MERCURY FROM AMALGAM

A. Introduction and Overview:

1. Definition of the Hazard:
   a. Mercury is "odorless" and "colorless" gas
   b. Despite apparent coherency, it easily penetrates all spaces

2. Historical Record:
   a. 1832 Crawcou Brothers
   b. 1860's Amalgam War
   c. 1890's Amalgam Science
   d. 1920's Mercury Challenge (Germany)
   e. 1980's Dr. Hal Huggins (US)
   f. 1985 The Mercury Controversy
   g. 1990 60 Minutes Program Misrepresentation
   h. 1991 FDA Review; NIH-OMAR-NIDR Risk Assessment Conference
   i. 1992 FDA and CDC Conclusion on Dental Amalgam Safety
   j. 1993 Sweden begins phase out dental amalgam
   k. 1995 Germany shifts amalgam liability to materials suppliers
   l. 2002 Canada ????

3. Mercury in Dental Amalgam:
   a. 40-45% Hg overall
   b. Hg is in Ag-Hg reaction product phase (Gamma-1)
   c. Gamma-1 melts at 127°C

B. Mercury Hazards:

1. Hazard Types:
   a. TOXICITY (concentration dependent response)
   b. HYPERSENSITIVITY (immune system response)

2. Mercury Hazards:
   a. Dentist, Assistant-------- Toxicty
   b. Dental Hygienist--------- Toxicity
   c. Patient---------------- Toxicity, Hypersensitivity

3. Mercury Exposure Times for Dental Personnel:
   a. Leakage during storage of amalgam products. (Dent, Assist, Hyg)
   b. Spillage during trituration. (Dent, Assist, Hyg)
   c. Vaporization during finishing and polishing. (Dent, Assist, Hyg)
   d. Vaporization during amalgam removal. (Dent, Assist)
   e. Vaporization during disposal of scrap materials. (Dent, Assist, Hyg)

4. Mercury Exposure Times for Patients:
   a. Insertion or removal of dental amalgam.
   b. Mastication.
C. **Mercury Toxicity:**

1. **Chemical Forms of Mercury:**

<table>
<thead>
<tr>
<th>Form</th>
<th>Skin</th>
<th>Lungs</th>
<th>GI Tract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elemental Hg</td>
<td>80%</td>
<td>0.01%</td>
<td></td>
</tr>
<tr>
<td>Inorganic HgS</td>
<td>80%</td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Organic Hg-(CH₃)₂</td>
<td>....</td>
<td>....</td>
<td>95-98%</td>
</tr>
</tbody>
</table>

2. **Government Regulations:**
   a. OSHA = Occupational Safety and Health Administration
   b. NIOSH = National Institute of Occupational Safety and Health
   c. ACGIH = American Conference of Govt Industrials Hygienists

   (1) TWA = Time Weighted Average
   (2) TLV = Threshold Limit Value
   (3) MAC = Maximum Allowable Concentration

   \[ TLV = 0.05 \text{ mg/m}^3 = 50 \mu\text{g/m}^3 = 5 \text{ ppb} \]

3. **Definition of the CONTROVERSY:**
   a. Does a patient *breathe* Hg vapor or *swallow* Hg mixed in saliva
   b. Does Hg exposure contribute to either TOXICITY (or HYPERSENSITIVITY)

4. **Human Exposure Estimates:**
   a. Estimate for worst case scenario of 16 amalgams

<table>
<thead>
<tr>
<th>Source</th>
<th>Inorganic</th>
<th>Elemental</th>
<th>Organic</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>\ldots</td>
<td>0.5 \mu g/day</td>
<td>\ldots</td>
<td>= 0.5 \mu g/day</td>
</tr>
<tr>
<td>Water</td>
<td>10 \mu g/day</td>
<td>\ldots</td>
<td>\ldots</td>
<td>= 10 \mu g/day</td>
</tr>
<tr>
<td>Diet</td>
<td>\ldots</td>
<td>\ldots</td>
<td>100 \mu g/day</td>
<td>= 100 \mu g/day</td>
</tr>
<tr>
<td>Amalgams</td>
<td>\ldots</td>
<td>20 \mu g/day</td>
<td>\ldots</td>
<td>= 20 \mu g/day</td>
</tr>
</tbody>
</table>
5. **Symptoms of Mercury Toxicity:**
   a. Ataxic Gait
   b. Convulsions
   c. Numbness in Mouth and Limbs
   d. Constriction of the Visual Field
   e. Difficulty in Speaking

