercury was found in both mother and fetus blood. Also there was accumulation in the amniotic fluid and in maternal urine and feces.

At 16 days, mercury levels were highest in the mother in the kidney, liver, G.I. tract and thyroid. In the fetuses the highest levels were found in the pituitary, liver, kidney, and placenta.

At 33 days, some fetal tissues (such as brain, blood and liver) showed higher levels than the same tissues in the mother. ■

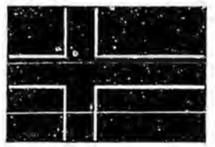
60 MINUTES AUSTRALIA

Australia's 60 Minutes recently aired a segment on amalgam. The report titled "Mouthful of Trouble," featured an interview with Dr. Hal A. Huggins, several patients and mercury-free dentists from Sydney and Melbourne.

The program favored Huggins. Using anecdotal evidence, the report did not mention scientific studies in Sweden, Canada or the United States.

While we applaud favorable exposure to the issue, we believe scientific data that is now available, should be included in such reports to support anecdotal evidence. ■

SWEDEN'S CHEMICAL INSPECTION ANNOUNCES: "AMALGAM WILL BE BANNED"

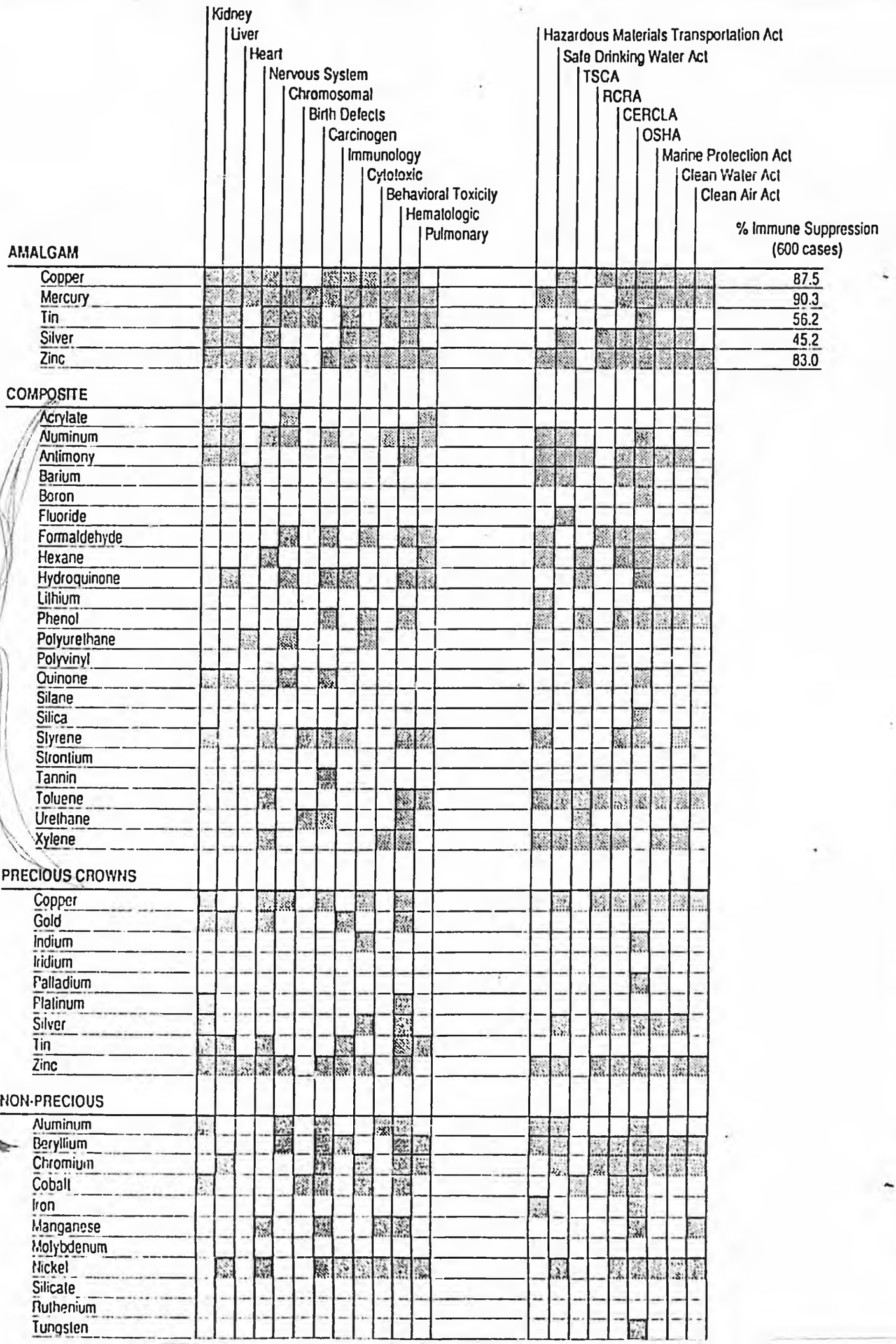


November 12 — In the continuing controversy over the possible health hazards of mercury silver fillings, director general of Sweden's Chemical Inspection, Kerstin Niblaeus, announced that the dental filling material will be eliminated from use in Sweden. The three-year-old agency believes the recommendation will be adopted.

In a recent interview Niblaeus stated: " *The question is not if, but when."* She further emphasized: *"I have not even considered that the government should not decide on a prohibition."*

The agency submitted a list of ten hazardous chemicals it recommended should be banned in that country. Mercury headed the list. ■

RESTORATIONS



In 1988, scrap dental amalgam was declared a hazardous waste material by the Environmental Protection Agency . . . Once a doctor removes an amalgam filling from your mouth and places it on the tray, it once again becomes a hazardous waste material . . . I ask the reader — what is it about the mouth that makes this same item non-toxic?

The Mercury Cover-Up

By SANDRA DENTON, M.D.

Sandra Denton, M.D.

Absolutely Amazing ! ! ! ! !

In just a few minutes I can present the "facts" to most lay people, and they can immediately grasp the significance that a poison has been implanted in their mouth without their knowledge or consent. Naturally, they are unhappy about this and would like to see the practice stopped.

Why is it then, that trained, educated professionals still ignore and discount these "facts" and even go so far as to place paid advertisements in the newspapers to assure the public of the safety of this poison??? The legal opinions right now seem to be indicating that this is frank negligent misrepresentation, possibly consumer fraud, and this action may have serious consequences.

What are some of the "facts" I tell my patients?

- Mercury comprises over 50% of the "silver" dental filling.
- Researchers from all over the world have measured mercury vapor coming off the filling, particularly after stimulation through chewing, brux[illegible] and brushing.[1,2,3,4] (For many years the American Dental Association maintained that once mercury was placed with the other ingredients of the dental filling — silver, tin, zinc, copper — it was tightly bound and did not escape.) In the face of voluminous research they were forced to change their position and admitted that although mercury does come out of the filling, the amount is "insignificant."
- Everyone knows that mercury is a poison. It is in fact, as Sharma and Obersteiner stated, ". . . a strong protoplasmic poison that penetrates all living cells of the human body. Mercury is a powerful biological poison with no necessary biological function."[5]
- Mercury is extremely toxic. Sharma and Obersteiner at Utah State University discovered mercury is the single most toxic metal that they investigated (even in such minute concentrations as 3.47×10^{-7} moles). Mercury is even more toxic than lead, cadmium and arsenic![5] It has been stated by world regulatory agencies that the smallest amount of m[illegible] that [illegible]

KNOWN! How then can we be so certain that the amount coming out of our dental fillings is insignificant?

- The world's foremost researchers on mercury toxicity, Drs. Thomas Clarkson and John Hursh of the University of Rochester School of Medicine, Department of Toxicology and Drs. Magnus Nylander and Lars Friberg of Karolinska Institute in Stockholm, Sweden, concluded from their research[6] that "the release of mercury from dental amalgams makes the predominant contribution to human exposure to inorganic mercury including mercury vapor in the [illegible]ral population."
- The International Conference on Biocompatibility of Materials was held in November 1988 in Colorado Springs, Colorado. Many of the world authorities on mercury met to discuss the issue of dental amalgam and other materials commonly used in dentistry. (The proceedings of this meeting are being published by Life Sciences Press in Tacoma, Washington (206/272-0530) and audio-visual [illegible] Hygeia

Back Up

Springs, Colorado (1-800 / 331-2303). On the last day of the meeting, the doctors in attendance drafted and signed their official conclusion, which read: "Based on the known toxic potentials of mercury and its documented release from dental amalgams, usage of mercury-containing amalgam increases the health risk of the patients, the dentists, and dental personnel."

- Autopsy studies show a positive correlation between the number of occlusal surfaces of dental amalgam and mercury levels in the brain and kidney cortex.
- Research has shown mercury dental amalgam to have an adverse effect on the T-lymphocyte count (a very important part of our immune system). In one patient, Dr. David Eggleston of the University of California, found a T-lymphocyte count of 47% (ideal levels are between 70-80%). After removal of the amalgams the T-lymphocyte count rose to 73%. Reinsertion of four amalgam restorations on top of the composite fillings, not even in direct contact with the teeth, resulted in a decrease to 55%. The amalgams were removed and the T-lymphocyte count measured 72%.[10] Dr. Eggleston's important research is ongoing and even more startling results are being published now. With all the concern about the immune system diseases of today, does it make sense to continue using a dental material that might have such a drastic effect on one's defense system?
- Multiple Sclerosis patients have been found to have 8 times higher levels of mercury in the cerebrospinal fluid compared to neurologically healthy controls.[11] Inorganic mercury is capable of producing symptoms which are indistinguishable from those of multiple sclerosis.
- In 1988 scrap dental amalgam was declared a hazardous waste material by the Environmental Protection Agency.[12] Scrap amalgam, the portion that remains, after placing a filling in your mouth, must be handled with great care. According to the Material Safety Data Sheet for mercury, [illegible] mandates [illegible] office, the [illegible]

Prior to the use of mercury fillings, lead fillings had been customary for many years and had been considered safe. For years radiation was considered safe. Does the routine use of pesticides for many years reduce their toxicity?

to handle scrap amalgam in the following manner:

1. Store in unbreakable, tightly sealed containers, away from heat.

2. Use a no touch technique for handling amalgam.

3. Store under liquid, preferably glycerin or photographic fixer solution.

Once a doctor removes an amalgam filling from your mouth and places it on the tray, it once again becomes a hazardous waste material and must be handled in the same manner described above. If this scrap amalgam should find its way into the ground, one may be fined a sizable amount.[12] I ask the reader — what is it about the mouth that makes this same item non-toxic? Or is it possible that the mouths of some 80% of Americans with amalgam fillings are in actuality "toxic waste dumps."

In Alaska, during April and May, 1989, the state dental association appropriated money for a paid advertisement titled "Straight Talk About Dental Amalgam." Let's compare facts.

"FACT": The fillings in your teeth are safe. For more than 100 years dentists have used, observed and tested amalgam filling materials, and we have found them to be both safe and effective. No other material has been so thoroughly tested, nor found to be as cost effective as dental amalgams.

This statement is very misleading. Amalgam fillings have been tested for their strength but not for their safety. Although asked several times to do so, the ADA cannot produce these "studies" showing safety. On the other hand the research pointing out its toxicity is voluminous. Prior to the use of mercury fillings, lead fillings had been customary for many years and had been considered safe. For years radiation was considered safe. Remember the days of shoe fluoroscopy? Does the routine use of pesticides for many years reduce their [illegible] dental [illegible]

plete confidence in the safety of dental amalgam. The members of the dental team, who work with amalgam everyday, are as healthy as their peers in the general population. And most of us have — and would accept — amalgam fillings in our own mouths. Over 100 million Americans have amalgam fillings.

If this statement is true, as the Alaska Dental Association would have us believe, then why do dentists have the highest suicide and divorce rate among professionals? Why was neuropsychological dysfunction present in 90% of dentists tested by Joel Butler, Ph.D., professor of psychology, University of North Texas? This information was presented at the ICBM conference November 1988. His abstract reads "Areas of suboptimal function were evident in shifting tasks - attention span, ability to concentrate - recent memory deficits - visual recall, control dyspraxia - tremor and perceptual accuracy in judgment.

Psychological problems were concentrated in the areas of irritability, impatience, tension, frustration and conflict. Notably absent was calmness. Observation of data suggest that the longer a dentist practices, the less ability he has to pass the entrance exams into dental school. Dr. Butler is alarmed at the implications of his studies and wants to inform dentists of the damage that is undermining their personalities and motor skills."[7]

If the above "FACT" is true, why then do female dental personnel have a higher spontaneous abortion rate, a raised incidence of premature labor, and an elevated perinatal mortality?[13] This has been substantiated by the Environmental Protection Agency to be characteristic of women chronically exposed to mercury vapor.[14] Recent studies in pregnant women indicate that elemental mercury does cross the placenta and incorporate into the fetus. "...the placenta, the chorioallantoic membrane, the [illegible] and the neonatal [illegible]

Why do female dental personnel have a higher spontaneous abortion rate, a raised incidence of premature labor, and an elevated perinatal mortality?

mercury while working in dental offices were found to contain significantly higher mercury levels than in control women with no occupational exposure to mercury."[15] Sikorsky's work in Poland studied 81 females (45 dentists and 36 dental assistants). Sikorsky found hair mercury levels much greater than in 34 non-exposed controls. There was significant positive correlation between total mercury levels and reproductive failures and also with a prevalence of menstrual cycle disorders.[16] This is a very recent and significant study. There was a high incidence of spina bifida births that occurred in the Sikorsky study population (5 out of 117 pregnancies). The normal ratio of occurrence is 1 in 1000 births. Folic acid deficiency has been associated with spina bifida and mercury is known to block the function of folic acid in the body. Other articles with similar information abound in the literature.[17, 18, 19, 20, 21] I also encourage the reader to get Sam and Michael Ziff's book Infertility and Birth Defects - Is Mercury From Silver Dental Fillings An Unsuspected Cause?[22]

If dentists and dental personnel are so "healthy", why do dentists, according to the insurance industry, have one of the highest utilization rates of medical insurance? Another reason to consider why more dental personnel are not diagnosed as mercury toxic may be explained by an incident reported by Macdonald[23] who stated "Since symptoms vary greatly, improper diagnosis may result. Failure to consider mercury as a causative factor in digital numbness resulted in two exploratory surgical procedures for a 40 year old dentist. He was treated in several prestigious medical facilities for 16 years before a 'long shot' test for urine mercury was taken." One must also remember that the diagnosis of mercury intoxication is extremely difficult because of the insidious nature of the onset and because of most physicians' unfamiliarity with proper testing techniques.

Most physicians would like to be able to diagnose mercury toxicity by finding a high urinary level of mercury. High levels may be found in acute exposures (macromercurialism). However, they are rarely present in the chronic low-dose exposures (micromercurialism). The chapter on mercury of the fifth edition of Clinical Toxicology of Commercial Products by Robert Gosselin, M.D., Ph.D.; Roger Smith, Ph.D.; and Harold Hodge, Ph.D., D.Sc., makes this clear. "Urinary mercury levels are characteristically low in chronic exposure suggesting a hypersensitivity reaction." Another article by L.J. Goldwater, "The Toxicology of Inorganic Mercury"[25] says that urinary mercury levels may give some indication of the degree of exposure. However, they are of limited value

Why do dentists, according to the insurance industry, have one of the highest utilization rates of medical insurance?

in the diagnosis of poisoning. High levels can be found in human subjects who are symptom free, and low levels in those exhibiting marked evidence of micromercurialism. It has been suggested that, in some cases, failure to excrete mercury is a factor in the development of poisoning. T.W. Clarkson in Biological Monitoring of Toxic Metals,[6] discusses the significance of urine mercury values. "Urinary excretion of mercury is used widely in monitoring workers exposed to mercury vapor (see U.S. EPA, 1984). However, the relationship between urinary excretion and absorbed dose is not well understood; urinary excretion may be directly related to the kidney burden of mercury unless renal damage has occurred." This point was also made by Lamm and Pratt in their 1985 study when they discovered a clear, negative and significant correlation between time on the job and the level of mercury in the urine. These researchers found that the longer a worker was on the job, the less mercury is excreted in his urine.

Blood levels are not helpful in the diagnosis of mercury poisoning since mercury in the blood for a few minutes. Mercury quickly finds its way into the various tissues of the body, depositing in the brain, adrenals, thyroid, and other organ systems. Only at high levels of exposure will this parameter be of any value.

One must also remember that the diagnosis of mercury intoxication is extremely difficult because of the insidious nature of the onset and because of most physicians' unfamiliarity with proper testing techniques.

Another point to be considered is Dr. Magnus Nylander's report which appeared in Lancet describing the increased uptake of mercury in the pituitary gland of dentists.[27]

There are not enough words to describe the dentists and dental assistants I have seen whose lives have been devastated by the effects of chronic mercury exposure. It is truly heartbreaking - and preventable!

The last part of the above "FACT" indicates that since over 100 million people have mercury fillings in their mouth, it must be right. The majority is not always right. Reports indicate that every one of us has measurable residual amounts of pesticides in our body. Does that reduce the degree of toxicity?

"FACT": Any dentist who encourages you to remove amalgam fillings in order to "remove toxic substances from the body" is guilty of a breach of ethics. In addition to the ADA, the United States Public Health Services, the National Institute of Dental Research and the Consumers Union have all investigated the allegations about amalgam — and have found them to be useless.

Remember, the ADA formerly maintained that mercury did not come out of the filling. It may interest you to know that the same dentist subject to breach of ethics for suggesting toxicity may remove the fillings for cosmetic reasons without threat of disapproval, censure, or removal of his license. If it is unethical to remove a documented biological known poison from the mouth, it is ethical to

proper ethics to be allowed to replace an amalgam for cosmetic reasons, but to be reprimanded because replacement of amalgam for any other purpose may jeopardize the health of the tooth? Is it considered proper ethics to withhold the information that mercury is present in the restoration and to use amalgam indiscriminately? In the American legal system the judge always directs the jury that it can not return a verdict of guilty if there is any reasonable doubt.

Alaska State Senate majority leader Pat Rodey, has recently stated "there is enough evidence to establish REASONABLE DOUBT as to the safety of dental amalgams in any prudent person's mind." Senator Rodey followed his words with action by introducing a senate resolution which will be voted on in the next session. It reads thus:

"SENATE RESOLUTION NO. 12
IN THE LEGISLATURE OF THE
STATE OF ALASKA
SIXTEENTH LEGISLATURE
FIRST SESSION

Relating to the use of informed consent by dentists when they insert dental fillings that contain mercury.

BE IT RESOLVED BY THE SENATE:

WHEREAS it is a common dental practice in the state to use an amalgam of materials for dental fillings; and

WHEREAS this dental amalgam is thought by most persons to be made only of silver, but its composition is actually 50 percent mercury; and

WHEREAS some studies have shown that toxic mercury vapors can leak from the fillings into a patient's blood system and lead to mercury poisoning, particularly in chemically sensitive or allergic persons; and

WHEREAS dental patients should have the right to choose which materials are used for their dental fillings, but they often lack basic information from the dentist that would help them make an informed choice;

BE IT RESOLVED that the Senate respectfully requests the Governor to direct the Board of Dental Examiners to report to the legislature by the 10th day of the Second Session of the Sixteenth Alaska State Legislature its recommendations on the manner in which dentists [illegible] that [illegible] dental filling material;

(2) mercury in fillings can have toxic effects on some persons;

(3) there are alternative materials that could be used for dental fillings that could have other effects on the person; and

(4) they have the right to insist that an alternative material be used."

It is hoped that other states will follow this recommendation in passing similar legislation.

In a "Concept Paper" the Alaska Department of Health and Social Services on January 17, 1989 stated: "Those persons who have had a large number of amalgam fillings, who have experienced symptoms commensurate with chronic low level mercury exposure and who have tried traditional treatments may wish to consider replacement therapy".

There are not enough words to describe the dentists and dental assistants I have seen whose lives have been devastated by the effects of chronic mercury exposure. It is truly heartbreaking — and preventable!

