Author's response to reviews

Title: Mercury from chlor-alkali plants: measured concentrations in food product sugar

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Author's response to reviews: see over
November 23, 2008

Dear Editors of Environmental Health,

Attached please find the revised manuscript as per your request. Below please find a point-by-point response to the reviewers’ concerns:

Reviewer 1 Ari Rabl: “The measured Hg concentrations in all the samples should be shown in a Table, to give the reader a clearer idea of the magnitude of the problem.”

Our response: Table 1 provides the measured Hg concentrations in all of the HFCS samples.

Reviewer 1 Ari Rabl: “Some indication of the significance of the results should be given …..the neurotoxic impacts…of course, the lack of epidemiological data for elemental Hg is no assurance that children will not be affected, hence the interest of the present study. …..For example, dental fillings are a nearly universal source of Hg ingestion, and the resulting doses have been extensively studied. Pregnant women have such dental fillings. The authors should look for available data of Hg ingestion by infants and pregnant women…”

Our response: A literature review was conducted and there are no published studies of mercury exposure from dental amalgam in pregnant women. There are no human studies that provide information regarding consumption of inorganic mercury in infants. Canada released a report entitled Assessment of Mercury Exposure and Risks from Dental Amalgam in 1995 that provided some data on daily mercury exposure from amalgam alone in children. This report is found at http://dsp-psd.communication.gc.ca/Collection/H46-1-36-1995E.pdf. The US Department of Agriculture recently released per capita consumption data for high fructose corn syrup for the year 2007. On average, the typical American consumes 49.8 grams HFCS/day. This information is found at http://www.ers.usda.gov/briefing/sugar/data/table52.xls. We have incorporated this new information into the text as follows:

“With the reported daily consumption of 49.8 g HFCS per person, however, and our finding of mercury in the range of 0.00 to 0.570 mcg mercury/g HFCS, we can estimate that the potential daily mercury exposure from HFCS can range from zero to 28.4 mcg Hg. This range can be compared to the range of mercury exposure from dental amalgam in children reported by Health Canada [19]. In the report issued by Canada, daily estimates of mercury exposure from dental amalgam in children ages 3-19 ranged on average from 0.79 to 1.91 mcg Hg. Canada and other countries do not recommend the use of mercury amalgam in pregnant women or children.”
Given that there is no published data of studies conducted to determine mercury exposure from dental amalgam in pregnant women and there are no studies published of mercury exposure in infants from non-fish food, we have also added the following paragraphs with references that provide information on the adverse neurological effects of exposure to all forms of mercury in pregnant women and infants:

“Mercury in any form, as water-soluble inorganic salts, as lipid-soluble organic mercury compounds, or as metallic mercury are extremely potent neurological toxins [20]. Organic mercury compounds such as methylmercury that are fat soluble and readily cross the blood brain barrier are especially damaging to developing nervous tissues [21,22]. For example, prenatal exposure as low as 10 ppm methylmercury, as measured in maternal hair growing during pregnancy, may adversely the development of the fetal brain [22, 23]. Confounding associations and concerns related to early life exposure to mercury include the following sources: maternal fish consumption during pregnancy, the thimerosal (sodium ethylmercurithiosalicylate, approximately 49% mercury weight) content in vaccines and dental amalgam with various stages of brain development [24].

Mercury regulation varies from country to country. While the US government only regulates methylmercury in fish, several other governments regulate all forms of mercury in all foodstuffs. In the US, the current action level of 1 mcg methylmercury/g fish or seafood was set in 1977 during court proceedings of the United States of American VS Anderson Seafoods, Inc. [25]. The data used to determine the action level in fish came from a poisoning incident that occurred in Iraq under Saddam Hussein’s regime in 1971-1972. There was not a chain of custody for the specimens taken from the victims of that poisoning that were tested by World Health Organization or American researchers, and an appropriate epidemiologic study was not undertaken [26]. Further risk assessment for methylmercury has been conducted using human data from the massive episodes of mercury poisoning in the tragic Minimata Bay incident in Japan, as well as from large scale epidemiological studies concerning childhood neurodevelopment and neurotoxicity in relation to fetal exposure in various fish eating communities around the world [21, 22]. There has never been a blinded, placebo, controlled study published giving humans mercury or methylmercury, nor would this kind of study be considered ethical. A no adverse-effect-level for mercury in humans has ever been determined [26]. The implications for mercury in ingested HFCS are not known and clearly more epidemiological and neurotoxicological studies are required.”

Reviewer 1 Ari Rabl: “I suggest changing the title to “Mercury from chlor-alkali plants: measured concentrations in food product sugar.”

Our response: This has been accomplished, please see new title.

Reviewer 2 Kate Mahaffey: “Within the US, the number of mercury-process chlor alkali plants has diminished markedly. I think the current number for the US is three.”
Our response: According to page 33 of the Environmental Protection Agency’s Spring 2008 Regulatory Agenda – apparently published in the Federal Register - “there are eight (8) mercury cell chlor-alkali plants operating in the US, with three (3) expected to close in 2008.” We have now listed this factual and reliable source of information as reference [2].

For details:  [http://www.epa.gov/regulations/documents/regagendabook-spring08.pdf](http://www.epa.gov/regulations/documents/regagendabook-spring08.pdf)

Reviewer 2 Kate Mahaffey: “Even if these data do uncover something important, the source of mercury chlor alkali is diminishing.”