6. **Incidence** of Mercury Toxicity: very low (no deaths from dental use)

7. **Treatment** of Mercury Toxicity:
   a. Removal from Hg exposure *(55 day half-life in body)*
   b. Elimination of Hg problem

8. **Mercury Toxicity Incidents:**
   a. **Historical Problems:**
      (1) Tanners (Inorganic Mercury)
      (2) Thermometer Technicians (Elemental Mercury)
      (3) HgS Mine Workers (Inorganic Mercury)
   b. **Recent History:**
      (1) Almaden, Spain (Inorganic Mercury)
      (2) Minamata Bay, Kyushu, Japan (Methyl Mercury)
      (3) Iraq (Methyl Mercury)
      (4) Alamogordo, NM (Methyl Mercury)
      (5) Sweden (Methyl Mercury)
      (6) Michigan (Elemental Mercury)
D. Mercury Hypersensitivity:

1. **Symptoms** of Mercury Hypersensitivity:
   a. Dermatitis (Upper extremities, eyes, gingiva, lips)
   b. Edema
   c. Stomatitis
   d. Rash

2. **Incidence**: extremely low (est. by ADA <1/1,000,000 persons)
   a. Detection: by symptoms only/ no known reliable detection test
   b. Only a few documented cases in literature

3. **Treatment** of Mercury Hypersensitive Patients:
   a. Non-amalgam options:
      (1) Remove from Hg exposure
      (2) Restore with composites, casting alloys, ceramics
   b. Amalgam options:
      (1) Pre-medicate with anti-histamines
      (2) Use rubber dam and high volume evacuation
      (3) Coat setting amalgam with varnish

E. Detection of Mercury Problems:

1. Monitoring of Work Place: (Toxicity)
   a. Air sampling measurements (dosimeters)- Jerome Hg Analyzer

2. Monitoring of Personnel: (Toxicity)
   a. Air Hg exposure levels (badges)
   b. Blood tests (not discriminating for type, source, or time)
   c. Urine tests (not discriminating for type, source, or time)
   d. Hair tests (not discriminating for type, source, or time)

3. Monitoring of Patients: (Toxicity)
   a. Intraoral air measurements

4. Monitoring of Patients: (Hypersensitivity)
   a. Patch testing by dermatologist or allergist (very unreliable)
   b. Immune system tests (not discriminating)
BATTING ANTI-AMALGAMISTS

A. Quackery(???) in Dentistry:

1. Examples of Methods of Detection/Treatment:
   a. Measurements of muscle activity (kinesiology)/ restoration removal
   b. Measurements of electrical activity (amalgameters)/ amalgam removal

2. Anti-Amalgamists:
   a. Key Players:
      (1) Hal Huggins, D.D.S., M.S. (Colorado Springs, CO)
      (2) Michael R. Thurman, D.D.S. (TX)
      (3) Joel M. Berger, D.D.S. (NY)
      (4) Sam Ziff, (Ph.D.) (FL)
      (5) Mike Ziff, D.D.S., (M.S.) (FL)
      (6) David Eggleston, D.D.S., M.S. (CA)
      (7) Murray J. Vimy, D.D.S. (Alberta CANADA)

   b. Key Organizations:
      (1) Toxic Element Research Foundation (Hal Huggins, 1983)
      (2) Health Consciousness (Roy Kupsinel, 1984)
      (4) Dental Amalgam Mercury Syndrome, DAMS (1989)
      (5) Bioprobe

   c. Modus operandi:
      (1) Video-tapes of patient testimonials
      (2) Distribution of patient oriented literature:
         Mercury hazards: Roy Kupsinel
      (3) Confusion of toxicity and hypersensitivity information
      (4) Misinformation about prevalence of Hg in environment
      (5) Piggy-backing of Hg questions with F issues
      (6) Attempts to publish quasi-scientific articles
B. Mercury Releases from Dental Amalgam (Published):