The Alaska Public Interest Research Group investigated information presented in this paper and is now supporting efforts to introduce legislation that will mandate the provision of full information about these potential health effects from mercury amalgams. The group is also supporting additional legislation to "hold harmless" dentists who provide this information (in rejection of ADA guidelines which prohibit even telling patients about these concerns).

"FACT": The Board of Dental Examiners of the State of Alaska supports the position of the American Dental Association that "there is no scientifically documented evidence of a cure or improvement of a specific disease due to the removal of (silver) amalgam restorations from a non-allergenic patient."

This is true because poisoning is not a specific disease. Nonetheless, I have [illegible] cases of seizure disorders, [illegible] memory loss, irritability, disturbances, depression, neurological symptoms, various eye problems, headaches, muscle tremors, joint pains, intestinal problems, irregular heart beats and/or unexplained chest pains, agitation and irritability, suicidal thoughts, and many many more conditions disappearing after amalgam removal.

The Alaska paid advertisement goes on to say, "Decisions about fillings, like all decisions about your dental health, should be made in your dentist's office within the bounds of the doctor/patient relationship." This may be somewhat difficult if the reader experiences what many of my patients tell me happens when they either inquire as to what material is being placed in their mouth or if they should request non-mercury fillings be placed in their mouths or that of their children. In many cases the dentist has gone into an absolute rage and stormed out of the office. In several other documented instances, the dentist, despite the request for non-mercury fillings, deliberately placed mercury amalgam fillings. What does that do for the doctor/patient trust and relationship????

If the dentists of Alaska, or any dentist, care about our health, as the advertisement claims, they would give serious consideration to the evidence that is mounting at an alarming rate proving mercury is detrimental to our health and well being. When the report appeared in a Swedish newspaper May of 1987 stating that the Swedish government health board declares amalgam toxic and unsuitable as a dental filling material it was quickly disregarded. Headlines in the ADA literature read "Amalgam ban reports are bogus." I think it is quite significant that public hearings occurred in Sweden toward the end of 1988 and the previous ruling was upheld and reinforced.

Fortunately, there are dentists who have seriously questioned the information being propagated by the establishment. They can no longer, with a clear conscience, continue placing a poison in unsuspecting patients who trust their dentist. Especially now that we have suitable alternatives which, according to pro-amalgam dentist Dr. George Freedman, may be stronger than amalgam. (*Dentistry Today*, Feb. 1989). These con[illegible] attending meetings

to learn more about the materials they are using and how to properly remove unsuitable ones. There are two such meetings in the near future. The International Academy of Oral Medicine and Toxicology will hold its annual meeting September 15-17, 1989, in Detroit, Michigan. For information call 313 / 627-4934. Huggins Diagnostic Center will host an intensive five day course October 18-23, 1989, on Biocompatible Materials and treatment protocols. Call 1-800 / 331-2303.

Clinical observation seems to indicate that serum biocompatibility testing through Huggins Diagnostic Center is very valuable. Immunologic reactions to various dental materials are identified and quantified, providing guidance in determining the need for removal and replacement with appropriate materials. For information about this test call (1-800 / 331-2303). Some patients who have not had the benefit of this test have had to replace their dental materials a second or third time before finding compatible restorations.

An excellent reference text for the health professional and victim interested in learning more about mercury toxicity is Chronic Mercury Toxicity — New Hope Against an Endemic Disease. Doctor's Guide for Lifestyle Counseling by H.L. Queen (1988). For your copy call 1-800 / 2 HEART 2. The book describes the insidiousness of the problem and, more importantly, outlines protocols for proper use of intravenous vitamin C and other treatment modalities.

In subsequent issues of *Health Consciousness* I will discuss patient instructions for someone going through detoxification and helpful clinical pointers for both physicians and dentists.

I trust this article has caused some to have "second thoughts" about the safety of amalgam, and others to stand up and end what was referred to by Dr. Alfred Stock in 1926 as a "terrible sin against humanity."

BIBLIOGRAPHY —
THE MERCURY COVER-UP

1. Svare, C.W., Peterson, L.C., et al; The Effect of Dental Amalgams on Mercury Levels in Expired Air. J. Dental Research, Vol 60, No.9, 1668-1671, 1981.
2. [illegible] Lorscheider, F.L.; Serial [illegible] Intra-Oral Air Mercury: [illegible] Dose from Dental Amalgam." J. Dental Research, Vol 64 No. 8, 1072-75, Aug 1985.
3. Huggins, H.A., Its All In Your Head. Toxic Element Research Foundation, Colorado Springs, CO. 1985.
4. Ziff, S. Silver Dental Fillings - The Toxic Time Bomb. Aurora Press, New York, N.Y. 1984, 1986.
5. Sharma and Obersteiner; Metals and Neurotoxic Effects; Cytotoxicity of Selected Compounds on Chick Ganglia Cultures; J. of Comparative Pathology; Vol 91, 235-244, 1981.
6. Clarkson, T.W., Friberg, L.; Hursh, J. and Nylander, M. In: Biological Monitoring of Toxic Metals, Plenum Press, N.Y. Feb. 1988.
7. Proceedings of the International Conference on Biocompatibility of Materials, November 1988, in publication currently by Life Sciences Press, Tacoma, WA.
8. Eggleston, David, D.D.S., Nylander, Magnus, D.D.S. "Correlation of Dental Amalgam With Mercury in Brain Tissue." Research and Education, Vol 56, No 6, 704-707, Dec. 1987.
9. Nylander, Magnus; Friberg Lars; Lind, Birger: "Mercury Concentrations in Human Brain and Kidneys in Relation to Exposure From Dental Amalgam Fillings": Swed. Dent. J. 11:179-187, 1987.
10. Eggleston, David, D.D.S.; Effect of Dental Amalgam and Nickel Alloys on T-Lymphocytes: Preliminary Report, J. Prosthetic Dentistry, Vol 51, No 5; 617-623, May 1984.
11. Ahlrot-Westerlund, Nutr Res, suppl, 1985, 403: Second Nordic Symp on Trace Elem in Human Health & Disease, Odense, Denmark. Aug 1987.
12. Hemenway, Caroline, Amalgam Declared Dangerous, Dentistry Today, 10, Feb. 1989.
13. Bloch P.; Shapiro I.M.; Summary of the International Conference on Mercury Hazards in Dental Practice. J. Amer Dent. Assoc 104:489-90, 1982.
14. "EPA Mercury Health Effects Update Health Issue Assessment", Final Report 1984 EPA-600 / 8-84-019F. United States Environmental Protection Agency. Office of Health and Environment Assessment, Wash. D.D. 20460.
15. Editor: This is Only a test . . . J. Calif Dental Assoc 12:37, 1984.
16. Sikorsky's work in Poland; Int. Arch Occup Environm Health, (59) 552-557, 1987.
17. Goncharuk, G.A. "Problems Relating to Occupational Hygiene of Women in Production of Mercury", Gigiema Truda I Professional Zaplevaniya, 5:17-20, 1977.
18. [illegible] Z. [illegible] Dimitrov, G., "Ovarian [illegible] Having Professional Contact with metallic Mercury", Akusherstvoi Ginekologiya 13 (1): 29-34, 1974.
19. Gordon, H., "Pregnancy in Female Dentists — A Mercury Hazard" in Proceedings of Internat. Conf. on Mercury Hazards in Dental Practice, Glasgow, Scotland, Sept. 2-4, 1981.
20. Kuntz, Am. J. Obst. & Gynecol., 143: 440-443, 1982.
21. Koos. B. and Longo, L., "Mercury Toxicity in the Pregnant Woman, Fetus and Newborn Infant", Am. J. Obstet. Gynec., Oct. 1976.
22. Ziff, Sam; Ziff Michael, D.D.S.; Infertility and Birth Defects - Is Mercury From Silver Dental Fillings An Unsuspected Cause? Bio-Probe, Inc. Orlando, FL. 1988.
23. Macdonald, G. Occupational Hazards in Dentistry. J. Calif Dent Assoc 12: 17-19, 1984.
24. Gosselin, R., M.D., Ph.D.; Smith, R., Ph.D.; and Hodge, H. Ph.D., D.S.C.; Clinical Toxicology of Commercial Products, Fifth Edition, Chapter on Mercury.
25. Goldwater, L.J.; "The Toxicology of Inorganic Mercury", Annals N.Y. Acad. Sci. 65:498-503, 1957.
26. Lamm, O., and Pratt, H. "Subclinical Effects of Exposure to Inorganic Mercury Revealed by Somatosensory - Evoked Potentials" Eur Neurol 24: 237-243, 1985.
27. Nylander, M., "Mercury in Pituitary Glands of Dentists"; Lancet, 442, Feb. 22, 1986.

Bio-Sketch — Sandra Denton, M.D.

KUP'S KOMMENT:

I had the indeed pleasure of being with Sandra Denton, M.D. at the World Congress on Alternative Medicines in Athens, Greece this spring. I asked Sandy if she would honor HC by being on the cover and writing a feature story for you. Her most beautiful photo appears on the cover and her most dynamic, high impact writing *The Mercury Cover-Up* appears here!!!

There is an aura of love, calmness, caring, compassion, and balance about Sandy that is immediately perceived. She is also a very powerful, effective, truthful and well documented speaker and writer; and from the feedback that I have received from HC readers and patients of hers, a superb physician. What a treat you have in this issue of HC with Sandra Denton, M.D.

The Mercury Cover-Up is a paper to be read by all the members of the health profession as well as the medical/allopathic profession and as many lay people as possible. Extra issues will be available for a while and I am planning on having printed reprints of this article. Thanks, Sandy! God bless you!

Dr. Denton received her medical degree from the University of Tennessee in 1971 and completed an internal medicine internship at St. Luke's Episcopal Hospital in Houston, Texas. She then specialized in emergency medicine for almost 14 years, becoming board certified in 1981. Serving as director of two hospital emergency medical services in Louisville, Kentucky for five years, Dr. Denton gave many lectures in her field of expertise, "poisoning and toxicology."

Dr. Denton made a career change in 1985 when she became convinced of the benefit of nutritional and preventive medicine. By learning many of the therapies taught by the American College of Advancement in Medicine, she felt she could [illegible] and improve the quality of life [illegible] keep them [illegible]

She [illegible] American [illegible]

Chelation therapy is an accepted therapy for the treatment of heavy metal poisoning and recognized by some for its efficacy in improving arterial circulation throughout the body.

Keeping in line with her interest in toxicology, Dr. Denton became aware of the presence of mercury in dental fillings and immediately recognized the potential health problems. Having majored in chemistry in college, she saw that anything having such a strong affinity for sulfhydryl groups could cause major disruption of normal cellular functions in the body. It occurred to her that many of those people who used to frequent the emergency room with strange, bizarre, unexplained, undiagnosed symptoms, finally being labeled as "crazy", could instead be suffering from chronic mercury toxicity. She began to investigate this possibility and has collected numerous articles (almost 3000) and several books on the subject of mercury toxicity. She spent four months at Huggins Diagnostic Center reviewing patient charts, answering phone calls from patients worldwide, going through the files adding to her documentation, and doing research.

Dr. Denton has since treated hundreds of patients whose health problems have definitely improved when toxic dental materials were properly removed and detoxification procedures followed. She, of course, works closely with dentists trained in this area.

Realizing that most physicians are not aware of even the presence of mercury in the dental fillings, much less its effects, Dr. Denton lectures to interested professional organizations. In fact, she recently had the privilege of lecturing at the World Congress of Complementary Medicine in Athens, Greece, to physicians from 44 countries. Dr. Denton also gave two lectures at the International Conference on Biocompatible Materials, November 1988: 1) Clinical Pointers on Detoxification of Mercury 2) Infertility and Birth Defects [illegible] Mercury Connection [illegible]

/ 272-0530) and tapes are available through Huggins Diagnostic Center (800 / 331-2303). Dr. Denton also lectured at the International Academy of Oral Medicine and Toxicology meeting September 1988.

Dr. Denton has studied the various treatment modalities for mercury toxicity extensively. While raising awareness of the problem both at the public and professional level, she endeavors to teach the solution as well. She is a frequent radio and television guest.

Dr. Denton has become involved with dental personnel, treating their health problems and fighting their battles for disability from their occupational exposure to a known poison.

Her professional memberships include:

American College Advancement in Medicine — chelation therapy and nutritional medicine

American Academy of Environmental Medicine — allergies and toxic substances in the environment

International Bio-Oxidative Medicine Foundation

International Ozone Association

Consultant for Toxic Element Research Foundation

Board of Directors for International Academy of Oral Medicine and Toxicology

Fellow, American College Emergency Physicians

Dr. Denton and her dental colleague, Dr. Paul Rubin of Seattle, Washington, made a professional cassette tape "Mercury Detoxification — Patient Instructions" which has been of great assistance in outlining general procedures for the patient to speed the healing process. To order call 206 / 328-0221.

Dr. Denton is in private practice with Dr. Robert Rowen at *Omni Medical Center,* which is a total holistic health center. Chelation therapy, oxygen therapies, applied clinical nutrition, acupuncture, neural therapy, sclerotherapy, counseling, a weight loss program, and mercury toxicity evaluation and treatment are only a few of the services offered at OMNI. For further information write Dr. Denton at:

[illegible] Center

Mercury Poisoning From Dental Amalgam

Jaro Pleva, Ph.D.[1]

This report is a critical evaluation of the use of dental amalgam with special consideration of the possibility of chronic mercury poisoning. The description of psychic and somatic symptoms associated with corrosion of amalgam might help people with similar symptoms to recognize the possible source of their problems. Medical practitioners need to recognize the characteristic manifestations of mercury poisoning and it is also my hope that this report might help dentists to a better understanding of the hazards of amalgam and combinations of metals.

The onset, development and disappearance of symptoms in relation to the dental treatments, an examination of my corroded amalgam fillings (details will be published elsewhere) and a knowledge of corrosion mechanisms, leads to the conclusion that corroding amalgam was the cause of a syndrome, typical of chronic mercury poisoning. All my observations, both as a patient and as a corrosion scientist, have reasonable explanations and can be supported by data from the scientific literature.

Analyses of saved silver amalgam fillings showed that they were badly corroded. Corrosion attacks on almost every aged amalgam filling show that assurances that amalgam is a stable alloy can be dismissed. Statements that amalgam is not harmful are unfounded and based on short-term considerations. Galvanic coupling of gold and amalgam gives a guarantee for mercury poisoning within a relatively short time. The label "oral galvanism" is insufficient and misleading since the problem is crevice corrosion of amalgam.

For various reasons the hazards of amalgam have been disregarded for at least 50 years, resulting in insufficient information about its dangers and an unsatisfactory development of alternative filling materials. The dangers of insidious mercury intoxication from amalgam are known at least since the 1920s, but after more than half a century the problem seems more to the fore than ever. Voices have often been raised, warning that silver amalgam (and before that copper amalgam) is not harmless and describing symptoms of poisoning. In spite of this, the amalgam situation in the mouth is seldom considered in medical practice. A study of the subject and today's situation, leads one to conclude that the dental and medical care

[1]. Manager, Corrosion Section,
Steel Research, Uddeholm AB,
Pb 703, S-68301 Hagfors 1, Sweden

systems have serious deficiencies in knowledge of important border sciences like corrosion chemistry and toxicology.

Dental and Medical history

From about 20 years of age (beginning of 1960s) most of my teeth, with exception of the front ones, were repaired with amalgam. In 1963 a gold bridge was placed in the left side of the lower jaw to replace two missing teeth. In 1976 one of the supporting teeth had to be treated for caries. The hole in the tooth was temporarily filled with amalgam through a hole drilled through the gold. The final treatment was delayed for a year and then the tooth was root-filled through the hole in the gold. The cavity was again filled up with amalgam.

Up to this time my general problems were migraine and feelings of stress, both increasing with time. The headache started in the late 1960s and became more severe a few years later, well before the period of worst symptoms. The migraine was most often precipitated by weather changes, especially low pressures. The feelings of stress I related to hard work and a lack of balance between office work and physical activity.

A few months after the final dental treatment I was surprised by strong, unexplainable symptoms. I woke up in the nights with intense anxiety and irregular heartbeat and each time, for a few minutes, I thought that these were the last minutes of my life. At the same time, other acute symptoms increased very much.

Table I.
Symptoms of the Amalgam Syndrome

Irregular heartbeat, often together with anxiety
Strong pains in the left part of the chest
Retinal bleeding
Dim vision, especially after exercise; slow and poor accommodation
Inability to fix the gaze, uncontrollable eye movements. Eyes drawing to one side
Geometric figures in the visual field, migrating in a few minutes from the periphery towards the center and slowly disappearing
A "film" over the eyes, dry eyes
Arcus senilis: a grey ring around the cornea (permanent)
Red, irritated throat; inflammation in upper airways and pleurisy a year after the dental treatment
Difficulties in swallowing
Severe amnesia; constant strain; anxiety; irritability; difficulty and even impossibility to control behavior; indecision
Loss of interest in life; tiredness; a feeling of being old
Resistance to intellectual work; reduced capacity for work, both intellectual and physical; reduced powers of comprehension, information does not come through.
Increased need for sleep
Vertigo
Headache (about once a week), often migraine-like, especially induced by weather changes and by prolonged sleep in the mornings
Facial paralysis, right side and partly permanent. Damage to balance and hearing
A painful pull at the lower jaw towards the collar bone
Increased salivaton, sour-metallic taste
Bleeding gums at toothbrushing
Joint pains, especially increasing 1981-2
Pains in the lower back
Weakness of muscles, slow muscle action
Pressure, pains, "needles" in the liver region
Asthmatic breathing troubles, a feeling of not being able to breathe, "cracking" in the lower part of the pleural sac, forcing to cough
Gastrointestinal irritation
"Needles" at lymph nodes under arms and in groin
Eczema

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A state of indescribable tiredness, stress and anxiety was constantly present. To perform simple tasks, to join discussions, to think, talk and to be social required considerable effort. During visits to doctors I mainly complained about my irregular heart. Since all tests were in general normal (a slightly elevated cholesterol level), the result was an entry in the records that the patient imagines his troubles. To several doctors I pointed out that there was an amalgam filling in the gold bridge, a filling which after a few months had become black and rough which indicated corrosion and dissolution of the amalgam. No doctor was interested in this fact.

Because of eye troubles I visited an eye specialist. He found bleedings in the retina and high blood pressure and sent me back to a general practitioner with the same results as before. Pains in the chest forced me to doctors again. ECG during rest and exercise showed normal heart-condition. The gastro-intestinal system was x-rayed and examined for a whole day without results. Mercury analysis of the urine and blood, performed on my urgent request, showed Hg-values below industrial limits.

The diagnosis that all this was because of stress or strained relations in the family I could not take seriously. From my previous life I was used to more stress, both psychic and physical than during this period. Since no doctor could help me I tried to find the cause by myself. I noticed that the surface of the amalgam filling (about 4 x 4 mm) in the gold bridge (surface 670 mm²) rather quickly became black and rugged. As a corrosion specialist I was fully aware of the fact that this was a galvanic cell where the more noble gold was the cathode and the amalgam the anode. This meant that the anode/amalgam was dissolving and that the metals ionized as cations. Too long I ascribed this effect little significance, believing that the process certainly could not result in dangerous amounts of dissolved mercury since the university-trained dentists twice had put amalgam in direct metallic contact with gold without the slightest hesitation.

When I had been tormented for about a year and a half and help was nowhere in sight, I did what now seems self-evident: I read about mercury poisoning in a toxicology book. My symptoms agreed well with those of chronic mercury intoxication. Then I went to a dentist and had the amalgam in contact with the gold exchanged for plastic. After about three weeks it became evident that this was a step in the right direction and that I really was mercury poisoned. The stinging sensations in the armpits and groins and the eczema disappeared first. Then many of the subjectively strongest symptoms began to diminish, but not all of them and not completely.

