Mercury Release from New Dental Amalgams

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Background

- All materials have an equilibrium vapor pressure
- By definition, at the melting point, the solid and the liquid have exactly the same vapor pressure; below the melting point, vapor pressures of a solid are only slightly less that that of an equivalent cooled liquid
- Previous published measurements of release rate of mercury from dental fillings have primarily focused on the release rate from old fillings, with published rates generally in the range of 1-10 ug/day-filling
- There is a paucity of data on mercury release from newly-made mercury-amalgam fillings
- When first mixed, a mercury-amalgam filling MUST have EXACTLY the same vapor pressure as pure mercury; solid-state diffusion and reaction must occur before the vapor pressure of mercury in the amalgam is reduced below that of pure mercury
- The KEY QUESTION is HOW MUCH MERCURY IS EMITTED FROM A DENTAL FILLING IN THE FIRST FEW DAYS/WEEKS?

Goal: Measure the release rate of mercury from newly-made mercury amalgams

Methodology:

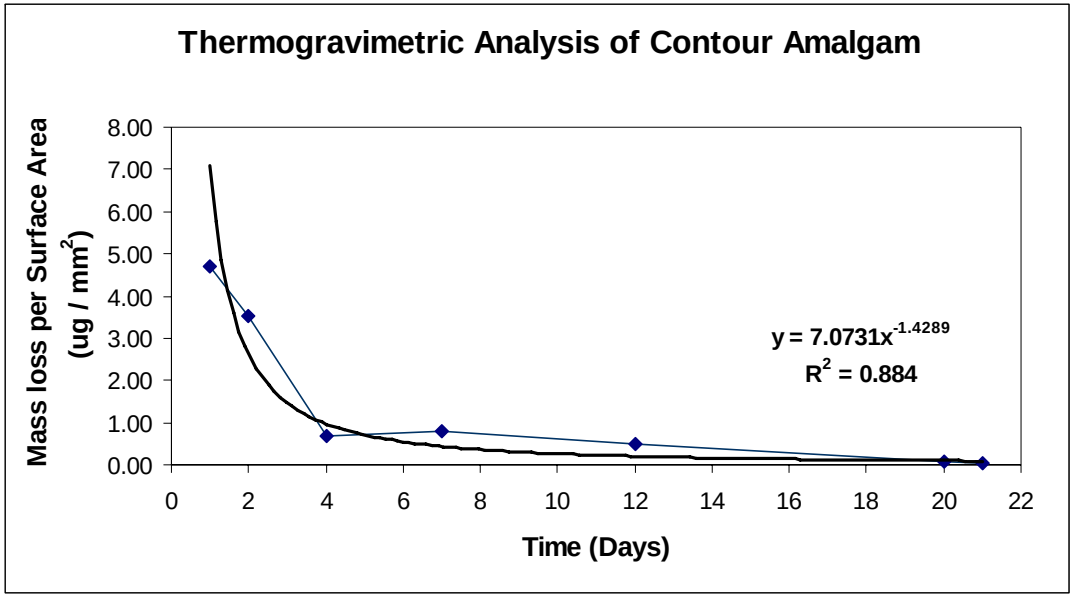
- Triturate mercury amalgam using commercial “single-spill” sample, under the supervision of a board-certified dentist
- Store samples in dry air for 0-21 days at body temperature (37° C)
- Use thermogravimetric analysis (TGA) to measure weight loss over 8-24 hour periods at body temperature
- Conduct analysis of gases emitted

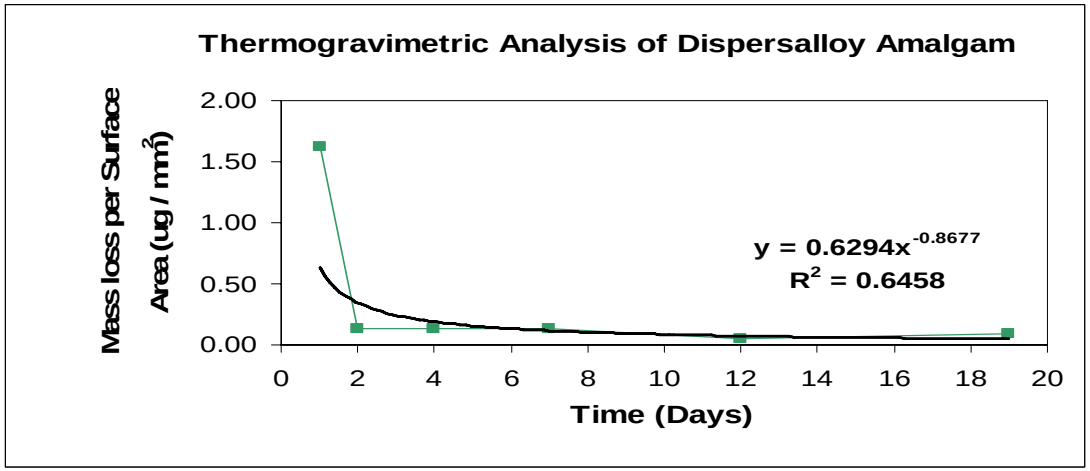
Samples Tested

Chemical Composition (weight %) Of 2 Alloys Studied

	Ag	Sn	Cu	Zn	Hg	
Contour	41%	28%	31%	0%	47%	new high-Cu
Dispersalloy	69.3%	17.9%	11.8%	1%	50%	old low-Cu