1. Corrosion: NO MERCURY RELEASED
   a. Low Copper Dental Amalgam: Hg re-reacts
      \[ \text{[Sn-Hg]} \quad \rightarrow \quad \text{[Sn]} + \text{saliva} \quad \rightarrow \quad \text{[Sn-O-Cl]} \quad \text{(soluble)} \]
      \[ \rightarrow \quad \text{[Sn]} + \text{saliva} \quad \rightarrow \quad \text{[Sn-O]} \quad \text{(insoluble)} \]
      \[ \rightarrow \quad \text{[Hg]} + \text{[Ag-Sn]} \quad \rightarrow \quad \text{[Ag-Hg]} + \text{[Sn-Hg]} \quad \text{(secondary rx)} \]
   b. High Copper Dental Amalgam: no Hg involved
      \[ \text{[Cu-Sn]} \quad \rightarrow \quad \text{[Sn]} + \text{saliva} \quad \rightarrow \quad \text{[Sn-O-Cl]} \quad \text{(soluble)} \]
      \[ 
      \rightarrow \quad \text{[Sn]} + \text{saliva} \quad \rightarrow \quad \text{[Sn-O]} \quad \text{(insoluble)} \]
      \[ \rightarrow \quad \text{[Cu]} + \text{saliva} \quad \rightarrow \quad \text{[Cu-Cl]} \quad \text{(soluble)} \]

2. Mechanically Stimulated Hg Release (Sublimation):
   a. Intraoral Levels: minute amounts transiently
      (1) Expired Air Measurements (Svare, 1984)
      (2) Intraoral Air Measurement (Vimy and Lorscheider, 1985)
      (3) Daily Dose Estimates (Vimy and Lorscheider, 1985)
   b. Measured concentrations in human tissues:
      | Urine | Brain |
      |------|------|
      | 5.3  | 29   |
      | 2.4  | 12   |
      | 0.7  | 4    |
      | 0.9  | 4.3  |

   (Vimy, et al, 1990)
C. **Patient Education on Mercury Controversy: (Published Articles)**

1. **School of Dentistry:**

2. **Health Society and Association Position Statements:**
   - FDI = [http://www.fdiworldental.org/assets/pdf/statements/amalgam.pdf](http://www.fdiworldental.org/assets/pdf/statements/amalgam.pdf)

3. **Consumer Protection Agencies:**
   - The mercury scare: if a dentist wants to remove your fillings because they contain mercury, watch your wallet. *Consumer Reports* 51(3): 150-152, March 1986.
   - The mercury in your mouth: You can avoid amalgam fillings or even replace the ones you have. But should you? *Consumer Reports* 56: 316-319.

D. **Disuse of Amalgam in Dentistry:**

![Graph showing the decrease in amalgam procedures over time](image-url)
MULTIPLE CHOICE STUDY QUESTIONS:

Which ONE of the following participants have NOT been directly involved in the "amalgam controversy" or "mercury controversy"?

a. Crawcou Brothers  
b. GV Black  
c. Amercian Dental Association  
d. Hal Huggins  
e. Ray Bowen

How can you detect small amounts of Hg in the dental operatory?

a. Hg vapor is a slightly yellow gas  
b. Hg vapor has a sweet taste  
c. Hg vapor causes itching around the eyes  
d. Hg liquid tends to stain the skin  
e. Hg must be measured with instruments

Which PHASE in set dental amalgam restoration contains almost all the Hg?