About three months after the exchange of the filling in the gold bridge I suffered a paralysis in the right half of my face, balance and hearing also affected. The tentative diagnosis by the first doctor was a rare, tropical disease, imported from abroad. Another doctor later diagnosed the manifestations as Herpes zoster otis. For all I know this latter diagnosis was based on the discovery of a small area of skin eruptions on the right ear. There was never pain or itching in the affected area. The facial paralysis / ear, balance troubles were considered unusually severe which is also confirmed by the fact that the damage was largely permanent.

Three years after elimination of the gold-amalgam galvanic cell (autumn 1981) many symptoms remained and some, e.g. tiredness, muscle pains and breathing troubles were increasing. A study of the literature on dental amalgams and a knowledge of metal stability and corrosion mechanisms led to the decision to have all amalgam removed. This was done in the summer of 1982. Already after the first treatments considerable improvements were noted. When the fillings opposite the gold bridge were removed, every tendency to headache or migraine disappeared. The change was so abrupt that I can see no other explanation than the removal of the fillings in these still living teeth. In writing this, headache has not reappeared except once, after a dental treatment when several fillings were drilled out and presumably some amalgam was swallowed and inhaled. Another interesting observation was the disappearance of the painful strain from the lower jaw towards the collar-bone when two amalgam fillings in the lower jaw were removed.

When all fillings had been removed, all symptoms except the facial paralysis and arcus senilis rather quickly diminished in about three months. Subjectively the mental

abilities and memory seemed to recover more slowly than the somatic functions. However, mental functions are more difficult to quantify than symptoms of a more physical character, for example irregular heart and difficulties in breathing.

Some symptoms I had thought to have other causes than amalgam also disappeared, especially back acne, which I related to office work and my height (190 cm). Also the pains below the ribs which were thought to be remnants of a hepatitis 20 years earlier, disappeared. In December 1982 I also found that small vesicles and exfoliation of the epidermis on the sole of one foot and on the insides of my hands completely disappeared.

About five months after the last amalgam filling had been removed some relatively strong symptoms returned for a period of one to two weeks. These were mainly heart irregularities together with anxiety attacks and strong metallic taste in the mouth. After this period I had a feeling of even better well-being than before.

The improvements in my health could not be related to any factor in my surroundings: work, home, personal relations or diet since these remained unchanged. The disappearance of the symptoms clearly falls into the period of amalgam removal and afterwards. Finally I want to stress the amazing improvement in well-being, only three months after the final dental treatment. In spite of still improving, I have regained a feeling of peace and calmness, of being able to appreciate smells, details and gradations in my surroundings, something I must go back 10-15 years to find. I no longer accept that a 40 year old person must have some age-related symptoms: tiredness, headache or pains in some places. According to my opinion, a prerequisite for health is that corroding alloys, releasing highly toxic heavy metals, are removed from the oral cavity.

Corrosion of Silver Amalgam

Some pieces of amalgam fillings, removed in 1982, have been saved and analyzed for corrosion attacks and composition with a JEOL scanning electron microscope with EDAX (Energy Dispersive Analysis with X-rays) equipment. The first apparent features, visible with the naked eye, both on these and other fillings, were that their surfaces towards the tooth cavities, were largely black. Fig. 1 shows an example of corrosion at the margin of a filling (five years old). The surfaces were clearly corroded, most severely near the margins towards the outer electrolyte (saliva), a feature which is characteristic for crevice cell corrosion.

A selective dissolution of the least corrosion resistant phase in the metallographically complex amalgam system has been observed many times and has been accepted as one of the most common causes for corrosion of silver amalgam (Jörgensen, 1965; Guthrow et al., 1967; Sarkar et al., 1975). Corrosion of this phase releases metallic mercury which can either ionize, evaporate or partly react with the other phases to form new corrodible phase and the attack can continue (Espevik, 1977). The filling becomes porous which enhances corrosion and causes the margins to crack (Fig. 1, Jörgensen, 1975). Severe corrosion could be seen, not only between filling and tooth, but also on the free surface towards the cheek.

Surfaces and the inner of fillings were analyzed with the EDAX equipment. The inner of the fillings showed no considerable difference between the two silver amalgam fillings aged 5 and 20 years. The mercury content of 40 percent was lower than in freshly prepared amalgam which contained 45 percent mercury. The new amalgam contained significantly higher amounts of copper relative to the silver content, which suggests a new type of amalgam. From the chemical and electrochemical point of view, the increased copper content (14 percent) must be considered completely unsuitable since copper is easily dissolved to easily soluble compounds (Wranglén & Berendson, 1982).

Analyses of the black corrosion products in the crevices yielded interesting information. The smooth black surface of a five year old filling contained 27 percent mercury, 3 percent silver and 66 percent tin. The black, porous surfaces of a 20 year old filling were devoid of mercury and silver and contained 40-60 percent tin, 37-51 percent zinc and 4-7 percent copper. The surprisingly high zinc content might originate from an underlying zinc phosphate cement layer, if originally present. Grey areas of the same crevice still contained 5 percent mercury and 4 percent silver and tin was enriched to 80 percent. The

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outer surface of the five year old filling showed about 10 percent lower mercury content near the margin compared to non-corroded surfaces. Point analyses of corroded areas showed none of the phases reported to be present in fresh amalgam (Espevik, 1977).

Corrosion is an electrochemical process which can be separated into two part reactions (Wranglén, 1967) : an anodic process which is the dissolution of the metal and a cathodic one, often reduction of oxygen and in an acidic environment the reduction of hydrogen ions to hydrogen gas. Both anodic and cathodic reactions must proceed simultaneously but can occur on separate places. The processes can be demonstrated by connecting a zinc and a platinum electrode in dilute sulphuric acid. Zinc will dissolve and hydrogen gas evolve on the platinum electrode. This is called galvanic corrosion of one of the two metals in direct metallic contact. Basically, the same process can occur on a microscopic scale between different phases of an alloy.

Another type of corrosion cell can occur, even in a pure and homogeneous metal if the conditions for anodic and cathodic reactions differ at various places of the surface. Oxygen-rich regions will be cathodic whereas regions depleted in oxygen will be anodic and corrode. In crevices, the oxygen partial pressure is low. Crevice corrosion is known to occur on metals like aluminium, stainless steel and dental amalgam (Wranglén, 1967; Espevik, 1977).

The electrolyte in a crevice corrosion cell differs from that of the surrounding solution. It is oxygen-depleted, enriched in corrosion products, i.e. metal ions and some other ions, often chlorides. pH values as low as 2 have been reported in amalgam crevices (Espevik, 1977).

An evaluation of the corrosion resistance of a metal must consider both the metal, the corrosive environment and other factors. The geometry of the model/apparatus, filling is important; crevices occur almost always and are in practice impossible to completely avoid. Amalgam fillings in the teeth are no exceptions (Schoonover and Souder, 1941; Jörgensen, 1965). It is a well known fact that amalgam of every known composition corrodes (Schoonover and Souder, 1941; al., 1965; Mateer and Reitz, 1970). Many people will have noticed that fillings which have to be exchanged are black along the margins. Corrosion in crevices between tooth and filling makes the latter brittle and causes the margins to crack (Jörgensen, 1965). It is important to observe that during corrosion the metal is dissolved as a positive ion, a cation, and not as a neutral atom. The latter is, however, the case when mercury evaporates.

Biological films which are sometimes ascribed high stability and properties which can prevent electron transport (Glantz and Bergman, 1982), can be removed during chewing. Since crevice corrosion of amalgam is a fact, such films can not have any real significance for this process. It is hard to imagine that their isolating properties could be better than the oxide film on an aluminium surface. Still, aluminium corrodes in crevices. In the presence of even minute amounts of nobler elements, galvanic microelements are formed and the passivisation becomes incomplete (Kaesche, 1971). The cathodic reaction is not blocked if the surface film is electrically conductive.

If there is contact between amalgam and gold or other noble metals, the anode amalgam will be polarized towards more positive potentials and the rate of corrosion will considerably increase (Schoonover and Souder, 1941; Fraunhofer and Staheli, 1972; Till and Wagner, 1973; Wagner and Till, 1973). My own experiences have shown that the entire surface of the filling then corrodes rapidly and that the gold then takes over the function as a cathode. The magnitude of the corrosion current in such a galvanic cell depends i.e. on the conductivity of the electrolyte saliva, the oxygen partial pressure etc. Relevant to the role of conductivity is an interesting observation I made when the gold-amalgam galvanic element was still present. Some days I had increased pains in the chest and more troubles with my eyes. After some months of observations I could connect the symptoms with my lunch salad. There was nothing wrong with the salad itself. Months later, when I had discovered the cause of my symptoms, I could also solve the riddle of the strong effects of the salad. I like salad with dressing, much salt, vinegar and spices. Vinegar and salt will produce an electrolyte with considerably

increased conductivity and of low pH. Both factors will produce higher corrosion currents and a concomitant increased release of mercury. Rost (1976) has described a case of chronic inflammation of the mouth, nose and throat. The symptoms were rapidly increasing after acid food was ingested. The patient had both gold and amalgam in the mouth. After elimination of the amalgam the symptoms disappeared.

Figure 1.

Corrosion attacks on a 5 year old filling opposite the gold bridge. Pieces of the margin have broken off.

Discussion

All symptoms described are well known from chronic mercurialism (Stock, 1926; Friberg and Vostal, 1972). They also agree well with cases similar to my own (Steffensen, 1934). The severe corrosion of my silver amalgam fillings and the disappearance of symptoms during and immediately after the removal of the fillings, proves that it really was a chronic mercury poisoning from amalgam. The typical pathological picture has been excellently described by Stock (1926), whose report on 20 years of observations clearly shows the sufferings of a chronically mercury poisoned person. I had the dubious pleasure to study the same phenomenon on myself during at least five years, both as a mercury poisoned patient and as a corrosion specialist.

Both my own experiences and the miserable situation of other persons I know of, demonstrate that it is almost impossible to discover that the cause of one's symptoms is poisoning from dental amalgam without being informed about this source of poison. It is, in this case, within us and not coming from the external environment. Most of us have more or less amalgam in the mouth both day and night and are not aware of the fact that half of it is mercury. There are gram amounts at elevated temperature in the relatively aggressive fluids of the mouth. Compared to the prohibition of cadmium-containing glazing on chinaware, warnings for cadmium in mushrooms and lead in gasoline, the situation seems almost grotesque.

I have observed my surroundings and questioned about 150 people with symptoms similar to those I experienced myself. A causal relation between their troubles and their dental status seems to emerge. The relation is most clearly seen when there are gold restorations which can come into contact with amalgam, but also when there are many large amalgam fillings and no gold. It is remarkable that no broad investigation on these relations has been carried out already a long time ago, for instance within the scope of investigations on the etiology of civilization diseases.

Mercury is probably the most toxic metal in our environment (Stock, 1936; Fellenberg, 1977; Till et al., 1980) and all forms are toxic (Friberg and Vostal, 1972). Since the half-time for excretion from the brain for the most slowly eliminated phase is years, also small amounts of mercury during a long time can produce the same effects as high concentrations during a short time (Hanschler, 1977). This was known already in the 1930s (Stock, 1938). An insidious long-term exposure can produce damage and symptoms after decades and the cause will be very difficult to establish (Fellenberg, 1977). Additional sources of poison will also be important. It is possible that insidious heavy-metal poisoning (mercury, cadmium, lead) can be a factor in the increasing frequency of civilization diseases (Fellenberg, 1977). It has recently been shown that mercury, in the same amounts as those released from amalgam (estimated), can produce parodontitis in germ-free animals (Till, 1978).

Materials, as hazardous as mercury, should not be put into the human body unless the last suspicion that it corrodes and gives symptoms of poisoning, has been eliminated. It is remarkable that the situation is the opposite: amalgam poisoned persons have to

Even if amalgam released mercury in amounts not measurable with today's instruments, but the body reacted to these amounts, the real effects must be considered and not presumptions and figures based on inadequate methods of measurement. However, literature on the hazards of silver amalgam and the special dangers of galvanic elements amalgam-gold can be found already from the 1920s. Among others, Prof. Stock (Stock, 1926; 1936; 1938) has in detail and very competently discussed the problem, both as a chemist and as a poisoned patient. Gasser (1976) has described a number of cases with symptoms similar to mine. These all disappeared when the fillings were removed. Gasser (1976) also examined the surfaces of old fillings (age unknown), attacked by crevice corrosion. The depth of corrosion was 50-90 micrometers which was estimated to have released 240-560 milligrams during several years in a mouth with many fillings. The corroded marginal areas were depleted in mercury. This agrees with the present EDAX analysis of the black surfaces. An increased silver content, observed by Gasser (1976) could not be seen in the present investigation. On the contrary, the silver content was in all instances considerably lower than in non-corroded areas.

It must also be pointed out that people with other metal combinations than with amalgam as one component, can be troubled by the currents passing between the metals. More local irritation can then occur than when mercury is released from amalgam (Wranglén and Berendson, 1982). However, currents are normally coupled to corrosion of metals and release of metal ions. For some symptoms it might be difficult to decide if they are caused by the currents or by released metal ions. The term "oral galvanism" is misleading since the main problem is corrosion and release of toxic metals.

Reports on corrosion of amalgam, published by dental institutions, often indicate a misunderstanding of possible corrosion mechanisms (Nilner, 1981; Glantz and Bergman, 1982); such questions should be handled by competent technical institutions. Sweeping, unfounded statements like "passivation of the surface of metallic dental materials is a commonly occurring phenomenon which means that the intraoral corrosion can be so insignificant that it can practically be considered to have ceased" (Glantz and Bergman, 1982) can not be considered sufficient justification for loading the mouth with grams of mercury, often in combination with gold.

The statement that there have never been reports on systematic dissolution of silver amalgam fillings (Glantz and Bergman, 1982) has no foundation in reality. Almost any old amalgam filling, viewed through the microscope, shows attack by crevice corrosion. Disregarding the question of the stability of single restorations, it is primarily the very common and thoughtless use of combinations of metals like gold and amalgam which indicates that dentists today have little qualification to prevent poisoning of their patients. More education and interest are needed to take advantage of present knowledge.

For the same reasons, statements that there are no reasons to advise dentists against the use of amalgam and that people should not be imparted the belief that we face considerable health problems (Friberg, 1982), do not reflect the real situation and are worthless when it comes to solving existing problems.

The correct approach is not first to use amalgam and then to demand that the patient himself shall prove that amalgam caused the ensuing problems. First it must be proved that amalgam is not harmful and that it does not corrode. It is certainly not sufficient to diffusely refer to many people without troubles (the first years). Furthermore, as long as patients with symptoms of mercury poisoning are not investigated regarding the amalgam situation and their complaints a priori are dismissed, there will be no reports on the suspected role of amalgam. Despite this, the number of persons who have solved their problems themselves is increasing. Scientific methods like chemical analysis are sometimes not sufficient and have no value on their own; the practitioner can seldom form the right diagnosis without taking the patient's statements seriously.

Conclusions

My own symptoms, the similarity with those of chronic mercury poisoning, their disappearance when the amalgam was re-

BIO-PROBE NEWSLETTER

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MERCURY FROM AMALGAM FILLINGS TRACED TO ORGANS AND TISSUES!

Hahn, Leszek J.; Kloiber, Reinhard; Vimy, Murray J.; Takahashi, Yoshimi; and Lorscheider, Fritz L.

Dental "silver" tooth fillings: a source of mercury exposure revealed by whole-body image scan and tissue analysis.

The FASEB Journal. Vol. 3:2641-2646. Dec. 1989.

ABSTRACT: "Mercury (Hg) vapor is released from dental "silver" tooth fillings into human mouth air after chewing, but its possible uptake routes and distribution among body tissues are unknown. This investigation demonstrates that when radioactive ^{203}Hg is mixed with dental Hg/silver fillings (amalgam) and placed in teeth of adult sheep, the isotope will appear in various organs and tissues within 29 days. Evidence of Hg uptake, as determined by whole-body scanning and measurement of isotope in specific tissues, revealed three uptake sites: lung, gastrointestinal, and jaw tissue absorption. Once absorbed, high concentrations of dental amalgam Hg rapidly localize in kidneys and liver. Results are discussed in view of potential health consequences from long-term exposure to Hg from this dental material."

AUTHORS' CONCLUSION: "Our laboratory findings in this investigation are at variance with the anecdotal opinion of the dental profession, which claims that amalgam tooth fillings are safe."

THE AUTHORS: This research study was conducted by the Departments of Radiology, Medicine, and Medical Physiology of the University of Calgary, Faculty of Medicine, Calgary, Alberta, T2N 4N1, Canada. Murray J. Vimy, D.M.D., F.A.G.D., F.I.A.O.M.T. is the dental member of the team. The other investigators are M.D.s or Ph. D.s in medical research. Purely dental researchers know dentistry, but are not expert on medical or physiological considerations. This research team and the research facility are highly qualified to investigate and evaluate the dental, medical, and physiological aspects of the use of dental mercury amalgam fillings. The safety of dental mercury amalgam fillings should, and will, be determined by the cooperative efforts of experts in the various human health disciplines and not by dentists alone.

THE JOURNAL: The FASEB Journal is the Official Publication of the Federation of American Societies for Experimental Biology--The American Physiological Society - American Society For Biochemistry and Molecular Biology - American Society for Pharmacology and Experimental Therapeutics - American Association of Pathologists - American Institute of Nutrition - The American

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Association of Immunologists - The Society for Cell Biology. It consists of over 30,000 scientists in these human health investigative disciplines. It is a highly respected and esteemed organization that presents no bias on the issue of the safety of dental mercury amalgam fillings.

THE EXPERIMENTAL PROTOCOL: The sheep was selected as the experimental model for this study because it is an animal that closely approximates the human in its physiological function and response. In studies of the hard tissue of the teeth, such as the incorporation of fluoride into tooth enamel, sheep are not a good model because of differences in the mineral structure of the teeth themselves. But this was not a study of tooth enamel; it is a study of the fate and physiological effect of a dental filling material. For this purpose, sheep are a far better model than are hamsters, rats, mice, guinea pigs, or other commonly used animals.

The use of radioactively labelled mercury in the experimental fillings guarantees specificity and eliminates the need for control animals. Other possible sources of mercury such as food, air and water will not contain mercury that is radioactively labelled. Extreme measures were taken by the researchers to guarantee experimental accuracy.

Amalgam fillings were placed into 12 molar teeth of the experimental animal. The fillings were deliberately over-carved to a concave form to ensure that they would not wear excessively. Each filling contained approximately 425 milligrams of mercury which, according to literature reports cited by the authors, is about 50% of the mercury in an average molar amalgam filling in humans. The animal was then provided free access to water and fed fresh hay twice daily for 29 days, after which it was sacrificed and evaluated. During the 29 days post-chewing intra-oral mercury vapor measurements were periodically taken. These measurements closely approximated like measurements derived from human subjects in previously published studies. The fate of the dental amalgam mercury was determined by whole-body scanning and measurement of radioactive isotope in specific tissues.

The results of this study clearly demonstrate that "substantial quantities of Hg from amalgam will appear in various body tissues as early as 29 days after placement of amalgam fillings in teeth". The highest levels of mercury were found in kidney, feces, stomach, and liver. Substantial amounts were also found in the gum tissue, the alveolar bone surrounding the teeth, and the lining of the trachea. Even during this relatively short time Hg accumulation was also found in the heart tissue, the brain and several endocrine glands (pituitary, thyroid, adrenal, pancreas, and ovary). The levels of mercury found in the blood and urine were a great deal lower than levels found in most tissues.

In other studies on sheep performed by this research team run as long as 140 days, it was found that Hg from dental amalgam fillings will progressively accumulate in tissues and remain elevated with time. In humans, each dental amalgam filling remains in the tooth an average of 7-9 years and often much longer.

The authors pointed out that it has been scientifically established that mercury can cause autoimmune disorders and that this study established that dental amalgam fillings can be a major source of chronic exposure to mercury.

EDITORIAL

Previously published research has conclusively demonstrated that mercury is released from dental amalgam fillings and that the amount of mercury released is greatly increased by stressing the fillings with chewing or brushing. Several published human autopsy studies have found a direct correlation between the number of amalgam fillings present and the amount of mercury found in brain and kidney tissues.

