Question 1: Are mercury releases caused by the use of dental amalgam a risk to the environment? The fate of mercury released from dental clinics as well as the fate of mercury released to air, water and soil from fillings placed in patients should be taken into account

SCHER noticed that nowadays dental amalgams may represent one of the major intentional uses of mercury. A mass balance of mercury emissions, in air, water and soil, from dental amalgam has been proposed by Bio Intelligence Service (2012). This type of mass balance contributes to the understanding of the magnitude and sources of mercury contamination caused by dental applications. However, it does not enable to quantitatively assess the risks of Hg in amalgam, particularly if one considers that a non-negligible risk from mercury in dental amalgam is likely to occur only at a local scale, close to relevant emission sites. For the soil and air compartment SCHER concluded that a quantitative Predicted Environmental Concentration (PEC) cannot be estimated and an assessment of local risk is not possible at the moment. Only for the aquatic environment a more quantitative assessment is considered possible. Exposure in surface water has been calculated considering three possible scenarios (worst, average and best case). The PECs calculated in the three hypotheses have been compared with the Water Framework Directive Environmental Quality Standards (Annual Average EQS and Maximum Allowable Concentration EQS) that have been set for mercury. The comparison shows that only in the worst scenario the PEC is above both AA and MAC EQS.

The most pessimistic estimations must be taken into account in the calculation of fish impregnation. In fact:
1) A part of the population (especially heavy consumers of coastal areas, including pregnant women and children) exceeds the TWI *. Yet it is essential in order to protect the entire population.
2) exposure to different types of mercury is cumulative. But the "worst case scenario" takes place in countries where the situation is most critical on dental mercury exposure, such as France and Poland (which both represent half of the EU consumption of dental mercury, as the first source of exposure * *). In order to protect every one,, the risk assessment should be based on the most worrying data and not on "average" values.

* INRA , AFSSA . Study of food consumption of seafood and Impregnating trace elements , pollutants and omega 3 . 2006.

** BIOIS 2012

Question 2: Is it scientifically justified to conclude that mercury in dental amalgam could cause serious effects on human health due to mercury releases into the environment?

Mercury coming from dental amalgam as well as from many other sources, ubiquitously distributed in the environment, can be taken up by the general human population via food, water and air. Regarding the contribution of environmental mercury coming from dental amalgam use, it can be concluded that emissions of Hg to soil are not considered as a concern regarding human health. Regarding inhalation, amalgam use will also make only a limited contribution to the overall human inhalation exposure. The contribution of amalgam use to the concentrations of methyl mercury found in fish is not known and consequently no clear conclusion on possible health risks is possible. However SCHER estimated three scenarios in fish based on five hypothetical values for the methylation rate of mercury. SCHER also noted that all additional sources which add to the methyl mercury burden in humans may increase the number of people at risk, thus respecting the more conservative WFD threshold would contribute to the prevention of human health effects.

SCHER ignores a major public health problem, partly induced by the pollution of dental origin: bacterial resistance to antibiotics. WHO (May 2013) notes that antimicrobial resistance increases morbidity and mortality, increasing therefore healthcare costs. **There is currently an extremely worrying increase in that resistance**: 3.7 % of new TB cases are multi resistant to antibiotic treatments; many nosocomial/iatrogenic infections are caused by highly resistant bacteria such as methycillin-resistant Staphylococcus aureus and multiresistant common gram-negative bacteria (P. aeruginosa, A. baumanii). In France, INSERM believes that the case of most concern in the city and in the hospital is the one of Enterobacteriaceae producing beta -lactamases with extended spectrum (E. coli and K. pneumoniae) .

Mercury is recognized for over 50 years as a vector for antibiotic resistance. Currently, many references on that topic apprear in Medline. Researchers became interested in S. aureus resistance in the 1960s, to both mercury and certain antibiotics in hospitals [Dyke 1967 Rosendal 1981]. This multiple resistance was soon encountered in other environments and other species of bacteria : E. coli [Grewal 1999], Citrobacter [Nakahara 1984], K. pneumoniae [Nakahara 1978], S. typhimurium [Makino 1981] and in other species [Ferreira da Silva 2007 Cabarello -Flores 2012 , Resende 2012] . Fast enough, **the hypothesis that the use of mercury induces antibiotic resistance was put forward and confirmed** [Hall 1970 , Joly 1975 Poiata 2000] .

According to the BIOIS report (2012), in Europe, **dental mercury contaminates each year**:

- **air** (3.5 tons from dental offices + 2 tons from the mouths of holders + 6 tons from sewage + 4.5 tons of waste from + 3 tons coming from sludge cremation = **19 tons**)
- **water** (1 ton after treatment plants wastewater + 1 ton from treatment + 1 ton waste sludge = **3 tons**)
- **soil and groundwater** (from 8 tons sewage sludge + 4 tons from burrials + 8.5 of waste = **20.5 tons**)

The induction of antibiotic resistance because of mercury pollution in the environment has been clearly demonstrated [Timoney 1978 , Rasmussen 1998, McArthur 2000 Ball 2007]. Two recent studies underline the emergency of this issue:

1) Meredith et al. [2012] showed that **the bioaccumulation of mercury in fish (such as the one induced by dental mercury in the SCHER expertise) can lead to an accumulation of mercury-resistant bacteria and antibiotics, even in the absence of isolated source mercury emissions**.

2) Even if the proportion of antibiotic resistance induced by mercury is unquantifiable that phenomenon is not a marginal one. Skurmik et al. [2010] compared a metropolitan French population (exposed to antibiotics and without significant exposure to mercury) to a Native American population of French Guiana (little exposed to antibiotics but highly exposed to mercury): the American Indians bacterial flora contains the most antiobitics-resistant e . coli.

Dental amalgam could also induce antibiotic resistance in the intestinal flora of the dental-wearer. Solid research supports this hypothesis [Summers 1993, Edlund 1996 Wireman 1997 Ready 2007]. This point remains a public health issue due to the spread of resistant bacteria via wastewater.

In conclusion, corroborative evidence strongly suggests that dental mercury is a danger that is easily removable with regards to antibiotics- resistance - a public health issue of major concern.

Question 3: Comparison of environmental risk from the use of mercury in dental amalgam and the use of alternatives without mercury

The information available on the Hg-free alternatives does not allow for a sound risk assessment to be performed. For the human health, SCHER is of the opinion that the conclusions of the 2008-opinion are still valid, except for alternative materials containing bisphenol A-glycidyl methacrylate (Bis-GMA). For these materials SCHER recommends to refer to an on-going SCENIHR mandate on the use of bisphenol A in medical devices, as soon as this becomes available. For the environment, considering the probably low level of emissions and the relatively low toxicity of the chemicals involved, it is reasonable to suppose that the ecological risk should be low. However, it is the opinion of the SCHER that, at present, there is no scientific evidence for supporting and endorsing these statements. Therefore, more research on alternative materials is recommended.

Bisphenol A (BPA) is this only danger that has been identified in alternative dental materials. However, the environmental footprint of this substance remains much lower than the one of mercury because BPA is neither biopersistent nor bioaccumulative.
Several resins and all glass ionomer cements do not contain BPA. Even though scientific datas confirming their safety are scarce, the use of these materials should be preferred to the use of materials for which hazards have been clearly demonstrated.

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