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LETTER TO THE EDITOR

Mercury and autism: Response to the letter of K. E. v. Mühlendahl [Int. J. Hyg. Environ. Health 208 (2005) 435]

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Sir,

We thank Karl Ernst von Mühlendahl for his comments (von Mühlendahl, 2005) and give additional information about the study by Holmes et al. (2003), which in our opinion represents a milestone in understanding the toxicology of mercury.

Estimation of the number of amalgam in pregnant mothers

In Fig. 1 mothers' amalgam counts are grouped as 0–3, 4–5, 6–7, 8–9 and >10 to account for any slight variation. The difference that was most critical in the paper (Holmes et al., 2003) was the total lack of any increase in mercury in first hair cut analysis of the autistic children no matter what number of amalgam fillings the mother had during pregnancy (Fig. 1). This was in sharp contrast to the data of the normal children. If the validity of amalgam count or the collection or measurement of mercury in the hair had been a problem (von Mühlendahl, 2005), how could mercury levels in the hair of normal children correlate well with their mothers' amalgam count, but not in the autistic children? This argument would also not explain, why the standard deviations of the mercury levels in autistic children were very small compared to normal children. Note that there was a strong correlation between mothers' amalgam counts and mercury in hair of healthy children, which is well known through studies on animals and humans, despite differences in fish consumption.

The outcome variable was the mercury content in the first baby's haircut

This work has been repeated by other research units (Adams, 2004; Hu et al., 2003).

The interpretations of these results

The interesting question is why is there significantly less mercury in the hair of autistic children compared to healthy children, despite a significantly higher mercury exposure (from maternal amalgam and thimerosal)? Also, why do severe forms of autism exhibit significantly less mercury in their hair than mild or moderate forms of autism? To explain the elevated mercury in the hair of normal children versus autistics, the biochemical processes involved in mercury excretion in a healthy person must be considered. It is well known that, in contrast to methyl mercury, the half-life after initial exposure to mercury vapour or ethyl mercury in the blood is very short. This does not mean that this form of mercury is less toxic than methyl mercury. Studies using ^{201}Hg-labelled thimerosal showed that 6 h post-injection in rabbits, over 75% of the radioactive mercury was taken up by body tissues (Gasset et al., 1975). This is because mercury rapidly penetrates from the blood through the membrane lipid bilayers of the cells and the blood–brain barrier. Inside the cells, mercury from ethyl mercury and mercury vapour is immediately oxidized to the more

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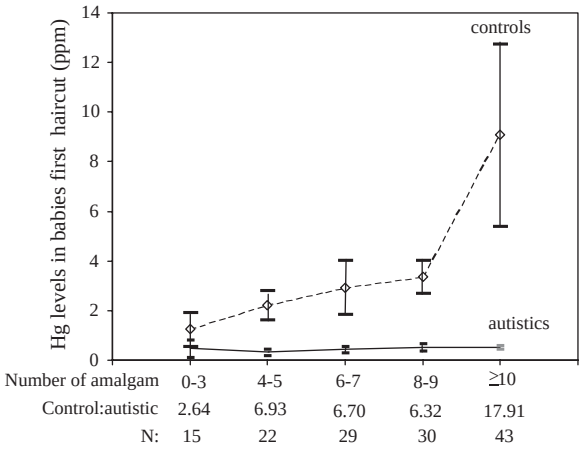

Fig. 1. Birth hair mercury levels of non-autistic (control) children versus autistics compared to their mothers' grouped numbers of dental amalgams. *N* equals the number of subjects, and the control to autistic ratios for each subset is presented (adapted from Holmes et al., 2003). Vertical bars indicate 95% confidence intervals. Mean hair mercury levels were statistically different from the control group ($P < 0.0000004$).

toxic form, Hg^{2+}, which is responsible for the known deleterious toxic effects inside the cells. Also, mercury must enter cells before it can be partly detoxified by formation of the glutathione–Hg–glutathione complex. This is because glutathione is located inside the cells at 4–10 millimolar levels (Meister, 1995) and in the blood at very low micromolar levels, about a 10,000-fold concentration difference. It is this same glutathione–Hg–glutathione complex that is transported out of the cells into the blood, where it is excreted by the kidney or by the bilary transport system of the liver into the faeces. This form of mercury is primarily found in the blood some hours or days after initial thimerosal and mercury vapour exposure. It is also this complex of glutathione and mercury that is apparently taken up by hair follicles from the blood over a longer period of time, since hair levels represent an integral of blood mercury levels during hair growth time. Increased excretion from cells into the blood results in higher blood mercury levels and increased blood delivery to the hair follicle (and liver for detoxification). Similar observations (Grandjean et al., 1995; Nelson and Bauman, 2003) are consistent with the fact that higher levels of hair and blood mercury seem to indicate better cellular excretion ability and therefore better health. A plausible analysis suggests that when considering a population with identical exposures to mercury, the relative increase of mercury in the hair, blood and urine of the subjects is an indicator of a better ability to excrete the mercury from intracellular compartments and body tissues rather than of an increased exposure. Mercury levels in blood, urine and hair are definitely not a reliable measure of total mercury body burden or clinical symptoms (for review, see Mutter et al., 2004, 2005). This important fact is still neglected in most recent reviews addressing the safety of dental amalgam (BfArM, 2003; Life Science Research Office, 2004).

Effective excretion of mercury will lead to higher hair, blood and urine mercury levels in a population that is being exposed to mercury at a constant, chronic, low level. The problem comes when those, who do not effectively excrete mercury, become exposed to a large dose, such as infants already exposed to mercury during pregnancy and who in addition received thimerosal-containing hepatitis-B vaccines on the day of birth. The USA EPA set a standard of exposure on the safe level of ingested methyl mercury of 0.1 μg/kg body weight. Using this safety level, the newborn would have had to weigh 125 kg to take this exposure safely.

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