This latest study clearly demonstrates that mercury from dental amalgam fillings transfers to numerous body tissues in a very short period of time. There can be no argument over the source of the mercury. It also establishes the entry routes into the body of the dental amalgam mercury. Besides the previously theorized lung inhalation and gastrointestinal absorption routes, this study also clearly identifies the tissues of the oral cavity as an entry route. Considering previously published research on the pathological effects of mercury on oral tissues, this finding adds significance to the consideration of mercury from dental amalgams as an additional factor in periodontal disease. Finally, this study further confirms the fact that measurements of mercury levels in blood and/or urine are not reflective of body burdens of mercury, particularly after exposure primarily to mercury vapor. This is significant and vital research, indeed.

As the authors of this study pointed out "Mercury (Hg) has been the major component of tooth filling

materials for the past 150 years and its use has met with continuing controversy, as clear evidence regarding its safety has not been demonstrated". It is a matter of record that the dental profession, until quite recently, has never even bothered to investigate potential health effects of mercury amalgam dental fillings. Opinions that this filling material is harmless when placed in human teeth are all based on evaluation of levels of mercury found in blood and/or urine, which are procedures well acknowledged to not be reflective of the body burden or toxic effects of mercury.

This landmark study represents a new quality of research on the potential health effects of mercury from dental amalgam fillings that has become apparent in recent years. The question is no longer being left to strictly dental investigators. Qualified investigators in other health disciplines have become involved. Moreover, publication in the FACEB Journal is significant. It means that a large number of health science experts will now become aware of the issue.

Three things are becoming increasingly clear. It is obvious that the controversy over the use of mercury amalgam dental fillings is no longer confined to the dental profession. Secondly, it is also becoming clear that the position of the dental profession that mercury amalgam dental fillings are totally harmless to human patients (unless they are allergic to mercury) is based on a dangerously insecure scientific foundation. All over the world scientists, physicians, government officials, environmentalists, and patients are discovering this uncomfortable situation. Thirdly, the patient must be advised when a toxic material is to be implanted in their teeth, the potential hazards of the material, the alternative materials available and be extended their constitutional right to freedom of choice and informed consent. The time has come for organized dentistry to seriously and honestly reevaluate its position.

In this regard, several state legislatures have been made aware of the potential toxicity of mercury amalgam dental fillings and the lack of dental patient freedom of choice and informed consent. The first to take some formal investigative action is the State of Illinois. The Eighty-Sixth General Assembly, Illinois House of Representatives recently adopted the following House Resolution No. 1084. Offered by Representative Cowlishaw:

> **WHEREAS**, It is a common dental practice in Illinois to use an amalgam of materials for dental fillings; and
> **WHEREAS**, This dental amalgam, thought by the public to be made only of silver, is actually 50% mercury; and
> **WHEREAS**, Studies have shown that toxic mercury vapors can leak from fillings into the blood system and cause serious health problems, particularly in persons with allergies or chemical sensitivities; and
> **WHEREAS**, Dental patients often lack information that would enable them to avoid having mercury used for their fillings; therefore be it
> **RESOLVED, BY THE HOUSE OF REPRESENTATIVES OF THE EIGHTY-SIXTH GENERAL ASSEMBLY OF THE STATE OF ILLINOIS**, that this body hereby requests that the Illinois Department of Public Health review the studies that have examined the health risks of mercury in dental fillings and report to the General Assembly by March 1, 1990, its findings about such risks as well as its recommendations for providing a means by which dental patients may be informed of the findings and of the alternatives to mercury content in fillings when seeking dental treatment; and be it further
> **RESOLVED**, That a copy of this preamble and resolution be presented to the Director of the Illinois Department of Public Health.
> Adopted by the House of Representatives on November 1, 1989. Signed Michael J. Madigan, Speaker of the House and John F. O'Brien, Clerk of the House.

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IS DENTISTRY POLLUTING THE ENVIRONMENT WITH MERCURY???

Recent articles in the ADA News (9 October 1989) and The Arizona Daily Star (16 October 1989) are sending shock waves through the dental community and drawing the interest of environmentalists and other citizens. The newspaper article was entitled "County Says Dentists are Dumping Excess Mercury"; the ADA response was "Arizona mercury decision 'misguided'".

Pima county (Tucson) Wastewater Management Department officials, working with the U.S. Environmental Protection Agency, have determined that dentists' offices are illegally dumping mercury into treated sewer water. Excess mercury was found in the Santa Cruz River, which is downstream from

the county's two sewer treatment plants, and officials traced the source to local dental offices. The county temporarily closed seven dental offices because of excessive mercury dumping.

The USEPA is ordering the county to keep mercury out of the Santa Cruz, which supports a large and complex array of plants and animals. Officials of the Arizona Game & Fish Department supported the county's action and pointed out the threat to wildlife caused by the mercury pollution.

Arizona Dental Society officials deny the allegations. According to the president of the Southern Arizona Dental Society: "There is mercury in the amalgam, but it's OK to put amalgam in your mouth and it's OK to put it in a landfill". Dental officials contend that free mercury is not available in amalgam once the metals are mixed together. [**BIO-PROBE COMMENT**: This is the very same 'mercury is locked-in the amalgam filling once it is placed in the teeth' explanation now conclusively disproved by numerous published scientific research studies.] Basing their position on this explanation, the dental officials maintain that the mercury pollution must be coming from other sources, not dental offices.

The Pima County Wastewater Management Department contradicted the dental officials. They routinely check all local users of mercury and found mercury only in the sewer lines of dental offices, but not in sewer lines of anyone else. A check of county records since 1985 supported the WMD position. Of the 73 mercury violations since 1985, dental offices violated the mercury limit 71 times and hospitals exceeded it twice.

These events in Arizona are supported by world-wide attention devoted to the environmental aspects of the use of mercury in dentistry. At least one dental school in Tokyo, Japan was temporarily closed for polluting waste water with mercury. In West Germany, attempts are underway to evaluate dentistry's contribution of mercury to waste water. Most importantly, the recent dramatic announcement of the intention to ban dental amalgam in Sweden was made by that country's Chemical Inspection Agency, which has the responsibility for environmental pollution.

DENTISTRY'S OBLIGATION TO THE ENVIRONMENT.

Obviously, dentistry has an obligation to the environment as well as the patient. It would be helpful to first understand the extent of the problem, which is two-fold: 1) New mercury added to the pool each year by the placement of new amalgam fillings; 2) The removal of existing amalgam fillings. Mercury amalgam fillings are removed for a variety of reasons and are replaced with new amalgam fillings, gold inlays, crowns, or composites.

According to U.S. government information on the amount of mercury used in dentistry each year and American Dental Association estimates of the number of dentists in the country, amalgam-using dentists use at least 2 pounds of mercury per year. Estimating that approximately 100,000 of the nation's 140,000 or so dentists use amalgam (excluding specialists and mercury-free general dentists), this adds about 200,000 pounds (100 tons) of new mercury to the pool annually. No figures are available as to how much of this is placed into teeth and how much of the excess mixed amalgam is discarded and disposed of. If only 10% (certainly a conservative estimate) of the mixed amalgam is thrown away or carved away from the top of the filling and washed down the drain, 20,000 pounds (10 tons) of mercury is immediately added to the environment annually in the United States in this manner. This leaves 180,000 pounds (90 tons) of mercury going into the teeth of U.S. citizens each year.

Since there is no data available on mercury disposal of removed amalgam fillings, we shall try to make reasonable and conservative estimates. All general practice dentists (non-specialist), whether or not they place mercury amalgam fillings, remove them. A reasonable and conservative estimate would be the removal of 5 amalgams per day. Dentists work at least 200 days per year, so each GP dentist removes at least 1000 amalgam fillings per year.

According to Craig's textbook on Dental Materials, each average sized amalgam filling contains 780 milligrams of mercury. Being as conservative as possible, we shall use the figure of 680 milligrams, which is 0.68 grams (1000 milligrams= 1 gram), for the amount of mercury in each removed amalgam. The amount of mercury in 1000 removed amalgam fillings would therefore be at least 680 grams, which is 0.68 kilograms (1000 grams= 1 kilogram). Since there are 2.2 pounds to a kilo, each GP dentist contributes at least 1.5 pounds of mercury (2.2 x 0.68) to the environment each year just from the removal of old mercury

amalgam fillings. Since these are very conservative estimates, the amount could be much more. So if a state has 1000 dentists, that is over 1500 pounds of mercury going into the environment each year in that state.

Where does it all go? Dentists drill out the old amalgams. The material is mixed with water and either vacuumed out of the mouth or spit into a sink. In either case, it goes out into the waste water. Dental offices have, or should have, traps in the lines to catch large particles of amalgam. These traps allow the water, and smaller particles of amalgam, to pass through. These traps will also allow the passage of free (elemental) mercury. The question of the stability of mercury within an amalgam mixture has already been settled. Mercury is not 'locked in' the amalgam. That has been repeatedly proven scientifically. Any number of forces will cause the release of mercury from mixed amalgam.

We at Bio-Probe are not experts on water treatment, but we did make an effort to learn what we could about the subject in a short period of time. We wish to express appreciation to Warren Clough (Ozark Water Analysis Co. Sulfur Springs, Arkansas. Tel: 800-835-8908) and Tim Robbins (Sears Home Improvement Dept. Orlando, Florida) for their prompt and willing cooperation in providing the following information. We will pass on to you additional information as it becomes available.

There are filters available that will remove small particles of amalgam and even elemental mercury from water. Carbon filters and ceramic filters will remove small particles, but not elemental mercury. They must be inserted into the plumbing and changed or cleaned on a regular basis. The only filters that will remove elemental mercury are reverse osmosis filters. Unfortunately, these filters are impractical for use in dental office waste systems. Only 25% of the water passes through the reverse osmosis filter to become decontaminated water. The remaining 75% is diverted to become waste water which still must be disposed of.

So none of these filters are practical solutions to the problem. Furthermore, none of these filters remove the mercury from the environment. They remove the mercury only from the waste water, so the problem of environmental contamination is not really solved; it is only diverted to another location.

Until better solutions are provided there are two approaches to minimizing dentistry's contribution to environmental mercury contamination.

1. 'Section' or 'dissect' the amalgam filling for removal. Most dentists simply drill away the old amalgam, which results in very fine particles mixed with water that easily pass through the traps. Sectioning entails using a small burr to cut the amalgam filling into pieces for easy removal. The sections will easily pop out of the tooth. Dissecting the amalgam filling out consists of using a small burr to cut away the circumference of the filling and popping out the entire filling. Both of these procedures minimize the amount of small particles of drilled amalgam that is mixed with water and provide large chunks of amalgam that are easily caught by existing traps. The traps should be emptied and cleaned regularly as it has now become obvious that water passing through the trapped amalgam particles will result in mercury leaching into the water.

2. Minimize or eliminate the amount of new mercury added to the pool each year by dentistry. Sweden is taking the dramatic approach by simply banning the use of amalgam altogether, based on environmental as well as patient health concerns. An argument can be made that this eliminates the 'freedom of choice' for those patients who elect to have mercury amalgam fillings on an informed basis. Does the patient's freedom of choice supercede concerns for the environment, or not?

Where do we go from here? It is obvious that the practicing dentist cannot totally avoid contaminating the environment with dental mercury at this time! Does the dental profession have an obligation to the environment, or not? If so, who in the dental profession bears the responsibility? Practicing dentists can stop adding to the pool of dental mercury by refusing to place new mercury amalgam fillings, but they cannot stop removing them.

Dental practice policies and procedures have always been determined by what is commonly called "organized dentistry". This consists of a coalition of the American Dental Association with its constituent state and local bodies, the state Boards of Dentistry, the dental schools, and governmental dental agencies. Since these groups determine and dictate dental policies and procedures, the responsibility for ensuring the safety of the environment (and the patient) rests on their shoulders.

Practicing dentists do not have the financial resources or the manpower to solve this problem. Organized

dentistry does. Steps should be taken immediately to find ways to protect the environment from dental mercury. If the dental profession does not willingly face its responsibility in this issue, it may soon find itself forced to do so, under extremely uncomfortable circumstances.

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ABSTRACTS

Johansson, A; Curstedt, T; Robertson, B; Camner, P.

Lung lesions after experimental combined exposure to nickel and trivalent chromium.

Environ Res. 50(1):103-19. Oct 1989.

Rabbits were exposed to a combination of 0.7 mg/m^3 of nickel (Ni^{2+}) as $NiCl_2$ and 1.2 mg/m^3 of chromium (Cr^{3+}) as $Cr(NO_3)^3$, to 0.6 mg/m^3 of Ni^{2+} as $NiCl_2$, or to filtered air for 4 months (5 days/week, 6 hr/day). Light microscopy of the lung tissue showed widespread areas with nodular accumulation of macrophages in all rabbits exposed to both metals, in two rabbits exposed to nickel alone, and in none of the controls. Pathology included attenuated septa, alveoli stuffed with surfactant-like material and densely packed debris, and obscure cell borders. The reaction in the group exposed to nickel alone was less prominent. Compared to controls, the volume density of alveolar type II cells showed a four-fold increase after exposure to both metals and a two-fold increase following exposure to nickel alone.

The authors concluded: "Our observations raise the concern that noxious effects might occur also in humans exposed to a combination of nickel and trivalent chromium".

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Glasscock, N. et al. (VAMC and UM, Ann Arbor, MI.)

Recorded changes in quality of crown & bridge restorations: 84 month report.

J Dent Res. 68(Spec. Issue):921. Abst. #439. June-July 1989.

Over 800 dental units distributed among four "alternative alloys" were evaluated at 1 month (baseline), 6 months, 12 months, 24, 36, 48, 72, and 84 months for 11 well defined criteria and for overall performance using a paired t-test. Three of the four dental alloys were nickel-chromium alloys (Ticon, Ceramalloy II, and Micro-Bond N/P2) and the fourth (W-1) was a palladium-silver alloy. Conclusions: 1) All alloys are deteriorating with prolonged clinical function for most criteria and overall performance - most statistically significantly; 2) clinically significant deterioration has been documented - for the first time - for several criteria and overall performance; and 3) Ceramalloy II has consistently performed worse than Ticon, Micro-Bond N/P2 and W-1.

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Wataha, JC; Craig, RG; Hanks, CT.

Analysis of culture medium for elements dissolved from casting alloys.

J Dent Res. 68(Spec. Issue):323. Abst. #1122. March 1989.

Atomic absorption spectroscopy was employed to detect metallic elements in cell culture medium in contact with 5 experimental dental casting alloys of known composition. It is accepted that dissolution of elements into interstitial fluid is needed to produce a cytotoxic reaction. Previous investigations had shown these alloys to be cytotoxic to Balb/c 3T3 cells. Most elements present in the casting alloys (including gold) were detected in the 3 day cell culture mediums. Concentrations for the different elements ranged from 100 ppb to 28 ppm. In no case was only a single element detected in the medium. The ratio of the concentration of an element in the cell culture medium to the atomic percent of the element in the alloy was found to range from 0.001 to 2.0 ppm/at %. It was concluded that most elements in these casting alloys dissolved to some extent into the cell culture medium, but that some elements, such as Cd (cadmium), Cu (copper), Ga (gallium), Ni (nickel), and Zn (zinc) dissolve preferentially to Au (gold), Ag (silver), and Pd (palladium).

*****

Vougiouklakis, G. et al. (U of Athens Faculty of Dentistry and NTU, Greece.)

Galvanic corrosion of prosthodontics alloys with high and low Ag content high Cu amalgams.

J Dent Res. 68(Spec. Issue):998. Abst. #1047. June-July 1989.

High copper amalgams with high or low silver contents do not contain the gamma 2 phase in contrast to the conventional amalgams. However, the presence in the oral cavity of various prosthodontics alloys can affect the corrosion process of the amalgams. The purpose of this in vitro investigation is to measure the galvanic corrosion of two amalgams combined in galvanic systems with three prosthodontics alloys. The amalgams used were one of high-Cu, high-Ag content (Tytin) and one of high-Cu, low-Ag content (ANA 2000). The prosthodontics alloys were one nickel-chromium base metal alloy (Ceramalloy II), one silver-palladium (Ney 76), and one gold-platinum alloy (Ney-Oro G3). A 1% NaCl solution at a constant temperature of 36 degrees Celsius (+ or - 1 degree) was used as the corrosion medium. The following methods were used: 1. Measurement of the potential of the galvanic cells amalgam/NaCl/NaCl/alloy. 2. Determination of the dissolution rates of Hg, Ag, Sn, and Cu up to 6 months of the systems amalgam/alloy by atomic absorption spectroscopy. 3. SEM examination of the corroded specimens. The potentials of the galvanic cells ranged from 10-140 millivolts. The total amounts of dissolved metals after 6 months were 1.15-3.00 mg/cm^2. According to the results of the present investigation we came to the conclusions that: a) The galvanic corrosion of amalgam A is in all the combinations the worst and b) for amalgam A the worst combination in regard to corrosion is with the silver-palladium prosthodontics alloy and for amalgam T were both with silver-palladium and nickel-chrome alloys.

BIO-PROBE COMMENT: In June of 1985 a research team at the University of Tennessee College of Dentistry published a study in the Journal of Prosthetic Dentistry [See Bio-Probe Newsletter 2(6):8. Sept 1985]. Fourteen dental casting alloys were analyzed for release of nickel and beryllium into acidic salivary solutions in vitro. The authors concluded that "nickel-beryllium dental casting alloys possess the potential to be a significant hazard to the laboratory technician, dentist, and patient". In 1987 another research team at the University of Michigan School of Dentistry and VA Medical Centers evaluated the use of base metal casting alloys in dentistry. They pointed out the hazards and advised the medico-legal need for "informed consent" if these alloys were to be used in patients. Their study was also published in the Journal of Prosthetic Dentistry [See Bio-Probe Newsletter 4(4):14. Sept 1987]. The current research presented in this newsletter emphasizes the previously determined hazards of the use of base metal alloys in dentistry. It has been estimated that 75-85% of the crown and bridge units now being placed are base metal alloys. Moreover, these alloys are routinely placed in oral cavities already containing numerous mercury amalgam fillings. The time has come for the dental profession to seriously consider the health effects of dental materials rather than solely their hardness and longevity!

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Guillermine G, Adriana TM, Monica EM.

The implication of renal glutathione levels in mercuric chloride nephrotoxicity.

Toxicology 58(2):187-195, Oct 2, 1989.

ABSTRACT

The effects of renal glutathione (GSH) depletion on renal injury following a single injection of mercuric chloride ($HgCl_2$) were evaluated in the rat. Animals were injected with different doses of $HgCl_2$ and the renal function were studied 1 hour later. Diethylmaleate (DEM) (4mmol/kg body wt, i.p.) induced a significant depletion of GSH by reducing renal GSH levels to 25% of control values. This effect lasted for 6 hours. $HgCl_2$-induced nephrotoxicity, as measured by fractional excretion of glucose, lithium, sodium, potassium and water was increased in rats treated with DEM. The time course of $HgCl_2$ nephrotoxicity was also investigated by determining the renal function of different times after $HgCl_2$ and $HgCl_2$ plus DEM injection. Renal impairment was significantly marked in rat depleted of GSH.

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Jaro Pleva, Ph.D.

Corrosion and mercury release from dental amalgam.

J Orthomolecular Med. 4(3):1-19, Third Quarter 1989.

ABSTRACT

Corrosion attacks on twenty-two dental amalgam restorations after in vivo service have been studied by Scanning Electron Microscopy together with the Energy Dispersive X-Ray Technique, and by optical

microscopy. From the measured depth and type of corrosion attack, estimates of released mercury amounts are made.

The amalgam fillings have been obtained from members of a group of 250 individuals, who suspected their health troubles potentially to be chronic mercury poisoning from amalgam and were to have all amalgam fillings removed. Three typical patient cases are presented.

Model calculations of released mercury, based on previously published measurements of corrosion currents with and without abrasion are also given.