a. Gamma  
b. Gamma-1  
c. Gamma-2  
d. Eta  
e. Epsilon

During dental amalgam POLISHING or REMOVAL operations, at what temperature does the first liquid mercury-rich phase appear?

a. 128° C  
b. 211° C  
c. 320° C  
d. 355° C  
e. 580° C

Which ONE of the following individuals is at the LEAST risk for mercury toxicity in the dental office?

a. Dentist  
b. Assistant  
c. Hygienist  
d. Patient  
e. Housekeeping Personnel

What is the main REASON for slow polishing with cooling during dental amalgam polishing?

a. To minimize melting of the Ag-Hg phase  
b. To increase the cutting efficiency of the abrasive  
c. To slowly dissolve the tarnish layers  
d. To smear material into the marginal openings  
e. To avoid cutting enamel

Which one of the following FORMS of mercury is present in dental amalgam as a hazard?

a. Elemental mercury  
b. Inorganic mercury  
c. Organic mercury  
d. Chelated mercury  
e. Catalytic mercury
Which one of the following PATHWAYS is the route for the most rapid absorption of mercury coming from dental amalgam restorations?

a. Skin  
b. Lungs  
c. Gastrointestinal tract  
d. Denticinal tubules  
e. Oral mucosa

What is the TLV for mercury safety as established by OSHA?

a. 0.03 mg/m³  
b. 0.50 mg/m³  
c. 0.20 μg/m³  
d. 50 μg/m³  
e. 500 ppb

Which one of the following SOURCES contributes the greatest amount of mercury to the body each day?

a. Air  
b. Water  
c. Diet  
d. Dental sources  
e. Medical sources

Which one of the following INCIDENTS involving mercury problems represents the greatest number of human deaths?

a. Mercury mining  
b. Minamata Bay accident  
c. Iraq accident  
d. Alamogordo accident  
e. Sweden pollution

Which one of the following TISSUES in the body is the most deleteriously affected by mercury toxicity?

a. Brain  
b. Liver  
c. Lungs  
d. Circulatory System  
e. Lymph System

What is the HALF-LIFE of Hg in the human body?

a. 1 day  
b. 21 days  
c. 43 days  
d. 55 days  
e. 98 days

Which of the following is NOT a normal pathway of Hg EXCRETION?

a. Hair and Fingernails  
b. Feces  
c. Urine  
d. Lungs  
e. Saliva
What is the main SYMPTOM for Hg hypersensitivity?
   a. Multiple sclerosis symptoms
   b. Headaches
   c. Ringing in the ears
   d. Localized erythema
   e. Swelling of lymph nodes

Mercury toxicity from dental amalgams is detected by:
   a. Intra-oral air samples
   b. Urine samples
   c. Hair samples
   d. Blood samples
   e. No known methods

Mercury toxicity from all combined sources can be assessed by:
   a. Tissue biopsies only
   b. Urine samples only
   c. Blood samples only
   d. Hair samples only
   e. Anyone of the above

Mercury hypersensitivity from dental amalgams is detected by:
   a. Intra-oral air samples
   b. Intra-oral voltage measurements
   c. Blood samples
   d. Muscle strength measurements
   e. No known methods

Mercury hypersensitivity in general can be measured:
   a. Inaccurately by patch tests
   b. Accurately by immune system tests
   c. Kinesiology tests
   d. Blood assays
   e. Chelation tests

What is the ADA recommendation for individuals suspected of hypersensitivity to mercury?
   a. Removal of all amalgams
   b. Placement of sealants over the amalgams
   c. Patch test to confirm the suspicion
   d. Blood tests for mercury toxicity
   e. Referral to an allergist or dermatologist

What is the suspected INCIDENCE of mercury hypersensitivity in the North American population?
   a. < 1/100
   b. < 1/1,000
   c. < 1/100,000
   d. < 1/1,000,000
   e. 100%
Which one of the following individuals in NOT considered an ANTI-AMALGAMIST?
   a. Hal Huggins
   b. PL Fan
   c. Mike Ziff
   d. Joel Berger
   e. Roy Kupsinel