Results

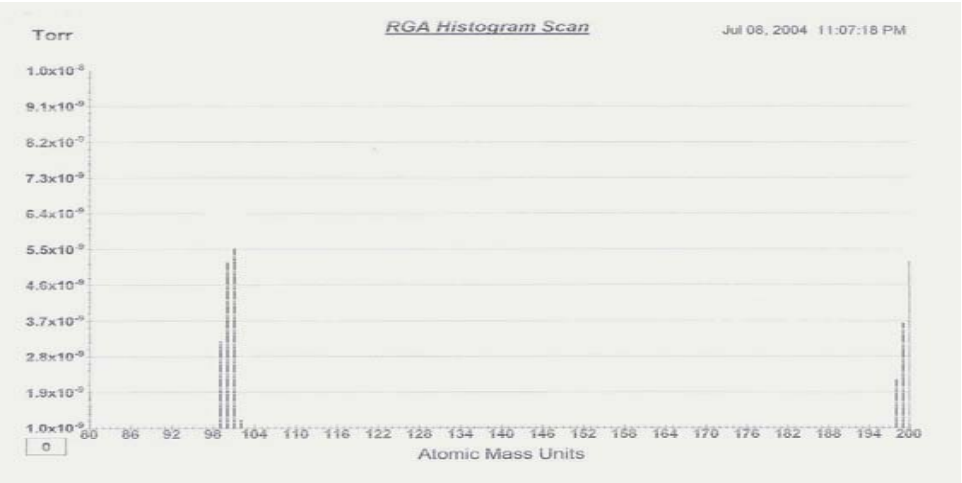




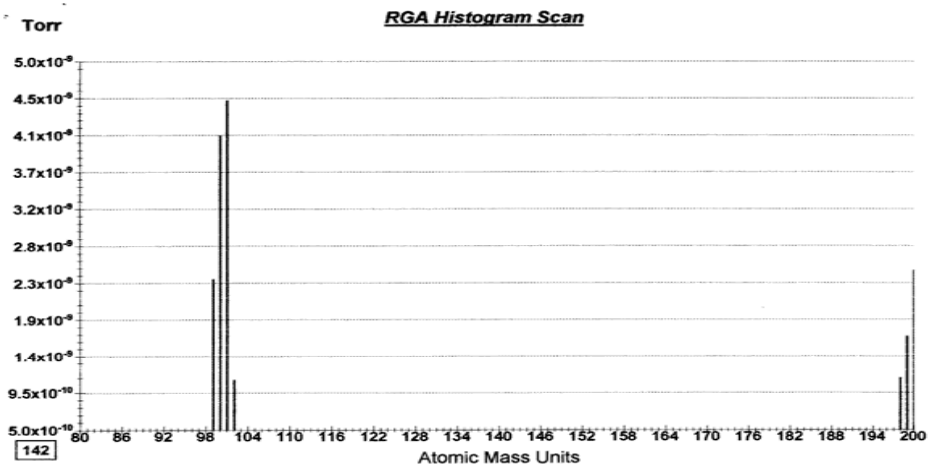
Note difference in scale: high-Cu alloy releases significantly more Hg than “old-fashioned” low-Cu alloy

Residual Gas Analyzer Results

Result from Amalgam



Result from Pure Mercury Drop



The RGA analysis reveals that **only mercury is present in the emitted vapor**, and it exactly matches the signature of pure mercury (one line for each isotope, for ions of +1 and +2 charge) in the mass spectrometer

Total release rate

- Contour amalgam:
  - Day 1: 4.70 µg Hg/mm^2 (295 µg per filling)
  - Week 1: 12.45 µg Hg/mm^2 (782 µg per filling)
- Dispersalloy releases
  - Day 1: 1.62 µg Hg/mm^2 (102 µg per filling)
  - Week 1: 2.55 µg Hg/mm^2 (160 µg per filling)

Notes:

- the amount per filling is for a “single-spill” filling; most fillings are 1-3 “spills”;
- assumes all filling is exposed (actual exposure to air may be only ¼ or less)

Limitations of Present Study

- Actual release rates for the first 4 hours could not be measured (equilibration of TGA required), so release rates on day 1 presumably higher than reported
- Current study involved samples stored in air at body temperature
- In the human mouth:
  - moisture may accelerate development of oxide layer, resulting in less Hg release
  - Brushing may abrade oxide layer, resulting in more Hg release

Conclusion

- Mercury amalgams emit much higher levels of mercury during the first few weeks than reported in the literature for fillings placed years ago (as should be expected)
- High Cu alloys (primarily in use today) release much more mercury than older-style Low Cu alloys
- Amounts emitted during first week are far in excess of FDA guidelines for exposure to methylmercury
- In-vitro studies needed to more exactly quantify release rates from new fillings – presently there is NO DATA on vapor release rates from newly-made fillings (except for this study)

- Funded by the Wallace Foundation
- Published in Masters Thesis of Jaime Aguillar, Arizona State University; journal article now in preparation