The investigations show, that the long-term release of mercury from a few amalgam fillings will often reach or exceed the recommended limits for daily intake of mercury. Hence mercury from corroding amalgam fillings represents a potential health hazard. Danger of galvanic contact between amalgam and gold restorations is particularly emphasized. (BIO-PROBE will publish a more detailed review of Dr Pleva's work in the next issue of the Newsletter)

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FORUM

The International Academy of Oral Medicine and Toxicology (IAOMT) will hold it's winter regional scientific session and board meeting February 17 & 18, 1990 in Tucson, Arizona. The meeting will be at the Viscount Hotel, 4855 East Broadway, Tucson AZ 85711. (602) 745-6500, $99.00/night (single or double).. State you are with IAOMT meeting when making reservations, includes American breakfast buffet; transportation to and from the airport by Arizona Stage Coach van.. The subject of the Saturday February 17, 1990 scientific session will be Toxins in the Dental Office. The Board Meeting will be Sunday February 18, 1990, from 8:30 A.M. - 12:30 P.M. and non-board or Academy members are invited to sit in.

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International Symposium On The Environment, Occupational, and Patient Health Hazards of Mercury Amalgam (Silver) Fillings to be held Friday March 30, 1990 in Raleigh, North Carolina. The meeting will take place in the North Carolina Senate Auditorium. Michael Fleming, D.D.S. Moderator. Speakers are Mats Hanson Ph.D. Sweden; Sandra Denton, M.D., Alaska; David Kennedy, D.D.S., California; Michael F. Ziff, D.D.S., Florida; Hal Huggins, D.D.S., M.S., Colorado; Robert Reeves, J.D., Kentucky; Jim Pearce, Environmental Action Foundation, Washington D.C.; Doug Rader, Environmental Defense Fund, Washington D.C.. In addition representatives of the top ten environmental groups in the United States, National Health Federation, and CANAH will be in attendance. Write to Elizabeth Ridenour, 3F Fountain Manor, Greensboro, NC 27405 for invitation to attend. There is no charge to attend but because of seating considerations, attendance will be limited.

*****

The Holistic Dental Association will hold it's 1990 Annual Meeting March 30 & 31st, 1990 at the Hyatt Regency Hotel in Columbus, Ohio. Outstanding Clinical TMJ authorities in the United States will be sharing their clinically proven techniques for Successful TMJ Treatment. In addition there will be major workshops on Nutrition in Dentistry; Homeopathy in the Dental Practice and Dento-Cranial Therapy. Hyatt Regency Columbus, 350 North High Street, Columbus OH 43215, (614) 463-1234. Convention rate for attendees is $89.00 per room for one or more persons. To insure the $89.00 rate please book your rooms prior to March 8, 1990. For more information call (614) 366-3309 or write H.D.A., 974 North 21st St., Newark, OH 43055

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The American Academy of Biological Dentistry presents "Solutions for the alternative health care practitioner" by John Yiamouyiannis, Ph.D.. and "The physics of living system" by Douglas Leber, February 3-4, 1990 at the Carmel Mission Inn, Carmel, CA. For more information call (408) 659-5385 or (209) 838-3522, or write American Academy of Biological Dentistry, P.O. Box 856, Carmel Valley, CA 93924.

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Clinical Research Associates Newsletter ©

3707 NORTH CANYON ROAD, SUITE 6
PROVO, UTAH 84604
PHONE 801-226-2121

NOW IN THE 13TH YEAR OF PUBLICATION SERVING THE DENTAL PROFESSION

SUBJECT: CLASS 2 RESINS— *UPDATE REVIEW*

New optimism is developing in favor of Class 2 resin restorations. Clinical data compiled after many years on numerous brands of resin show performance comparable to the time honored silver amalgam restoration (J Dent Res Vol. 68 Mar. '89 Abs. #32, #33, #39, #706.). Purpose of this report is to update clinicians in following areas: (1) developments that have improved Class 2 resins; (2) comparison of Class 2 resin vs. silver amalgam clinical characteristics; (3) summary of CRA's clinical research on Class 2 resins; (4) Class 2 resin misconceptions; & (5) CRA conclusions.

1. DEVELOPMENTS THAT HAVE IMPROVED CLASS 2 RESINS:

A. Realization that resin is more difficult to manipulate & requires significantly more time & higher fee

B. Identification of contraindications for resin use such as patients with abusive occlusal habits (bruxing, clenching, & nervous grinding); large restorations >½ tooth's isthmus width; visible horizontal cracks.

C. Accessory products & techniques that maximize resin potential such as:

(1) Adhesives that attach resin to dentin.
(2) Dispensing that allows direct placement into cavity preparation (Example: Compula systems).
(3) Pigmented etching gels to assist precise placement & thorough removal.
(4) Placement instruments with special configurations & non-stick surfaces.
(5) Special finishing burs, diamonds, disks, & silicone polishers.
(6) Light initiated polymerization that allows operator control of set.
(7) Elimination of hand mixing base & catalyst that reduces air incorporated into resin.
(8) Resin curing lights with higher intensity output & larger diameter tips.
(9) Post-curing after finishing & use of longer curing times.
(10) Transparent matrices & wedges.

D. Formulation changes by manufacturers as clinical data became available.

E. Quantitative methods for measurement of wear & margin degredation (Lutz, Roulet, Lambrechts, Christensen & Bangerter, Douglas & DeLong) established that silver amalgam wore & allowed accurate comparison of resin & silver amalgam which eventually has lead to identification of resins with clinical performance very similar to silver amalgam.

2. COMPARISON OF CLASS 2 RESIN VS. SILVER AMALGAM CLINICAL CHARACTERISTICS:

	A PATIENT ACCEPTANCE	B EASE OF PLACEMENT	C TIME FOR PLACEMENT	D BOND TO DENTIN	E POST-OP SENSITIVITY	F RECURRENT CARIES	G COST TO PATIENT	H LONGEVITY	I ESTHETICS	J TOXICITY	K WEAR	SUMMARY OF SCORES
AMALGAM	5	8	8	* 1-8	8	7	9	8	1	1	8	52 - 69
RESIN	9	5	4	8	** 4-8	*** 6-7	5	**** 3-8	9	5	***** 4-8	62 - 76

KEY:
10 = EXCELLENT
1 = POOR

* Increased bond with Parkell Amalgam-bond.
** Lining with glass ionomer & use of current generation dentin adhesive decreases sensitivity.
*** Current studies show nearly equal caries involvement.
**** Current generation brands last longer than earlier materials.
***** Some brands discussed below have wear similar to silver amalgam.

Although Class 2 resins & silver amalgam have different clinical characteristics, chart above shows overall they are more similar than expected. Newest developments in silver amalgam are materials & methods to bond amalgam to tooth (Amalgambond by Parkell) & formulations that significantly reduce mercury content (Indisperse by Indisperse Industries Inc., & Heragam 48 by Kulzer). Newest developments in resin are use of current generation dentin adhesives to prevent post-operative hypersensitivity, use of smaller particle filler in higher concentrations to minimize wear, & slow release of fluoride over time (Heliomolar Radiopaque by Vivadent

3. SUMMARY OF CRA'S CLINICAL RESEARCH ON CLASS 2 RESINS:

Summary below is based on 21 brands of resin that have undergone 2-5 year clinical evaluation at CRA in 2, 3, & 4 surface restorations in molars & premolars (Adaptic, Adaptic II, AH-1, Bis-Fil I, Class II, Distalite, Estilux Posterior, Extra Smooth, Ful-fil, Heliomolar, Heliomolar Radiopaque, Herculite, Isomolar, Occlusin, P-30, P-50, Post-Core I, Profile, Spectra-Dent, Status & Zeon).

A. Wear— Highly filled microfills have least wear & wear at same rate as Dispersalloy & in similar areas (ie: Heliomolar Radiopaque). All types of hybrids undergo combination of degredation & occlusal wear (ie: Adaptic II, Bis-Fil I, Ful-fil, Herculite, Occlusin, P-30, P-50, Status, etc.). Wear data generated using computerized occlusal mapping of restoration replicas (J Dent Res 66:126 Mar. '87 Abs. #58

B. Margin Adaptation— Hybrids have best adaptation at resin-tooth interface, but occlusal surfaces degrade & wear over time (ie: Adaptic II, Bis-Fil I, Ful-fil, Herculite, Occlusin, P-30, P-50, Status, etc.). Microfills & ultra-small particle hybrids may develop small chips at margin in manner similar to silver amalgam (ie: Heliomolar Radiopaque & Herculite).

C. Proximal Contact— If contacts were well established at placement, they remained tight over time (all resins).

D. Post-operative Hypersensitivity— Use of Vitrabond (3M) glass ionomer liner on cavity floor & Scotchbond 2 (3M) dentin adhesive on all exposed dentin has virtually eliminated all hypersensitivity in Class 2 resin restorations in CRA clinical research. Other brands of similar liners & dentin adhesives may be expected to provide same results.

E. Recurrent Caries— Properly placed resin restorations should not have recurrent caries. Heliomolar Radiopaque releases fluoride, but anticaries effect needs documentation.

F. Surface Smoothness— Hybrids have grainy surface. Microfills can be finished very smooth initially, but can develop surface porosity on heavy occlusal contact areas.

G. Cavosurface Margin Discoloration— None of current generation Class 2 resins have this problem when acid etch & bonding agent are used.

H. Color Match— None of current generation Class 2 resins undergo yellow-orange discoloration typical of old autocure resins. When color mismatch was noted, it was either operator error or material was available only in one color.

Overall, Heliomolar Radiopaque restorations have shown least change over time. This material had similar characteristics to Dispersalloy silver amalgam control ie: restoration body & proximal surfaces showed almost no change over 3 years of clinical service; margins developed small chips shortly after placement; most wear occured on marginal ridges; & bulk fracture sometimes occured if restoration was very large.

4. MISCONCEPTIONS:

A. Misconception #1— Class 2 resins can be placed rapidly & easily.
Experience has shown that Class 2 resins require at least 1½ times as much time as amalgam to place & can be technically very challenging.

B. Misconception #2— Resin will not last in Class 2 areas.
Newest information based on several long term studies shows comparable life of resin & amalgam in Class 2 areas.

C. Misconception #3— Most resin wear occurs in first year & then tapers off.
Quantitative wear instruments have confirmed both resin & silver amalgam wear is generally linear.

D. Misconception #4— Resin is less toxic than silver amalgam.
Sufficient data are not yet available to confirm this belief one way or the other. Replacement of silver amalgam with Class 2 resin to correct alleged biocompatibility problems cannot be substantiated scientifically.

E. Misconception #5— New extraorally cured resin inlay/onlay systems are better than direct placement resins.
Clinical studies demonstrating differences in intra vs. extraoral curing have not been completed due to newness of extraoral curing concept. However, early CRA data (1 year) casts doubts on validity of this theory.

5. CRA CONCLUSIONS:

Class 2 resins are coming of age after 20 years of ups & downs. Compilation of many years of clinical research on numerous resin brand names from diverse research centers has revealed service record of adequately placed composites surprisingly similar to silver amalgam. Also newer accessories & techniques conceived to solve clinical problems have improved resin performance. Today, biggest variables are operator's technical expertise & appropriate patient selection. Most important criteria for clinician in selection of resin brand name are. (1) ease of placement & finishing; (2) wear characteristics; & (3) strength characteristics. Popular brands that so far have proven themselves clinically are:

A. Heliomolar Radiopaque. (microfill with fluoride release) This material has had least wear of all 21 resins tested by CRA.

B. Herculite XR. (ultra-small particle hybrid) Has about twice as much wear as Heliomolar Radiopaque, but easier to handle.

C. Ful-fil. (small particle hybrid) Has about same wear as Herculite, but easiest of 3 to handle.

Several other materials appear promising but need more research to confirm clinical longevity Bis-Fil I, P-50, Prisma APH).

SUBJECT: RESIN CEMENTS

Resin cements are very similar to resin restorative materials, but contain less filler to obtain lower viscosity for ease in seating. Decrease in filler content increases wear or degredation. However, resin cement is now used extensively for: (1) bonding veneers; (2) bonding ceramic or resin inlays & onlays. (3) luting or bonding metal or porcelain-metal restorations & fixed prostheses; (4) bonding metal "Maryland" bridge, etc. Information below gives status report on important clinical considerations:

DR. MURRY J. VIMY, D.M.D.
WORLD HEALTH ORGANIZATION CONSULTANT
ABSTRACT OF
VITAL NEW MERCURY AMALGAM RESEARCH

DR. MURRY J. VIMY, D.M.D., FROM THE UNIVERSITY OF CALGARY IN ALBERTA, CANADA, and research scientists, F.L. Lorscheider, Y. Takahashi, L.J. Hahn, and R. Kloiber, have been conducting studies at the Departments of Medicine, Radiology and Medical Physiology at the University of Calgary. Initial results were presented at the 32nd Annual Meeting of the Canadian Federation of Biological Societies on 14-17 June 1989 and the Second Meeting of the International Society for Trace Element Research in Humans on Aug. 28 - Sept. 1, 1989

Dental Amalgams were placed in 12 molar teeth of 5 pregnant sheep on the 112th day (2nd trimester). Radioactive isotope was injected to detect the Hg. This allows specific identification of the mercury source, preventing possible misidentification with mercury from other potential sources. The fetuses received catheter implants. Radioactivity measurements were utilized to determine the presence and quantity of mercury from the dental amalgam fillings (in the mothers) in various body tissues of the mothers and fetuses. As early as 3 days following placement of the amalgam fillings in the mothers, mercury accumulation was evident in maternal blood and fetal blood, amniotic fluid, and maternal urine and feces. By 16 days after amalgam placement maternal mercury levels were highest in kidney, liver, G.I. tract, and thyroid. The mercury levels in the fetuses were highest in the pituitary gland, liver, kidney, and placental cotyledon (a portion of the placenta). At 33 days after amalgam placement (birthtime) most fetal tissues had higher levels of mercury than did the maternal tissues. Specifically, the fetal levels were higher in the liver, epiphysial bone (the ends of long bones in arms and legs), bile, bone marrow, blood, and brain. During lactation, there was 8 times more mercury in the milk of the mothers than in their blood serum. With amalgams in place for 73 days the mercury tissue levels in mothers continued to rise in kidneys, liver, parotid glands, lungs, G.I. tract, adrenal glands, pancreas, pituitary glands, urine, bile, brain, and thyroid glands.
The researchers concluded that mercury vapor released from dental amalgam fillings is readily absorbed in lung, gastrointestinal tract and jaw bone and progressively accumulates in maternal and fetal tissues with exposure duration Neonatal mercury exposure (after birth) from this dental material occurs via milk. Results indicate that dental amalgam is most probably the major source of chronic mercury exposure in humans.

Dental "silver" tooth fillings: a source of mercury exposure revealed by whole-body image scan and tissue analysis

LESZEK J. HAHN, REINHARD KLOIBER, MURRAY J. VIMY,* YOSHIMI TAKAHASHI,† AND FRITZ L. LORSCHEIDER†,1

*Departments of Radiology, *Medicine, and †Medical Physiology, University of Calgary, Faculty of Medicine, Calgary, Alberta, T2N 4N1, Canada*

ABSTRACT

Mercury (Hg) vapor is released from dental "silver" tooth fillings into human mouth air after chewing, but its possible uptake routes and distribution among body tissues are unknown. This investigation demonstrates that when radioactive ^{203}Hg is mixed with dental Hg/silver fillings (amalgam) and placed in teeth of adult sheep, the isotope will appear in various organs and tissues within 29 days. Evidence of Hg uptake, as determined by whole-body scanning and measurement of isotope in specific tissues, revealed three uptake sites: lung, gastrointestinal, and jaw tissue absorption. Once absorbed, high concentrations of dental amalgam Hg rapidly localize in kidneys and liver. Results are discussed in view of potential health consequences from long-term exposure to Hg from this dental material. — HAHN, L. J.; KLOIBER, R.; VIMY, M. J.; TAKAHASHI, Y.; LORSCHEIDER, F. L. Dental "silver" tooth fillings: a source of mercury exposure revealed by whole-body image scan and tissue analysis. *FASEB J.* 3: 2641-2646; 1989.

Key Words: dental amalgam • mercury • tooth fillings • mercury vapor • mercury exposure

MERCURY (HG) HAS BEEN THE major component of tooth filling materials for the past 150 years (1) and its use has met with continuing controversy, as clear experimental evidence regarding its safety has not been demonstrated (2). Dental "silver" tooth fillings typically have a weight composition that is approximately 50% pure elemental Hg, 35% silver, 13% tin, 2% copper, and a trace amount of zinc when mixed as an amalgam (3). A newly placed multisurface dental silver filling involving an occlusal (grinding) surface of a molar tooth contains between 750-1000 mg of Hg and has an average serviceable life span in the human mouth of 7-9 years (4, 5). Approximately 80% of all tooth restorations employ this Hg/silver dental amalgam (6).

The traditional view in dentistry maintains that the Hg component of dental amalgam becomes inert once the fillings have been allowed to set for several days, and that long-term danger to the patient from Hg vapor is therefore remote (7). However, more recent clinical studies in subjects with amalgam fillings who chewed gum for 10 min have demonstrated that quite substantial amounts of Hg vapor are released into intra-oral air from dental amalgam, being sixfold higher than pre-chewing levels (8). The intra-oral Hg vapor concentration remained elevated during 30 min of continuous gum chewing; and after cessation of chewing, the mouth Hg vapor concentration declined slowly to pre-chewing levels over a period of 90 min (9). Control subjects with no amalgams had insignificant intra-oral air Hg vapor levels that did not change as a function of chewing (8). Brushing the teeth with commercial toothpaste will also stimulate the release of Hg vapor from amalgam surfaces (10). Although a positive correlation has been demonstrated between the number of dental amalgams and the levels of Hg vapor in the mouth (8, 9), it remains uncertain how much of this Hg is absorbed into body tissues. A current review, addressing whether Hg usage in dentistry constitutes a potential public health hazard, has concluded that further experimental evidence is needed, particularly regarding the metabolic fate of Hg vapor (2). The objective of this investigation was to determine possible sites of uptake and patterns of tissue distribution for Hg released from in situ dental amalgams. Qualitative information by whole-body scanning and quantitative tissue measurements by scintillation detection were determined using radioactive ^{203}Hg in a sheep experimental model.

[1]To whom correspondence should be addressed, at: Department of Medical Physiology, Faculty of Medicine, Health Sciences Centre, University of Calgary, 3330 Hospital Dr. N.W., Calgary, Alberta T2N 4N1, Canada.

0892-6638/89/0003-2641/$01.50. © FASEB

METHODS

In the present study a 4-year-old ewe that weighed 61 kg was anesthetized with halothane administered through an endotracheal tube fitted to a Narkovet-2 gas anesthetic machine. Dental surgery was performed with the preparation and placement of occlusal amalgam fillings according to standard procedure (11) into 12 molar teeth (3 molars on each side of the upper and lower jaws). This particular number of teeth was chosen because previous attempts to estimate the daily dose of Hg and body burden in humans had focused on subjects having 12 or more teeth with occlusal amalgam fillings (9, 12). The amalgam mass placed in each finished molar tooth of this ewe was approximately 850 mg, of which 50% was elemental Hg. Figure 1 shows the placement of nonradioactive dental amalgam fillings in teeth of a sheep from a preliminary study with a lateral view of the skull (*A*), an occlusal view of amalgam restorations in the right lower jaw (*B*), and radiograph images of the upper and lower right jaws before (*C*) and after (*D*) amalgam placement. Before mixing the amalgam, 7.5 mCi of radioactive ^{203}Hg (New England Nuclear, Boston, Mass.), which had a specific activity of 12 mCi/g, was diluted 11-fold with nonradioactive Hg. At the conclusion of the dental surgery, the oral cavity was flushed with H_2O and rinsed several times by vacuum aspiration to remove any amalgam particle trimmings.