Which one of the following organizations is NOT in favor of amalgam REMOVAL?
   a. ADA
   b. Academy of Oral Medicine and Toxicology
   c. Toxic Element Research Foundation
   d. DAMS

Which one of the following organizations has concluded that dental amalgam is NOT safe?
   a. ADA
   b. Consumer Reports
   c. FDI
   d. FDA
   e. Academy of Oral Medicine and Toxicology

How is mercury released during ELECTROCHEMICAL CORROSION of LOW COPPER dental amalgams?
   a. Formation of soluble Hg-Cl
   b. Release of Hg ions
   c. Formation of soluble HgS
   d. Dissolution of Ag-Hg
   e. It is not released

How is mercury released during ELECTROCHEMICAL CORROSION of HIGH COPPER dental amalgams?
   a. Formation of soluble Hg-Cl
   b. Release of Hg ions
   c. Formation of soluble HgS
   d. Dissolution of Ag-Hg
   e. It is not released

What is the most active route of RELEASE of mercury from dental amalgam restorations?
   a. Corrosion of the gamma-2 phase
   b. Tarnish of the restoration
   c. Wear and abrasion of the surface
   d. Liquid diffusion from the surface
   e. Stimulated vapor pressure release

What are the HIGHEST levels of mercury release measured under the "worst scenario" conditions of 12-16 occlusal amalgams and active surface stimulation during chewing?
   a. 1 μg/m³
   b. 10 μg/m³
   c. 30 μg/m³
   d. 50 μg/m³
   e. 100 μg/m³
Which one of the following organizations is generally viewed as NEUTRAL in their analysis of the mercury controversy?

a. Consumer Reports  
b. ADA  
c. DAMS  
d. Academy of Oral Medicine and Toxicology  
e. FDI

On a timely basis, MERCURY LEVELS in the office should be:

a. Eliminated by vacuuming the carpets and cleaning the floors  
b. Eliminated by employees using chelation drugs  
c. Dusting all floor areas with sulfur  
d. Monitored by submitting employee hair samples for Hg analysis  
e. Monitored by annual blood samples for Hg analysis

Which of the following is most likely to discourage future amalgam use?

a. Patient concerns about amalgam safety  
b. Problems with amalgam safety in the dental office  
c. EPA concerns with effluent from dental offices  
d. Inadequate supplies of mercury for dentistry  
e. Environmental concerns
DISCUSSION STUDY QUESTIONS:

How do you insure that your dental office does not become progressively contaminated by mercury during dental amalgam procedures?

A new patient presents with a recently placed dental amalgam restoration, a 20 year old full gold crown, a small amalgam tattoo near that crown, 4 PFM restorations, and a Class III anterior composite. She complains that she is sensitive to Hg and must have the amalgam taken out. Explain your analysis of the situation and justify your choice for treatment.

Comment on the relative incidence of supposed mercury hypersensitivity in children versus adults.

Explain how the placebo effect might be the reason for the results observed within patients who provide testimonials about the merits of amalgam removal.

Your dental hygienist has just informed you that she and her husband are planning to start a family. She asks your advice about the correlation of Hg exposure in the dental office and birth defects. What do you tell her?

OSHA has recently announced that it has reduced the acceptable TLV to 10 μg/m³. How does that change your interpretation of dental amalgam contributions to mercury toxicity?

Make a list of materials involved in the construction of your living room at home, your furniture, your furnishings, and your clothes which do not involve mercury catalysts, mercury batteries, mercury salts as additives, or mercury contamination from air or water sources.

How would you avoid drinking, breathing, eating, or contacting mercury containing materials in your environment?

What is the difference in health risk between being exposed to naturally occurring mercury derivatives and man-made mercury contaminants?

What should be the OSHA level for Hg exposure for human beings?

What are the routine hygiene measures that should always be observed in the dental office?