Our response: The source of mercury chlor-alkali product may be diminishing in the US but the US continues to import huge quantities of mercury cell chlor-alkali product to make up the difference in the supply gap left behind when mercury chlor-alkali plants shut down their operations in the US. We downloaded specific import data from the International Trace Commission at [http://dataweb.usitc.gov](http://dataweb.usitc.gov)

Here is a summary of our findings for the importation of alkali and chlorine products listed under the North American Industry Classification System (NAICS) code of 325181

<table>
<thead>
<tr>
<th>Country</th>
<th># Hg Cell Chlor-alkali Plants</th>
<th># Other Type Chlor-alkali Plants</th>
<th>Amount Product Shipped to US (kg) 2006</th>
<th>Amount Product Shipped to US (kg) 2007</th>
<th>Percent Change 2006-2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Republic</td>
<td>2</td>
<td>0</td>
<td>3,434,319</td>
<td>4,150,232</td>
<td>20.8%</td>
</tr>
<tr>
<td>Denmark</td>
<td>2</td>
<td>0</td>
<td>7,458,313</td>
<td>4,488,189</td>
<td>- 39.8%</td>
</tr>
<tr>
<td>Belgium</td>
<td>4</td>
<td>1</td>
<td>133,922,897</td>
<td>159,624,585</td>
<td>20%</td>
</tr>
<tr>
<td>Finland</td>
<td>5</td>
<td>1</td>
<td>133,000</td>
<td>209,532</td>
<td>57.5%</td>
</tr>
<tr>
<td>United Kingdom **</td>
<td>3</td>
<td>2</td>
<td>19,822,143</td>
<td>80,131,118</td>
<td>304.3%</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>10,209</td>
<td>340,200%</td>
</tr>
</tbody>
</table>

** In all of Europe, the United Kingdom has the greatest capacity to produce mercury cell chlor-alkali products with three plants at Runcorn able to produce 738,000 tonnes mercury cell product per year. According to the Chlorine Industry Review Report for 2007-2008, the United Kingdom produced 774,000 tonnes of chlor-alkali product that year including the 738,000 tonnes produced from their mercury cell plants in Runcorn and the 36,000 tonnes produced using the membrane process at their two membrane chlor-alkali plants. The increase in chlor-alkali imports to the US from the United Kingdom is mostly a result of the increase in demand for mercury cell products.

For information and location of all plants and their production capacities in Europe, see the Chlorine Industry Review Report at [http://www.eurochlor.org/review2008](http://www.eurochlor.org/review2008)

**Reviewer 2 Kate Mahaffey:** “Because very little data are provided on consumption of HFCS, it is not possible to determine what contribution this source makes to overall exposures to inorganic mercury.”

Our response: While responding to the other reviewer’s comments, we found that the USDA has now released the per capita consumption data for HFCS for the year 2007. On average, the typical American consumes 49.8 g HFCS/day. This information is found at [http://www.ers.usda.gov/briefing/sugar/data/table52.xls](http://www.ers.usda.gov/briefing/sugar/data/table52.xls). In addition, we found a report released by Canada entitled Assessment of Mercury Exposure and Risks from Dental Amalgam in 1995. This report provided some data on daily mercury exposure from amalgam alone in children. This report is found at [http://dsp-psd.communication.gc.ca/Collection/H46-1-36-1995E.pdf](http://dsp-psd.communication.gc.ca/Collection/H46-1-36-1995E.pdf). The World Health Organization states that mercury amalgam is the greatest sources of inorganic mercury exposure in humans. To determine the contribution that mercury in HFCS may make to overall exposures in inorganic mercury, we have incorporated this new information into the text as follows:

“With the reported daily consumption of 49.8 g HFCS per person, however, and our finding of mercury in the range of 0.00 to 0.570 mcg mercury/g HFCS, we can estimate that the potential daily mercury exposure from HFCS can range from zero to 28.4 mcg Hg. This range can be compared to the range of mercury exposure from dental amalgam in children reported by Health Canada [19]. In the report issued by Canada, daily estimates of mercury exposure from dental amalgam in children ages 3-19 ranged on average from 0.79 to 1.91 mcg Hg. Canada and other countries do not recommend the use of mercury amalgam in pregnant women or children.”

**Reviewer 2 Kate Mahaffey:** “The manuscript appears to contain personal history (first paragraph under Background) that doesn’t contribute to the data presented in the paper.”

Our response: We have deleted the first paragraph under Background.

**Reviewer 2 Kate Mahaffey:** “The analytical methods appear to be sound, but calculation of the quantities of mercury added at each analytical step would be useful in separating the analytical contribution to total mercury content.”

Our response: The analytical methods are sound. There was no mercury added at each analytical step so there is no need for such a calculation.

**Reviewer 2 Kate Mahaffey:** “Because of a very small number of samples, little consumption data, and no effort to compare the findings to quantities of inorganic
mercury from other sources, it is impossible to judge the significance of this source to overall mercury exposure.”

Our response: With the new data available from the USDA on daily consumption of HFCS in 2007, we have now compared our findings to the quantities of inorganic mercury from dental amalgam and provided an explanation in our text as to the significance of our findings. Because FDA does not routinely test processed foods for mercury, there is no way to know how much inorganic mercury exposure comes from diet. The USDA data is specific for HFCS. There is no data on consumption of foods containing sodium benzoate or other chemicals made from mercury grade chlor-alkali products.

If you have any additional questions, please feel free to contact me at 304-582-2001 or rdufault@uttc.edu. We look forward to hearing back from you soon.

Sincerely,

Renee Dufault

Retired Public Health Service Officer
Instructor, United Tribes Technical College