After surgery the ewe was provided free access to water and fed fresh hay twice daily for 29 days. During the course of the study intra-oral Hg vapor measurements were taken intermittently after chewing as previously described (8). On day 29, the animal was killed with sodium pentobarbital/saturated KCl. The tooth structure above the gum line containing the entire amalgam filling was individually sectioned and removed intact from each of the 12 molars to reduce the high background from ^{203}Hg remaining in the fillings. The animal was then imaged using a Technicare Omega-500 large-field-of-view gamma camera equipped with a medium energy collimator (13, 14). An image of the sheep was obtained in the right lateral projection, using the 279 ± 28 KeV gamma rays of ^{203}Hg. In addition, transmission images were obtained using a flat 30-cm diameter ^{57}Co source that outlined the contour of the sheep's body. A posterior projection image was repeated after removal of the gastrointestinal tract. Tissue and fluid specimens were weighed at autopsy and analyzed for radioactivity. Isotope measurements were taken for

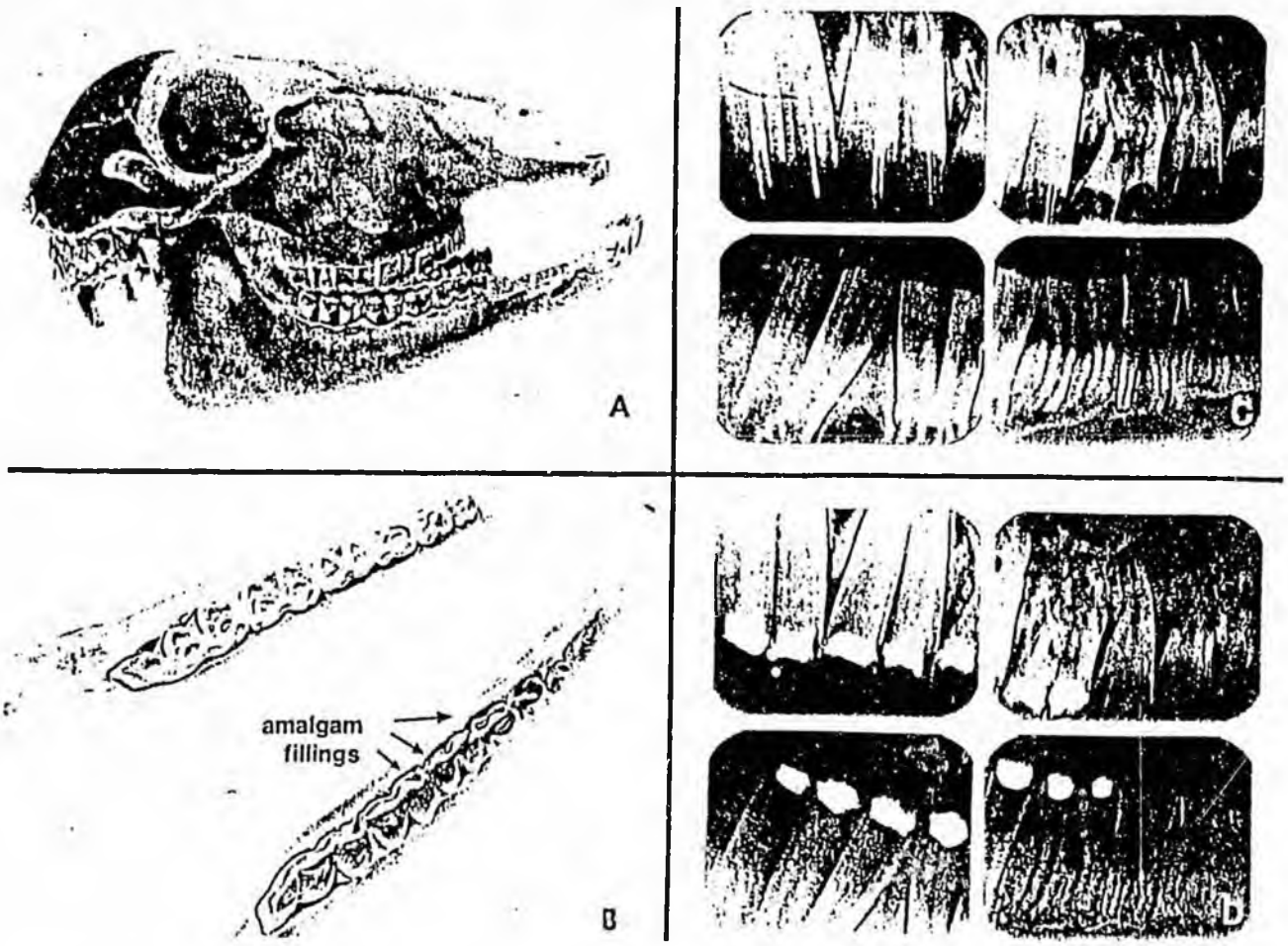

Figure 1. Placement of dental amalgam fillings in sheep teeth: *A*) lateral view of sheep skull; *B*) occlusal view of sheep mandible showing occlusal amalgam restorations in the mandibular right quadrant; *C*) periapical radiographs of the upper and lower right quadrants before amalgam placement; *D*) periapical radiographs of the upper and lower right quadrants after amalgam placement. The x-ray views indicate that anchorage of these fillings has been achieved with appropriate undercuts.

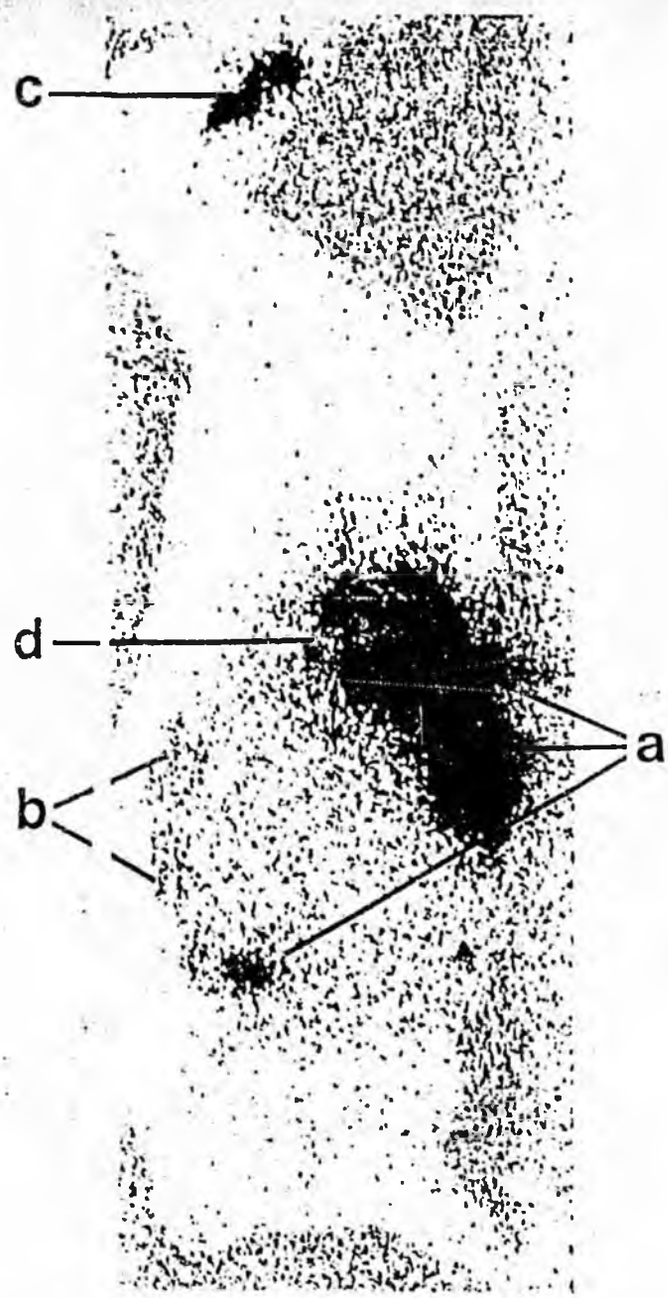

Figure 2. Right lateral image of amalgam ^{203}Hg distribution in the intact sheep, after removal of the dental amalgams, with superimposed transmission scan showing the body contour. The greatest concentrations of ^{203}Hg are in the gastrointestinal tract (*a*), kidneys (*b*), and in the gum and alveolar bone of the jaws (*c*). Liver activity (*d*) is obscured by large quantities of Hg in the gut on this image.

10 min per specimen (approximately 2% SD counting error) or 100 min per specimen for tissues with low counts (<10% SD counting error) in a Picker gamma well-counter calibrated to an energy range window of 249–309 KeV. Background counts +15% were set automatically for subtraction after a blank reading was taken for 100 min. This instrument subtraction level was sufficiently high so that no net counts were detectable during a repeat 100-min background measurement. At an 80% instrument counting efficiency, 1 μCi equals 1,776,000 cpm. Data, initially expressed as net radioactive cpm, were corrected for the physical half-life (47 days) of ^{203}Hg decayed to 29 days (65% remaining), for the specific activity of ^{203}Hg (83,300 ng/μCi), and for the dilution of ^{203}Hg with nonradioactive Hg (11-fold). The final calculation represented the total amalgam Hg (ng) per g (wet wt) of tissue or fluid as follows: (cpm/65%) × (83,300 ng/μCi × 11)/1,776,000 cpm/μCi/g.

RESULTS

Figure 2 demonstrates the ^{203}Hg distribution from amalgam within the body of the sheep as viewed from the right side. The transmission image obtained without moving the animal is superimposed to facilitate orientation. Primary sites of Hg concentration are in the abdominal cavity, specifically in the gastrointestinal tract, liver, and kidneys. A second major site is in the upper and lower jaws, even though the tooth structure containing the radioactive amalgam has been removed in its entirety.

Figure 3 is the posterior image of ^{203}Hg distribution from amalgam in the sheep's abdomen after removal of the gastrointestinal tract. The left kidney is clearly identified. The larger area of activity on the right side of the animal represents the liver and the right kidney, from which some tissue had been removed for well-counting.

Table 1 lists the total concentration of amalgam Hg in various tissues at autopsy 29 days after placement of dental amalgam fillings. Whole blood and urine contained 9.0 and 4.7 ng Hg/g, respectively. Muscle concentration of Hg was similar to blood, but concentration in fat remained low. In the oral/nasal tissues, Hg was concentrated primarily in gum mucosa (323 ng/g) and tooth alveolar bone (318 ng/g). In the gastrointestinal tract the washed stomach lining (929 ng/g) and

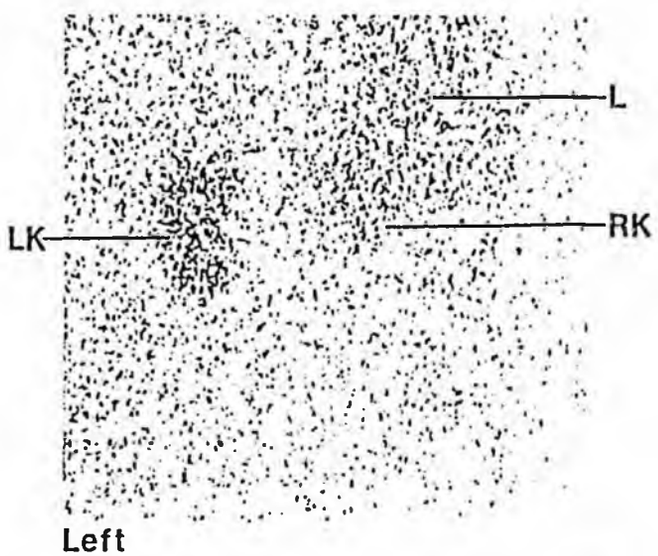

Figure 3. Posterior image of amalgam ^{203}Hg distribution in the abdomen after removal of the gastrointestinal tract which demonstrates Hg within the kidneys and liver. The left kidney (LK) is clearly identified. The large area of Hg deposition on the right side of the animal represents a combination of liver (L) and right kidney (RK). Some tissue had been removed from the right kidney, which had been mobilized and placed further from the detector, explaining the lower intensity compared with the left.

TABLE 1. Concentration of amalgam Hg in sheep tissues 29 days after placement of dental amalgam fillings

Tissue	ng Hg/g
Whole blood	9.0
Urine	4.7
Skeletal muscle (gluteus)	10.1
Fat (mesentery)	0.9
Cortical maxillary bone	3.6
Tooth alveolar bone	318.2
Gum mucosa	323.7
Mouth papilla	19.7
Tongue	13.0
Parotid gland	7.8
Ethmoturbinal (nasal) bone	10.7
Stomach	929.0
Small intestine	28.0
Large intestine	63.1
Colon	43.1
Bile	19.3
Feces	4489.3
Heart muscle (ventricle)	13.1
Lung	30.8
Tracheal lining	121.8
Kidney	7438.0
Liver	772.1
Spleen	48.3
Frontal cortex	18.9
Occipital cortex	3.5
Thalamus	14.9
Cerebrospinal fluid	2.3
Pituitary gland	44.4
Thyroid	44.2
Adrenal	37.8
Pancreas	45.7
Ovary	26.7

feces (4489 ng/g) contained the most Hg, although Hg concentration in other washed intestinal tract tissues was three- to sixfold higher than in blood, and bile concentration was more than twice that of blood. Heart muscle contained Hg levels that were similar to skeletal muscle. However, lung concentration of Hg (30 ng/g) was threefold higher than blood, and tracheal lining was much higher at 121 ng/g. Abdominal organs demonstrating the greatest concentration of Hg were kidney (7438 ng/g) and liver (772 ng/g). Spleen contained 48 ng Hg/g, which was fivefold higher than blood content. In the central nervous system the brain frontal cortex and thalamus concentrations of Hg were higher than in either blood or cerebrospinal fluid. Endocrine gland concentrations of Hg were three- to fivefold higher than blood. There is not a direct correlation between the intensity of Hg-203 localization on the whole-body scan and absolute radioactivity counts in autopsied tissues because of attenuation and geometry factors that affect the image.

DISCUSSION

The results of this study clearly demonstrate that substantial quantities of Hg from amalgam will appear in various body tissues as early as 29 days after placement of amalgam fillings in teeth. This Hg can be readily visualized by scintigraphy and can be easily quantified by analysis of tissue radioactivity. The experimental design of this in vivo isotope study has the advantage that all of the Hg measured originates only from dental amalgam and cannot be attributed to food, water, or background environmental sources.

Our findings indicate at least three principal sites for absorption of Hg from amalgam. First, the lungs absorbed Hg as did the cilia lining the trachea because of continual breathing of intra-oral air that had a Hg vapor concentration ranging from 19–50 $\mu g/m^3$ throughout this study. In humans, approximately 80% of inhaled elemental Hg vapor is absorbed into blood and becomes available for tissue retention (15). Second, the gastrointestinal tract contained a large amount of Hg likely due to mixing of intra-oral Hg vapor, amalgam microparticles, and dissolved mercuric ions with saliva and food before swallowing. About 10% of the elemental Hg in the human gastrointestinal tract can be absorbed into blood (16). Even though the efficiency of Hg absorption in the gut is low, large amounts of Hg in feces seen in the present study may signify a substantial pathway for uptake of Hg in its elemental or vapor forms. Amalgam microparticles containing Hg would not likely be susceptible to gut absorption. Third, some tissues in the jaw such as gum mucosa and the tooth root and surrounding bone also absorbed Hg. The Hg absorbed into the jaw could be transported from bone marrow directly into blood by venous routes radiographically demonstrated for human circulation (17). The highly vascularized oral mucosa may likewise afford a route for some Hg vapor transport directly into the systemic circulation.

We are confident that the Hg uptake observed in this animal was not the result of procedural contamination during dental surgery because serial blood measurements taken for 24 h after surgery had no measurable radioactivity. This indicates that the endotracheal tube prevented inhalation of Hg vapor. Any amalgam particles not removed from the mouth by surgical rinsing would have passed through the gastrointestinal tract well before 29 days when the imaging was performed.

After the Hg released from dental amalgam is absorbed into blood, the two principal target organs of rapid accumulation are kidney and liver. Based on organ weights for kidneys (250 g) and liver (1000 g) in the adult ewe, the total Hg concentrated in the kidney in this animal was 1.86 mg, and in the liver it was 0.77 mg, after only 29 days. Even during this relatively short time, the brain and several endocrine glands (pituitary, thyroid, adrenal, pancreas, and ovary) also showed evidence of Hg accumulation from the dental amalgams.

Since Hg/silver fillings remain in human teeth for 8-10 years, this would allow an extended opportunity for body tissues to be continuously exposed to Hg. Other investigators have recently reported that Hg concentrations in autopsied human brain and kidney are significantly higher in those subjects with dental amalgams than in subjects with no amalgams (18).

Each molar tooth of this sheep contained approximately 425 mg Hg, only one-half the amount of Hg used in the average human occlusally involved molar filling. In humans, occlusally involved Hg/silver dental fillings frequently encompass additional tooth surfaces such as buccal, lingual, mesial, and distal aspects. Thus, such complex human tooth restorations have a greater surface area exposed to grinding forces from which Hg may vaporize. This is in contrast to occlusal restorations in this sheep that are limited only to the occlusal surface and are totally supported circumferentially by solid tooth structure. The natural ovine molar is multiridged for forage grinding. Technical reproduction of these ridges to their original exact functional occlusal level in the amalgam fillings was not possible. Therefore, the restorations were purposely overcarved, which created a concave occlusal surface, ensuring that the amalgams would not be functionally too high and thus subject to abnormally rapid wear. None of the Hg/silver fillings were lost from the mouth during the course of this study.

We believe the sheep is a suitable experimental model for the purpose of our investigations because it exhibits molar chewing mechanics that are similar to those of humans. Moreover, intra-oral air Hg vapor levels in the sheep are very similar to those reported in humans with the same number of amalgams (9). Although sheep may chew more than the average human does, it is likely that humans who are chronic gum chewers or who exhibit bruxism (chronic grinding of teeth) would have daily periods of chewing that are comparable to sheep fed two meals per day. The sheep body weight also compares favorably with humans, and the sheep is the most widely used obstetrical model in research today.

In other studies of sheep that were not imaged (19), we have established that Hg vaporized from dental amalgam fillings will progressively accumulate in both maternal and fetal tissues as a function of time, and tissue Hg levels will remain elevated in experiments run for as long as 140 days. Exposure of newborn lambs to milk suckled from ewes with dental amalgams results in Hg uptake into tissues of the young.

In North America 5.4% of the population display contact hypersensitivity to Hg (20). The pathogenesis of a variety of immediate or delayed Hg-induced hypersensitivity responses by the immune system resulting in glomerulonephritis has been postulated (21). Experimental evidence supports this contention because Hg is capable of inducing autoreactive T lymphocytes and specific autoantibodies resulting in Hg-induced autoimmunity (22, 23), indicating a potential for Hg to precipitate antibody-mediated tissue injury and autoimmune disease. The kidney and endocrine glands are known sites of autoimmune disorders, which brings into question the long-term implications of Hg concentration in these tissues from dental amalgams as demonstrated by the present study.

Our laboratory findings in this investigation are at variance with the anecdotal opinion of the dental profession, which claims that amalgam tooth fillings are safe. Experimental evidence in support of amalgam safety is at best tenuous (2). From our results we conclude that dental amalgams can be a major source of chronic Hg exposure. As it has been estimated that in North America 100,000 kg of Hg are used each year in dentistry (7), continuing research in this area is essential and may have an effect on public health. FJ

The authors thank J. E. Fewell, Director of the Reproductive Medicine Research Group, and the Christie Unit for the Study of Human Reproduction, for providing facilities and assistance with materials to conduct this investigation. Nuclear medicine facilities were kindly supplied by the Foothills Provincial Hospital Department of Nuclear Medicine, Calgary. Partial support was provided by a grant from the International Academy of Oral Medicine and Toxicology. The authors are also grateful to S. Naatz and M. Satchwell for their assistance with the dental surgery, S. Kelly for assistance with animal management, and C. McKay and K. Wise for assistance with the nuclear medicine imaging procedures.

