Urinary mercury in subjects living close to chloralkali plants, the EMECAP study

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Abstract: EMECAP is EU-funded project with 12 partners from six countries. It covers many aspects many aspects on mercury (Hg) emission from chloralkali plants, including an epidemiological study of workers, and people living close to the plants. The aim was to study whether Hg contamination of ambient air could be shown to increase urinary Hg in those living close to the plants. Mercury in urine was determined in 482 individuals that lived close to two chloralkali plants in Sweden and Italy or in reference areas, and in 123 MCCA workers at the two plants. No increase of mercury in urine could be demonstrated in the populations living close to the plants, compared to those in the reference areas. The Swedish and Italian chloralkali workers had the highest exposure (medians 4-5 μg/g creatinine), followed by the groups in the general population with amalgam fillings (medians 0.6 – 1.3 μg/gC), and the groups without such fillings (medians 0.1-0.8 μg/gC). Urinary mercury was generally higher in Italy than in Sweden. Amalgam fillings, chewing, fish consumption, and female sex were factors associated with higher urinary mercury levels. In conclusion, the mercury exposure around these two chloralkali plants seems to be too low to be demonstrated as an increase in urinary mercury excretion. With a careful design it may be possible to demonstrate an increase of the mean urinary Hg level corresponding to an increase of mean ambient mercury down to about 10 ng/m^3.

Key words: mercury, chloralkali plant, general population, amalgam, fish

INTRODUCTION

In Europe the anthropogenic emissions of volatile mercury species have been estimated at about 300 tonnes per year (PACYNA ET AL., 2001). An important source is the chloralkali industry, where many of the plants in Europe still use the mercury cell process (SALLSTEN, 1990). The mercury cell chloralkali (MCCA) plants (about 60 plants at present) have been estimated to contribute about 15 % of the anthropogenic Hg emissions in Europe (PACYNA ET AL., 2001). When inhaled Hg^0 is rapidly absorbed by the

blood, and about 80 % is retained. The elimination occurs via urinary and faecal excretion (WHO, 1991). At steady state, a substantial part of the absorbed dose is found in the kidneys. The half time for Hg in urine is then about two months. Urinary mercury is widely used for assessment of exposure to inorganic Hg (mainly Hg^0) in humans (BARREGÅRD, 1993). Inorganic Hg like Hg^0 may cause a variety of adverse effects, the most classical ones in the central nervous system (tremor and mental changes) and the kidneys (e.g., proteinuria).

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SUBJECTS AND METHODS

In the village of Rosignano Solvay, Italy, 111 randomly selected subjects living close to the cell hall of the Rosignano Solvay plant since at least one year, agreed to participate and completed the study. In Donoratico, the reference area on the coast about 20 km south of Rosignano Solvay, 128 completed the study.

In the village of Bohus, Sweden, we recruited young, having no amalgam fillings, living close to the cell hall of Eka Chemicals, or in the reference area, Nodinge 6 km north of Bohus. In total, 160 completed the study. Moreover we examined 82 subjects from Bohus and Nodinge aged < 65 years with no restrictions on amalgam fillings.

All subjects received a questionnaire on background factors, and were asked to count the number of teeth filled with amalgam. They delivered a first morning urine sample at home. The assessment of urinary mercury was based on creatinine-corrected levels (U-HgC, μg Hg per g creatinine), in order to take hydration and urinary flow rate into account. Total mercury in urine was determined by cold vapour atomic absorption spectrometry after preconcentration on a gold trap (HORVAT ET AL., 1986, 1991). The detection limit of the procedure is 0.05 ng/ml. The precision was 2 to 5 %. The accuracy of the results was checked by the use of the certified reference materials.

RESULTS AND DISCUSSION

The urinary mercury (U-Hg) levels in the general population, stratified by site and number of amalgam fillings is presented in Figure 1. The distribution of UHgC was skewed, and approximately log-normal. Therefore, in multivariate analyses, lnUHgC was used as the dependent variable. U-HgC was statisti-

cally significantly higher in Italy than in Sweden. There was also a clear and significant increase of U-HgC with number of teeth filled with amalgam. A multivariate analysis of the general population showed several statistically significant determinants, but no effect of site (living in reference area or close to a chloralkali plant). When making the analyses separate for each country, there was a tendency towards higher levels in Donoratico. The most sensitive analyses with respect to the potential increase of U-HgC from ambient air close to MCCA plants, are those performed on subjects without amalgam fillings. The results for these analyses were essentially the same as indicated above.

The most important question to be answered in the epidemiological part of the EMECAP project was whether people living close to MCCA plants had higher U-Hg than their respective reference groups. In univariate and multivariate analyses no such increase could be shown. In Italy, there was rather an effect in the opposite a direction. In summary, no impact of mercury in ambient air around the MCCA plants could be demonstrated. The reason for this is probably the relatively low mercury levels shown at the environmental monitoring.

The fact that dental amalgam is a major source of exposure to inorganic Hg is well known, also in Sweden (WHO, 1990; BARREGĹRD, 1995). The large impact of amalgam fillings confirmed the a priori hypothesis assessment that a potential impact on the nearby population from inhalation of ambient air contaminated with Hg from the MCCA plants could only be evaluated in people without amalgam fillings.

An advantage of the EMECAP project is that the same sampling equipment and analytical laboratory were used for all populations examined. Thus differences shown between groups or countries could not be caused by methodological differences. The results from the EMECAP study may be used by researchers aiming at demonstrating an increased Hg uptake from ambient air in the general population. Separate power calculations indicate that, under certain conditions, an increase of 10 ng/m^3 could be detected. Such mercury levels may be found around certain plants (JAROSINSKA, 2004).

CONCLUSIONS

The EMECAP project showed that no increase of urinary mercury excretion could be shown in the general population living close to two mercury cell chloralkali plants in Sweden and Italy. The ambient mercury concentrations around the plants are too low, in comparison with "normal uptake" from dental amalgam or diet. Carefully designed studies could, however, have the power to demonstrate an increased Hg uptake at 5-10 times higher ambient mercury levels.

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