REFERENCES

1. American Academy of Dental Science (1876) *History of Dental and Oral Science in America,* Samuel S. White Publ., Philadelphia
2. Enwonwu, C. O. (1987) Potential health hazard of the use of mercury in dentistry: critical review of the literature. *Environ. Res.* 42, 257-274
3. Skinner, E. W., and Phillips, R. W. (1969) Dental amalgam alloys. Metallography of amalgam. (Chapt. 20, p. 303); Dental amalgam: technical considerations (Chapt. 22, p. 332) In *The Science of Dental Materials,* 6th Ed. W. B. Saunders Co., Philadelphia
4. Paterson, N. (1984) The longevity of restorations. *Br. Dent. J.* 157, 23-25
5. Phillips, R. W., Hamilton, A. L., Jendresen, M. D., McHorris, W. H., and Schallhorn, R. G. (1986) Report of committee on scientific investigation of the American Academy of Restorative Dentistry. *J. Prosthet. Dent.* 55, 736-772
6. Bauer, J. G., and First, H. A. (1982) The toxicity of mercury in dental amalgam. *Calif. Dent. Assoc. J.* 10, 47-61
7. Rupp, N. W., and Paffenbarger, G. O. (1971) Significance to health of mercury used in dentistry: a review. *J. Am. Dent. Assoc.* 82, 1401-1407
8. Vimy, M. J., and Lorscheider, F. L. (1985) Intra-oral air mercury released from dental amalgam. *J. Dent. Res.* 64, 1069-1071
9. Vimy, M. J., and Lorscheider, F. L. (1985) Serial measurements of intra-oral air mercury: estimation of daily dose from dental amalgam. *J. Dent. Res.* 64, 1072-1075
10. Patterson, J. E., Weissberg, B., and Dennison, P. J. (1985) Mercury in human breath from dental amalgam. *Bull. Environ. Contam. Toxicol.* 34, 459-468
11. Hampson, E. L. (1980) Amalgam restorations. In *Textbook of Operative Dentistry,* 4th Ed., pp. 39-63, Wm. Heineman Medical Books Ltd., London
12. Vimy, M. J., Luft, A. J., and Lorscheider, F. L. (1986) Estimation of mercury body burden from dental amalgam: computer simulation of a metabolic compartmental model. *J. Dent. Res.* 65, 1415-1419
13. Anger, H. O. (1967) Radioisotope cameras. In *Instrumentation in Nuclear Medicine* (Hine, G. J., ed) Vol. I, pp. 485-552, Academic Press, New York

14. Sorenson, J. A., and Phelps, M. E. (1987) The Anger camera: basic principles. In *Physics in Nuclear Medicine*, 2nd Ed., pp. 298–317, Grune & Stratton Inc., Orlando, Florida
15. Nielsen-Kudsk, F. (1965) Absorption of mercury vapor from the respiratory tract in man. *Acta Pharmacol. Toxicol.* 23, 250–262
16. Task Group on Metal Accumulation (1973) Accumulation of toxic metals with specific reference to their absorption, excretion and biological half-times. *Environ. Physiol. Biochem.* 3, 65–107
17. Stortebecker, P. (1967) Dental significance of pathways for dissemination from infectious foci. *J. Can. Dent. Assoc.* 33, 301–311
18. Nylander, M., Friberg, L., and Lind, B. (1987) Mercury concentrations in the human brain and kidneys in relation to exposure from dental amalgam fillings. *Swed. Dent. J.* 11, 179–187
19. Vimy, M. J., Takahashi, Y., and Lorscheider, F. L. (1990) Maternal-fetal distribution of mercury (^{203}Hg) released from dental amalgam fillings. *Am. J. Physiol.* In press.
20. North American Contact Dermatitis Group (1973) Epidemiology of contact dermatitis in North America: 1972. *Arch. Dermatol.* 108, 537–540
21. Druet, P., Bernard, A., Hirsch, F., Weening, J. J., Gengoux, P., Mahieu, P., and Berkeland, S. (1982) Immunologically mediated glomerulonephritis induced by heavy metals. *Arch. Toxicol.* 50, 187–194
22. Hirsch, F., Kuhn, J., Ventura, M., Vial, M-C., Fournie, G., and Druet, P. (1986) Autoimmunity induced by $HgCl_2$ in Brown-Norway rats. I. Production of monoclonal antibodies. *J. Immunol.* 136, 3272–3276
23. Pelletier, L., Pasquier, R., Hirsch, F., Sapin, C., and Druet, P. (1986) Autoreactive T cells in mercury-induced autoimmune disease: in vitro demonstration. *J. Immunol.* 137, 2548–2554

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BIO-PROBE NEWSLETTER

Volume 5 March 1989 Issue 2

SWEDISH PARLIAMENT HAS STATED THAT THE USE OF AMALGAM WILL BE DISCONTINUED AS SOON AS A SUITABLE REPLACEMENT IS AVAILABLE.

This statement by the Parliament is in addition to an existing prohibition on the use of amalgam during pregnancy. Further it appears that this prohibition will be extended to children in the near future. The Third Amalgam War may continue on for a while yet in Sweden before there is complete surrender but the major battles are being won by the anti-amalgam patients, scientists, medical doctors and dentists.

The Swedish Parliament has further stated that funding for research on the health effects of amalgam will be made available. To this end, Dr. Lars Friberg has submitted research proposals calling for the allocation of a total of 16 million Swedish Crowns over the next four years. Dr. Friberg's research proposals will investigate and evaluate, among other things, the release and uptake of mercury vapor from amalgam; its effect on the immune system; the impact on neurological function of the CNS; and effects on reproduction.

The Swedish Medical Research Council has approved initial funding of one million Crowns for work to begin. A previously approved project of the Medical Research Council, the writing of a booklet addressing the amalgam controversy, has been completed. The leading Swedish authorities on both sides of the issue participated in providing their views to the author. Bio-Probe understands that the conclusions to be drawn from this effort appear to weigh heavily in favor of the anti-amalgam position. The booklet, some 70 plus pages in length is being distributed to libraries and schools and being made available throughout Sweden so that everyone from children on up will be able to read the facts about the amalgam issue and draw their own conclusions. Something sorely needed in this country.

It is interesting to note, that the study by Dr. Mats Hanson that follows was done in 1985. A tremendous amount of progress in exposing the true facts has certainly transpired since that date. We feel that when this page in history is written, the whole world will owe a debt of gratitude to Dr. Hanson and his dental patient organization and the political pressure that they brought to bear on the issue. We will also be indebted to those wonderful scientist researchers, all over the world, who

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have and are continuing to provide the scientific validation of the unsuitability and toxicity of amalgam as a dental material. Soon the results and findings of new experiments will be providing additional scientific data further demonstrating the potentially devastating health effects of mercury released from amalgam dental fillings. These new studies could be the coup-de-gras to the pro-amalgamists.

In our last issue, we talked of the major research effort underway at the University of Calgary in Canada, investigating the release and uptake of mercury from amalgam dental fillings. I am still not at liberty to disclose any of the findings but let it suffice to say, that the initial experiments have produced enough scientific data to complete three articles that have been submitted for publication. I am also happy to report that the International Academy of Oral Medicine and Toxicology has provided a total of $13,000 funding to the University of Calgary in support of this particular research project. The same is true for the Foundation For Toxic Free Dentistry which has just made a contribution of $2000 to the University of Calgary for this same project.

In Sweden, Dr.Magnus Nylander has completed work on another project showing the relationship of amalgam fillings to the mercury content of the pituitary gland. Again, we are not at liberty to disclose any further data because it has been submitted for publication.

When published, these papers will be another step in the process of leaving the establishment twisting slowly in the breeze, all alone with their "experts". The same can be said for the National Council Against Health Fraud spokesmen such as John Dodes and William Jarvis who have publically stated that any dentist who considers mercury amalgam dental fillings to be a health hazard is a fraud or a quack. What we find especially interesting in this regard is that more and more attorneys are requesting scientific data on the mercury issue. Remember, all we need is one successful court case and the ball game is over. Before the amalgam story is completed, it will take an act of Congress to save the pro-amalgamists who have so willfully ignored the preponderance of scientific data that has been published since 1984. Will we ever know how many millions of innocent victims of mercury toxicity there are because they listened to the unconscionable and negligent misrepresentations of the establishment experts on the "safety" of amalgam?

An abstract of a scientific study completed at the University of Iowa and published in the March 1989 issue of the Journal of Dental Research adds additional refutation of the pro-amalgam position that essentially claims that amalgams make no contribution to blood mercury levels. The study demonstrated that when amalgam fillings were removed from the test subjects there was almost a 50% drop in blood mercury levels. This was a statistically significant drop in 9 of the 10 patients in the study. The full abstract is contained in the ABSTRACT/REVIEW Section of this issue and provides what we consider to be very significant data:

1. Amalgam dental fillings DO make a significant contribution to mercury levels in the blood.

2. The definition of half-times for the elimination of mercury from blood after amalgam removal is extremely important and to our knowledge, the first time such data has been published. Based on the half-time provided, it appears that it should take about 6 months for blood mercury levels to stabilize at those related only to environmental and dietary sources.

3. Two prior studies by Ott & Kroncke (1981,1984) concluded that amalgams make no contribution to blood mercury levels. Other scientists around the world have questioned the validity of the protocols and methodology utilized by Ott & Kroncke. This study directly refutes the Ott & Kroncke work. If nothing else, their work can no longer be cited by the establishment as unequivical proof!

CHANGES IN HEALTH CAUSED BY EXCHANGE OF TOXIC METALLIC DENTAL RESTORATIONS

An epidemiologic study of 519 patients with suspected mercury poisoning from amalgam

by
MATS HANSON, Ph.D.

SUMMARY:

Of 519 cases of adverse effects caused by dental restorative materials, 80.6% reported improved health status after exchange to alternative filling materials. The remaining cases were about equally divided between unchanged and worse health status. Mean ages and duration of disease showed that severe symptoms appear after a number of years but that it is often possible to trace health disturbances with a likely identical etiology back to youth. Acute, severe effects are often precipitated by amalgam in contact with goid.

The geographical distribution with conspicuously elevated levels in sulfide-ore areas should merit a thorough investigation on relations between geochemistry, health and susceptibility to additional toxic load, especially MS related to dental fillings, selenium and environmental heavy metals should be studied.

Amalgam-poisoned persons suffer not only from their disease but also economically and socially. Actually, from some of the descriptions one might think people were "treated" by the Inquisition rather than by the health care system. The situation for people with adverse effects from dental materials is unworthy of a civilized society.

The symptom complex is clearly identical to that reported from inorganic mercury exposures in industry. Anyone who wants to claim that these people suffer from anything else than mercury poisoning has to find an acceptable explanation, not "psychogenic" without explaining what causes the psychic changes. Neither is a label, chosen from a large collection of various "syndromes" with unknown causes, an explanation. That is of no help to the patient, just a mania for classification.

From the various medical diagnoses given you can, however, get an idea on which hospital departments should be first searched for misdiagnosed and in reality mercury poisoned patients. The politicians have the responsibility to ascertain that such a search is carried out. The medical establishment is not likely to do that since the matter is too embarrassing.

In a wider perspective, the study of how humans are affected by the environment, including dental fillings, chemicals in the household and at work, the properties of air, water and ground, should be very much intensified. The emphasis should be on how all this works together to determine whether the individual will have a good or bad quality of life, even if each component is below legal limits, how all this is affected by and affects the defense systems of the body, including minerals, vitamins etc.

Finally, the results of the present questionnaire is a complete condemnation of amalgam as a dental filling material. Dentistry must get a new direction with emphasis on non-toxicity and safety.

INTRODUCTION:

During 1985 the Scandinavian Dental Patient Organization sent out a questionnaire as an additional page in their journal, TF-bladet. The aim was to obtain information on, and to what degree an exchange of amalgam, some other metals e.g. gold-plated brass screwposts and combinations of different metals, for composite plastics and sometimes gold, affected the state of health.

We also wanted to obtain a good description of the symptoms and the most usual diagnoses (if any) in order to make it easier in the future to correctly find the causes of diseases.

In addition we asked some social questions to find out how the patients have been treated by the dental and medical care system when the patients own view differed from that of the professionals. It is extremel

clear from the results that to not be believed, not to be listened to or to be declared psychosomatically ill, especially when the patient is aware of that he/she knows more than the doctor or dentist, that is often worse than the disease. In addition to the statistical material the respondents have by themselves, spontaneously given additional information, especially about this side of their situation. Often there were several pages with comments, something which made it a bit hard for myself who was to compile the results and had a pile of half a thousand answers. Nevertheless, these comments give a human aspect to the statistical material.

Every answer represents a human tragedy, completely unnecessary. The responsibility for the present situation lies with many generations of dental professors who have, when they have been confronted with the amalgam controversy, by ignorance, fright and a desire to make a fast career, chosen to behave like the three apes who don't want to see, hear or say anything. A typical example is found in Skinner's Science of Dental Materials. In the third edition from 1948, you can read about gold in contact with amalgam: "Such a condition is always a hazard to the health of the patient. When couples of this nature are studied under laboratory conditions, the amalgam corrodes, regardless of a polished surface or a protective tarnish film." In the fourth edition this has been replaced by : "Such a practice should be avoided whenever possible." The responsibility for today's situation; that poisoned people do not get help, lies with a very limited number of bureaucrats and "experts" at the dental schools, medical and dental authorities, ADA and NIOM.

Dentists around the country have learnt at the dental school how to use amalgam and have often not even heard that the safety of amalgam ever has been questioned. The dentists can consider themselves cheated. Certainly no dentist want to put something harmful into the teeth of his patients and the dentists want to trust their "experts" and rely on their evaluations to the utmost extent in order to be confident that they have done the right thing. It seems as if more and more dentists have come to the insight that it is better to trust their own eyes, judgement and what the patients tell them. Dentists who consider their own exposure harmless do not fool anybody but themselves. The effects of mercury are slow and insidious. Occupational exposure limits are compromises between economy and health with economy as the dominating factor. The limits vary widely between different countries and safe levels, as reported in the literature, even more. The most recent risk evaluation gives a figure of 1 microgram/m^3 as probable safe continuous exposure level for the general population (Gerstner & Huff, J Toxicol Environ Hlth. 2:491, 1977).

When you meet all these persons, having many symptoms characteristic of mercury intoxication, having 5-10 grams of mercury in their mouths, whose symptoms reduce or disappear when the fillings have been take out, and who are classified as psychosomatically ill, you are tempted to formulate a new dogma for dentistry and medicine: Only experimental animals and Japanese can be mercury poisoned! Surprisingly, industrial exposure limits are considered "safe" for anyone; pregnant women, children, sick and weak people. And what are "normal" blood and urine levels? Nobody knows since amalgam has been disregarded as a source of mercury. The workers in the factories have also amalgam. What are they really exposed to? Do they have symptoms from mercury exposure? The controls are "normal" people with mercury exposure from amalgam. The system fully guarantees that nobody can be recognized as mercury poisoned. When you look at the symptom list you are fully justified to ask if the medical care system really knows what a healthy person looks like. Not a "healthy" one with amalgam fillings.

SYMPTOM DESCRIPTION AND CHANGES AFTER AMALGAM REMOVAL

The respondents were asked to report the 10 most severe symptoms and , if possible, to order them into degree of severity. Usually people had considerably more symptoms with a possible mercury etiology. The reported symptoms were grouped under some general headings e.g. "problems with vision" which thus contains several characteristic changes.

Symptoms & Signs	Symptom no of times	much better a	better b	un-changed c	worse d	% a+b	% c+d
Muscle & joint pains	285	77	126	52	20	75	25
Tiredness	222	49	130	36	7	81	19
Vertigo	206	75	105	20	6	87	13
Headache, pressure over head	182	70	82	23	7	84	16
Gastrointestinal trouble	169	52	78	31	8	77	23
Problems with vision	168	50	70	32	16	71	29
Oral ulcers, burning mouth	124	56	47	16	5	83	17
Irregular heart, circulation	111	47	47	11	6	85	15
Loss of memory (short-term)	98	11	45	37	5	57	43
Breathing troubles, asthma	90	35	39	13	3	82	18
Loss of hearing, pains in ears	86	23	31	26	6	63	37
Depression	85	36	34	11	4	82	18
Concentration problems	81	14	44	21	2	72	28
Eczema, rash, skin problems	78	34	32	6	6	85	15
Pains, general	73	17	37	13	6	74	26
Throat troubles	68	25	32	10	1	84	16
Nervousness, restless	68	16	36	13	3	76	24
Sleeping difficulties	67	24	30	12	1	81	19
Agony	67	25	31	10	1	84	16
Metal taste	62	34	19	8	1	85	15
Tremor, jerks	61	32	17	8	4	80	20
Cramps	60	20	27	8	5	72	22
Infection prone	55	22	23	9	1	82	18
Bad temper, shyness, aggression	52	17	26	7	2	83	17
Aching teeth, cheek, jaw	50	18	18	10	4	72	28
Weakness of muscles	49	5	28	14	2	67	33
Allergy	48	7	27	10	4	71	29
Kidney, urinary tract troubles	44	20	16	6	2	82	18
MS, ataxia, paralysis	43	16	19	3	5	81	19
Numbness	37	19	12	5	1	84	16

Symptoms & Signs	Symptom no of times	much better a	better b	un-changed c	worse d	% a+b	% c+d
Vomiting, feeling sick	37	17	12	5	3	78	22
Paresthesia, tension	34	12	20	2		94	6
Changes in blood pressure	29	11	10	7	1	72	28
Heat sensation, burning of skin, smarting, ague	29	9	14	6		79	21
Sinusitis	27	12	10	4	1	81	19
Abnormal perspiration	26	7	11	6	2	69	31
Salivation none/excessive	26	14	10	1	1	92	8
Anorexia	23	14	4	4	1	78	22
Tender/swollen lymph nodes	22	6	12	2	2	82	18
Troubles with sexual organs	19	9	6	3	1	79	21
Loss of hair	18	6	9	2	1	83	17
Chronic fever, irregualr temp	17	9	4	4		76	24
Disturbance of taste and smell (excluding metal taste)	16	5	4	6	1	56	44
Speech difficulties	13	6	5	2		85	15
Swollen, edema	13	6	6	1		92	8
Sensitivity to electromagnetic fields	12	3	2	4	3	42	58
Thyroid hypo/hyper	12	5	5	1	1	83	17
Light-sound-sensitivity	8	4	2	2		75	25
Bleeding nose, bruises	8	3	1	2	2	50	50
Changes in hair color/struct.	8	3	3	2		75	25
Noises in head	7	2	1	4		43	57
Pains in chest	6		5	1		83	17
Epilepsy	6	1	5				
Phobias	5	2	2		2		
Psoriasis	4		4				
Urinary incontinence	4	2	2				
Parkinson	1	1					
Scleroderma	1	1					
Ulcerous colitis	1		1				
Diabetes	1		1				1

ABSTRACTS/REVIEWS

Richter-Snapp K., Boyer D.B., Peterson L.C., and Svare C.W. The contribution of dental amalgam to mercury in blood. J Dent Res. 68:314, Abstract 1059, Mar 1989. (Dows Inst for Dent Res., Univ of Iowa, IA).

ABSTRACT:

The purpose of this study was to determine if dental amalgams do result in mercury exposure and, if so, the amount of exposure. This was done by comparing the concentration of mercury in blood of 10 subjects before and after removing all amalgam restorations. Baseline concentration of mercury in whole blood was measured weekly for a minimum of 6 weeks prior to amalgam removal by means of an ultraviolet spectrophotometer. Once baseline levels were established, all existing amalgams were removed. After the amalgams were removed, weekly blood sampling was continued and the duration of sampling was determined using the sequential method described by Dixon and Massey. The mean baseline concentration for all subjects was 2.18 ± 0.90 ng Hg/ml prior to amalgam removal. After removal, 9 of the 10 subjects exhibited a statistically significant decrease in blood mercury at the 95% level of confidence and the mean decrease was 1.13 ± 0.60 ng Hg/ml. The baseline mercury levels were related to the number of amalgam surfaces. The linear correlation coefficient was 0.724 with number of occlusal surfaces and 0.433 with total number of surfaces. The half time for elimination of mercury from blood after amalgam removal was 25.9 ± 9.1 days. The daily intake of mercury from amalgams in the subjects was estimated to be at least 1.5 ug.

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Hursh J.B., Sichak S.P. and Clarkson T.W. In vitro oxidation of mercury by the blood. Pharmacol Toxicol. 63(4):266-273. Oct 1988.

ABSTRACT:

A method is described for studying the in vitro oxidation of mercury vapour by red blood cells at short times and with diminishing mercury vapour concentrations. It is found that for 40% red blood cell suspensions and 37 degrees at concentrations greater than about 6 ng mercury vapour/ml, the oxidation rate is zero order, and that at lower concentrations the rate changes to first order. The effect of temperature and of added hydrogen peroxide are studied. Results are considered in terms of the generally accepted belief that the catalase-compound I system is the main path of oxidation. If the results obtained in vitro in these experiments apply in vivo to man, it follows that inhaled mercury is carried in the blood to the brain and other organs primarily as dissolved vapour rather than as inorganic mercury ions.

BIO-PROBE COMMENT: This represents additional confirmation of earlier work by Magos (1967). It would also confirm findings of the four recent autopsy studies showing a direct correlation between the numbers and surfaces of amalgam dental fillings and mercury brain levels.

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Aschner M. and Clarkson T.W. Distribution of mercury 203 in pregnant rats and their fetuses following systemic infusions with thiol-containing amino acids and glutathione during late gestation. Teratology 38(2):145-155, Aug 1988.

ABSTRACT

To investigate the effect of amino acids and the tripeptide glutathione (GSH) on tissue uptake of methylmercury (MeHg) in the developing rat fetus in utero, pregnant rats were continuously infused into the external jugular vein with 0.1 mM L-cysteine, 0.1 mM L-leucine, 0.1 mM GSH or saline commencing on day 17 of gestation. This was followed at 24, 38, and 72 hours by external jugular infusion of 50 microM [^{203}Hg]-MeHgCl administered in 1 ml over 1 hour. Pups were surgically removed from the uterus on gestational day 21. Whole body, brain, kidney, liver, and placental ^{203}Hg radioactivity was

measured by means of gamma-spectrometry. Brain ^{203}Hg concentration in pups exposed in utero to L-cysteine was significantly higher compared with pups exposed to saline (P less than 0.05). Brain ^{203}Hg concentration in pups exposed in utero to L-leucine and GSH was significantly depressed compared with pups exposed to saline (P less than 0.05). Kidney ^{203}Hg concentration was not affected by any treatment compared with controls. These effects occurred despite no difference in total ^{203}Hg body burden among pups, irrespective of the treatment. In addition, infusion with L-cysteine resulted in a significant increase in ^{203}Hg brain concentration in dams compared with controls, and ^{203}Hg brain concentration in L-leucine- and GSH-treated dams was significantly depressed compared with controls. Thus ^{203}Hg distribution in both adult and developing animals is altered by chronic amino acid or GSH infusions and suggests that MeHg uptake may be mediated through the formation of a cysteine-MeHg complex which is transported across the blood-brain barrier by the neutral amino acid carrier transport system.

BIO-PROBE COMMENT: This study and other recent work raise the question of should L-cysteine be a part of any mercury detoxification protocol? It is a scientific fact that mercury binds with the cysteine molecule as further evidenced by this study. Although the L-cysteine caused an increased uptake of brain mercury the question remains whether the complex resulting from mercury combining with cysteine is non-toxic. It appears to be a Catch-22 situation. Cysteine is required for the production of glutathione and mercury reduces available cysteine. One question that needs to be answered is can we supplement with methionine to produce enough cysteine for an adequate supply of glutathione without taking supplemental cysteine? It would appear from the scientific data available that if the body has an adequate supply of cysteine two things would occur: 1) methyl mercury reaching the brain would be complexed with cysteine and would be non-toxic in comparison to uncomplexed methylmercury and would remain such until normal metabolic conversion to inorganic mercury. 2) adequate metabolic levels of cysteine would provide for adequate levels of glutathione which in turn would inhibit the amount of mercury transportable across the blood brain barrier. In which case, we should be supplementing with cysteine.

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Mahler D.B. and Aday J.D. Sn in the Ag-Hg phase of dental amalgam. J Dent Res. 67(10):1275-1277, Oct 1988.

ABSTRACT:

In a recent study, Sarkar and Eyer (1986) studied an amalgam which was formed using a unique procedure. Based on their results, they concluded that the solubility of Sn in the Ag-Hg (gamma 1) phase of dental amalgam was virtually nil (less than 0.25 wt%). This finding is contrary to the published results of other investigations. The purpose of the present study was to clarify these disparate findings. A low-copper dental amalgam was examined by electron probe microanalysis. This amalgam was selected because it exhibits unusually large gamma 1 grains (10 microns). Because the influence of the electron-analyzing beam can be completely contained within these large grains, grain boundaries or peripheral phases would not be excited, and a valid analysis of the gamma 1 grains themselves could be made. The analyses showed significant Sn contents of 2.0-3.0 wt%. Analyses of areas which contained grain boundaries showed slight or no differences in Sn content compared with that for the grains alone. Furthermore, secondary electron scans of this dental amalgam failed to reveal the intergranular precipitates of Sn-Hg observed by Sarkar and Eyer (1986) in their amalgam. These different results can be explained by the fact that the unique amalgam investigated by Sarkar and Eyer doe not exhibit the same diffusional patterns as does dental amalgam, and that the composition of the gamma 1 in the two amalgams is not the same. The final conclusion is that the Ag-Hg (gamma 1) phase in dental amalgam does indeed contain a significant amount of Sn.

BIO-PROBE COMMENT: Other research has demonstrated that the release of mercury from amalgam is preceded by that of tin (Sn).

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Bayne S.C., Taylor D.F., Roberson T.M., Wilder A.D., Studevant J.R. Heymann H.O. and Lisk M.W. Long term clinical failures in posterior composites. J Dent Res 68:Abstract 32, page 185, Mar 1989. (U of North Carolina, Chapel Hill, NC).

ABSTRACT:

Dental amalgam failure rates have been reported as 20% at 5 years and 50% at 10 years. The current perception is that the failure rate for composites is considerably higher! The objective of this work was to measure the incidence and type of failure for several categories of posterior composites over 5 to 10 years.

17 posterior composite materials (SC, UV, VL cured and/or midifills, hybrids, microfills) were examined using direct (USPHS) and indirect evaluations (Leinfelder method) at 0,1,2,3,4,5, and more years. Clinical failures were categorized as excessive wear, recurrent caries, fracture, or other causes. Failure was compared statistically across materials types and failure causes by using Poisson regression methods with proportional hazards structure.

The failure level for 899 restorations (all composites pooled) at 5 years was 9.2% from all causes (wear = 0.4%, caries = 3.2%, fracture = 2.8%, other = 2.8%). Failures varied among products from 0% to 11.8% for caries and 0% to 11.2% fracture. The total failure level was less than half of that for conventional amalgam. Although the restorations in this study may represent better than average clinical practice conditions, the low failure levels still seems to establish that posterior composites can provide excellent long term clinical service.

BIO-PROBE COMMENT: There were a multitude of other abstracts reflecting successful positive results of two to five year studies of different composites. We selected this abstract because we feel it places the entire issue in proper perspective. Further, we are going to insure that the Swedish Parliament is made aware that "a suitable replacement to amalgam" is presently available and that there is no real reason to delay the demise of amalgam.

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Leary R., Kilgus G., and Leinfelder K.F In-vitro microleakage of glass ionomers and dentin bonding agents. J Dent Res. 68:Abstract 44, page 187, Mar 1989. (Sch of Dentistry, Univ of Alabama at Birmingham).

ABSTRACT:

The purpose of this study was to measure the microleakage of glass ionomer as a liner and restorative material, a new polyamide sealing agent (Barrier) and a new dentin bonding agent (Scotchbond II) Also evaluated was the effect of insertion technique on microleakage. Both hydroxyl ion detection and basic fuchsin techniques were used to monitor microleakage. Only Class V cavity preparations were employed. The results of the study demonstrated that of all variables included, glass ionomer was the most effective in reducing microleakage. Using Retief's method of scoring, the mean value for glass ionomer as a liner or restorative material was 0.5 When used as a liner, any microleakage initiated at the gingival margin progressed no further than the restoration/glass ionomer interface. The polyamide liner was effective in reducing microleakage in the occlusal area only. Finally, the microleakage (OH-) of Silux (3M Co.) was significantly less than Durafill (Kulzer, Inc.). The use of Scotchbond II had only a limited effect (25% reduction) on the microleakage of Durafill. The difference in leakage rates can be attributed to water sorption. On the basis of this study, the most effective method of reducing microleakage was on incorporation of glass ionomers as a liner or base.

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Ferracane J.L., Mafiana P.N. and Okabe T. Rate of mercury dissolution from amalgam/alloy galvanic couples. J Dent Res. 68:Abstract 223, page 209, Mar 1989. (Baylor College of Dentistry, Dallas TX).

ABSTRACT:

Galvanically coupling amalgam to more noble alloys is suggested to cause an increased release of mercury. The purpose of this study was to determine the rate of mercury release into saline from amalgam coupled to three dental alloys. Amalgam (D=Dispersalloy-J&J) specimens were aged one day and then electrically coupled by silver paste to: 1) Type III gold (Au-"G" Cast, Degussa), 2) Co-Cr (Vitallium-Austenal) and 3) 316L stainless steel (SS-Allegheny Ludlum). Specimen edges (n=3) were coated with epoxy, leaving two polished surfaces (#600 SiC) exposed and immersed in 10 ml of 0.9% NaCl (pH=6.9) for 3 hours, 24 hours and 6 days at 37°C. Specimens were re-polished before immersion in fresh solutions at each time. Mercury was evaluated with a Jerome 511, and aqua regfia was used to recover Hg adsorbed to the gold surface. Total Hg loss was greatest from the Au-D couples (30 ug/cm^2; 70% recovered by aqua regia). The CoCr-D (10 ug/cm^2) and SS-D couples (12 ug/cm^2) released less Hg than D (20 ug/cm^2) in 7 days. Dissolution was equivalent at 3 hours and 24 hours and was slightly reduced at 7 days for all but Au-D, which increased dramatically. Hg dissolution from amalgam alone or galvanically coupled to steel or Co-Cr occurs rapidly and is self limiting. Although mercury release is greater from amalgam coupled to gold, little Hg remains in solution due to adsorption onto the gold.

BIO-PROBE COMMENT: Other in vitro studies have shown that the release of mercury from amalgam is greater in natural saliva. Had this experiment been done in saliva the dissolution and coupling should have been greater. We wonder why our dental schools are still teaching the placement of amalgam cores under gold crowns, or the placement of amalgam fillings opposing gold restorations? As Dr. Hanson brought out in his article, the prohibition against such practices, that is so routinely ignored and which can be so devastating to the patient, is in the primary dental materials text book.

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Nimmo A., Werley M.S., Tansy M.F., and Martin J.S. Profile of respirable particulate produced during amalgam removal. J Dent Res. 68:Abstract 334, page 223, Mar 1989. (Temple Univ, School of Dentistry, Philadelphia, PA).

ABSTRACT:

Dentists frequently remove existing amalgam restorations with a high-speed handpiece utilizing water spray along with high-velocity evacuation. The purpose of this study was to evaluate the size and range of fully respirable (u) amalgam particles produced under the conditions listed above.

The patient model consisted of a manikin head and dentoform (Columbia Dentoform) connected to an Andersen Cascade Impactor particle sizer. The dentist model consisted of a particle sizer placed in the dentist's breathing zone. Nine MOD amalgam restorations were placed in maxillary premolar ivorine teeth with Tytin (Kerr) amalgam. The restorations were removed using a high-speed handpiece with water spray and high-velocity evacuation. The particle sizers were used to evaluate patient and dentist particulate inhalation for each restoration.

The patient model collected 4.00 $\pm$ 2.60 mg of particulates ranging from <0.10 to 10 u, and having a mean particle size of 1.44 $\pm$ 0.60 u. The dentist model collected 4.40 $\pm$ 4.20 mg over a similar range with a mean particle size of 1.88 $\pm$ 1.83 u.

These results suggest that both patient and dentist are subjected to similar particulate exposures during amalgam removal. Particle mass distribution was approximately equal across the range.

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Nimmo A., Werley M.S., Tansy M.F. and Martin J.S. Filtration efficiency of dental face masks during amalgam removal. J Dent Res. 68:Abstract 333, page 223, Mar 1989.

ABSTRACT:

Dentists are exposed to moderate amounts of fully respirable particulates during amalgam removal (Nimmo et al. J Dent Res 67:335, 1988). The purpose of this study was to evaluate the in vitro filtration efficie... of two types of dental face masks during amalgam removal.

MOD amalgam restorations were placed in 40 ivorine premolar teeth using Tytin (Kerr) amalgam. Restorations were removed from two teeth during a 14 min period using a high-speed handpiece without water spray. The aerosol produced was analyzed by two Anderson Cascade Impactor samplers; one served as the control (C), while the other was equipped with a dental face mask. The two face masks tested were a tie-on (TO) mask (3M Tie-on Surgical Mask, model 1818), and a molded cup type (CT) mask (3M Aseptex Face Mask, Model 1942). These procedures were repeated for a total of 10 samples of two amalgams removed for each mask type. Paired t-test analyses were done.

The TO mask reduced the amount of particulates collected from 4.10 ± 3.62 mg (C) to 0.98 ± 1.58 mg. The CT mask reduced the amount of particulates collected from 5.36 ±7.05 mg (C) to 0.45 ± 0.77 mg. The average size of particles collected was 3.76 + - 3.10 u (C) compared to 0.68 ± 0.91 u (TO) and 3.71 ± 3.91 u (C) compared to 0.47 ± 0.82 u (CT). The TO mask demonstrated a significant reduction ($p<0.05$) in the amount and size of fully respirable particulates produced during amalgam removal.

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McGlynn F.D., Wruble M., and Ray R. Nocturnal bruxing and sleep posture. J Dent Res. 68:225, Abstract 350, Mar 1989. (Univ of Missouri-Kansas City, Univ of Florida, Gainesville, and Rollins College, Florida).

ABSTRACT:

Knowledge about relationships between nocturnal bruxing and sleep posture is of clinical and theoretical value. This work sought to develop a sleep-posture coding system and to describe connections between amounts of nocturnal bruxing and posture categories in the code.

Four nocturnal bruxers slept for 4 nights each in a laboratory. Infrared videotapes of the sleeper were computer interfaced to a continuous record of unilateral masseter EMG activity. Each posture category was a constellation of mutually exclusive and exhaustive sub-categories that described in two dimensional space and angular positions of the head, arms, and trunk. Brux events were defined in terms of duration, mean EMG amplitude, and rhythmicity and were expressed as rate per time in each posture. Brux rates were not different across the global posture categories. Among several error-protected ANOVAs involving posture subcategories, a 2 x 2 x 4 (torso position x head position x subject) analysis showed that subjects bruxed more while on their backs ($p.<0001$), that some subjects showed this association more than did others ($p.<0001$), and that head position did not influence rate of bruxing.

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Schwartz J.L. and Shklar G. Beta Carotene decreases growth and GGT activity in human carcinoma. J Dent Res. 68:227, Abstract 366, Mar 1989. (Harvard School of Dental Medicine, Boston, MA).

ABSTRACT:

Previous studies have shown that beta carotene could inhibit, in vivo, the growth and GGT activitiy of carcinoma. It has also been shown that a decrease in GGT was related to the inhibition of carcinogenesis by beta carotene, (Suda, Schwartz, Shklar. Eur. J Cancer. 23:43-46, 1987). This study proposed the use of beta carotene, in vitro, to inhibit human oral carcinoma (4 cell lines). In addition, the GGT level was noted. Beta carotene (1,6,60,250,350 ug/well, in 0.1% ethyl alc+DMEM+10.0% FCS) was added to cells that were plated into tissue culture wells (104 cell/wells) for 24 hours to 15 days. The number of cells were counted per mm^2 area of well. The amount of DNA present in the well was used to verify relative numbers of cells. The level of GGT was determined for carcinoma and normal cells. Normals cells were also incubated with DMBA, (2-10 days) to observe if normal cells would exhibit premalignant changes. The results indicated that beta carotene inhibited the growth parameters of the carcinoma cells, and the GGT level. The normal epidermal cells were not inhibited in growth, and the GGT% remained lower than the tumor cells. Normal cells, treated with DMBA, initially showed an increase in growth, then a marked decrease, with an increase in GGT. Beta carotene decreased GGT, and the epidermal cells did

not show a decrease in growth. Beta carotene may selectively alter the growth and metabolism of human oral carcinoma.

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Trickler D., Shklar G., Schwartz J., and Reid S. Experimental cancer regression by oral administration of combined alpha tocopherol - B Carotene. J Dent Res. 68:227, Abstract 367, Mar 1989. (Harvard School of Dental Medicine. Boston, MA).

ABSTRACT:

Beta carotene and alpha tocopherol have been shown to be capable of regressing epidermoid carcinoma of hamster buccal pouch, when injected into the pouch tissue (Schwartz et al: Biochem Biophys Res Comm 1986) (Shklar et al: JNCI 1987). Neither has yet been shown capable of regressing oral cancers when administered orally. Eighty adult male hamsters (Mesocricestus auratus) had the right buccal pouches painted 3 times weekly with a 0.5% solution of 7,12 dimethylbenz(a) - anthracene in oil. After 12 wks cancers had developed, DMBA painting was stopped, and the animals were divided into 4 equal groups, Group 1 animals were untreated. Group 2 animals received 10 mg/ml beta carotene and 1 gm/ml dl-alpha tocopherol acid succinate combined in vegetable oil. Animals received 0.2 ml of the mixture daily by mouth, using a 1 cc syringe. Group 3 animals received only beta carotene and Group 4 animals received only tocopherol, in similar doses. Tumor size was recorded weekly. The animals in Groups 1, 3, and 4 were all sacrificed after 22 weeks because the tumors were large and necrotic and the animals cachectic. Tumor burden in groups 3 and 4 was slightly lower than in group 1. After 22 weeks the tumors in group 2 animals were small in 15 of the 20 animals. This is the first demonstration that nontoxic agents given orally can regress established cancer. The combination of agents may act synergistically.

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FORUM

The 1989 Annual Scientific Meeting of the International Academy of Oral Medicine and Toxicology will be held in Detroit, Michigan September 15-17, 1989 at the Somerset Inn. IAOMT special roomrates are $70.00 (single or double occupancy) and $90.00 for an Executive room. In addition, contractual arrangements have been made with Northwest Airlines for a 40% reduction in normal coach fares and a 5% reduction on Supersaver fares. As usual, the meeting promises to provide the latest scientific data available on many different subjects: Trevor Lyons, LDS. Fungi & protozoan and their role in periodontal disease; James Masi, Ph.D. Bio-engineering factors in dentistry; Bob McMahon DDS, MS. Atypical facial pain caused by residual bony defects "Alveolar bony cavitational osteopathosis"; David Kennedy, DDS. OSHA Guidelines in relation to the dental environment; Michael F. Ziff, DDS. Update on the scientific literature; and last but not least, Murray J. Vimy, DMD, will update us on the tremendously important research on the safety of mercury amalgam being done by he and his colleagues at the University of Calgary. For more information please write to IAOMT , P.O. Box 458, Ortonville, MI 48462, Attn: Sandy, or call her at Dr. Regiani's office (313) 627-4934.

The National Center For Homeopathy will be hosting their 1989 Annual Conference in Baltimore, Maryland April 21-23, 1989. Whether you are new to homeopathy or have been a longtime homeopathic practitioner, you will acquire much new information from some of the leading practitioners and scholars in the field. For more information call the National Center For Homeopathy (202) 223-6182, or write to them at 1500 Massachusetts Ave., N.W., Suite 42, Washington D.C. 20005.