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MERCURY DETERMINATION IN DENTIST'S HAIR AND NAILS BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS

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RESUMO. *Determinação de mercúrio em cabelo e unhas de dentistas por análise instrumental por ativação com nêutrons.* No presente trabalho, determina-se o teor de mercúrio no cabelo e unhas da mão de um grupo de dentistas que normalmente manuseiam este elemento tóxico em sua profissão.

Os resultados foram obtidos por análise instrumental por ativação com nêutrons. O procedimento experimental se baseou na determinação da área do pico do ^{197}Hg, cuja meia-vida é de 65h. Após a irradiação, sob um fluxo de nêutrons de $5X10^{12} n.cm^{-2}.s^{-1}$, a atividade das amostras foi medida por meio de um detetor de Ge (Li) acoplado a um multianalisador de 4.096 canais.

Não foi verificada nenhuma contaminação nas amostras de cabelo analisadas. Já no caso das amostras de unha, teores de mercúrio acima dos níveis considerados "normais" para a população em geral foram encontrados, indicando uma aparente contaminação devida sobretudo à absorção externa deste elemento.

ABSTRACT. This work is concerned with the determination of mercury in scalp hair and fingernails of a group of dentists who usually handle with this toxic element in their profession.

The results were obtained by instrumental neutron activation analysis. The experimental procedure was based on the evaluation of the ^{197}Hg photopeak area, whose half life is 65h. After irradiation at a neutron fluxo of $5X10^{12}n.cm^{-2}.sec^{-1}$, the activity of the samples were measured by using a solid state Ge (Li) detector coupled to a 4.096 channel pulse height analyser.

No contamination was found in the hair samples analysed. For the fingernail samples, on the other hand, mercury contents above the levels considered "normal" for the population were obtained, thus indicating an apparent contamination due mainly to the external absorption of this element.

INTRODUCTION

During the last years public attention has been concerned with environmental pollution and with the influence of trace elements on human health. As it is known, these trace elements can get into the human body by means of ingestion of contaminated food, simple air inhalation or even by direct absorption from the biosphere.

It is therefore important to establish a detection and monitoring programme, whose aim would be to define "normal" levels and to point out possible contaminations. Yet, the interpretation of these results requires a perfect knowledge of the exposure-to-dose relationship, and of the distribution of trace elements within human tissues and organs, especially for the so-called "normal" levels.

Mercury which is the purpose of our study has already been detected in all the tissues of human victims of accidents, although these victims had not been subjected to any abnormal exposure to mercury other than dental repair (7, 9). The mean concentrations mostly fell between 0.5 and 2.5 ppm of Hg on the dry basis, the highest Hg levels being present in the skin, nails and hair, which are also exposed to atmospheric and other contaminations. Rodger *et al* (13), for instance, obtained the following mean Hg concentrations of subjects with no known abnormal exposure to mercury: head hair, 5.5; pubic hair, 1.6; fingernails, 7.3 and toenails, 2.4 ppm. Of course, these levels tend to increase when any kind of accidental or industrial exposure occurs. The mean Hg concentrations of the head hair and fingernails of a group of 20 dental assistants were 32.3 and 68.8 ppm. respectively, compared with 8.8 and 5.1 ppm for these tissues in 26 control subjects (7).

Higher levels, up to 98.6 in head hair and 1.068 ppm in the fingernail of one individual, were observed in a group of workers as the result of Hg contamination of their laboratory.

Lower head hair Hg levels, ranging from 0.2 to 6.0 ppm, were obtained for Canadian controls, compared with 5-10 ppm in individuals with occupational exposure to mercury (8).

The Hg level of hair and fingernails gives, therefore, some indication of the Hg status of individuals and of their environment, although the "normal" range is extremely wide (2, 13).

As already stated, the environmental contamination and its control constitute a serious problem. This problem becomes even more critical when the individuals are potentially subjected to abnormal exposures due to their professional occupation. Dentistry is one of these occupations, since the dentists handle significant amounts of mercury in the metallic form.

This element is used for making amalgams for filling in teeth and during the process the metal gets on to the hands from where it can be spread. The vapour is also present in significant amounts, in the atmosphere. As a result, dentists are much more exposed than the general public (10) and some may even be poisoned (11).

Having in mind this problem and considering the lack of information concerning our own country, we decided to investigate the level of mercury in head hair and fingernails of a group of 43 dentists by using instrumental neutron activation analysis. In order to judge if the chosen group has really been subjected to abnormal Hg exposure, it became essential to establish the "normal" concentration levels for the population as a whole.

The experimental procedure is based on the evaluation of the 77.6 keV ^{197}Hg photopeak

area, whose half life is 65h. The nuclear reaction ^{196}Hg (n, γ) ^{197}Hg seems to be more suitable than the ^{202}Hg (n, γ) ^{203}Hg usually used, since the radionuclide ^{197}Hg peak does not suffer from any interference, whereas the ^{203}Hg peak has energy very close to the ^{75}Se peak.

EXPERIMENTAL

Sample preparation

Hair and nail samples for the evaluation of the mercury contents in the population in general were randomly collected from the inhabitants of the city of São Paulo. For the dentists the choice fell upon those who frequently handle with mercury compounds in their profession. A special care was taken in the sampling of hair in order to obtain analytical results sufficiently representative with regard to the mercury composition.

It is known that the variability of the elemental concentration occurs according to the hair's location in the scalp (4) and even within a single hair (5, 6). Unfortunately in our case, it was not possible to collect hair strands from different places of the same scalp. The hair samples were always clipped from the back of the head and very close to the scalp. The length of all the hair strands analysed did not exceed 5cm.

The washing of hair samples is another important factor since from the analytical point of view the hair composition is affected substantially by its treatment before irradiation. Some authors do not use any treatment at all (12) whereas others use a mild washing, which does not affect the content of trance elements chemically bound to the hair but removes dirt and fat (3). We opted for a mild washing consisting of distilled water and a methanol-acetone mixture, according to Atalla *at al* (1). Indeed, these washing agents reduce the content of macro-elements, like sodium and chlorine which seriously interfere in the activation analysis with termal neutrons, without affecting the trace elements composition. The hair and nail samples were washed with 20ml of distilled water, 20ml of a mixture methanol-acetone and again with 20ml of distilled water, each washing being repeated thrice. The washed samples were then dried at room temperature for at least 24 hours and the hair was cut in small segments not longer than 2mm.

Samples weighing about 50mg were conditioned in quartz ampoules (7mm internal diameter x 5cm long) for irradiation. The mercury standard solution was prepared by dissolving known amounts of mercury nitrate in a few drops of 0.5N nitric acid and then diluting to a known volume using distilled water. After filling with the desired amount of standard or sample the ampoules were heat sealed, while being kept in liquid nitrogen to avoid heating of the sample and losses of mercury volatilization.

Irradiation and counting

Each sample was irradiated together with the standard in an aluminum container (rabbit), 7cm long x 2cm internal diameter, at a thermal-neutron flux of approximately 5×10^{12} .n.cm^{-2} sec^{-1} during 8 hours.

The samples and standards were subsequently cooled for a period of 4 days, prior to the counting, to allow the decay of radionuclides of short half-life, such as ^{24}Na, which can seriously interfere in the analysis.

The gamma-spectra of the samples and standards were recorded by using a solid state Ge(Li) detector, model 8.001-1.022V, with a resolution of 2.6keV for the 1.332keV peak of ^{60}Co. The detector was coupled to a 4.096 – channel Hewlett-Packard analyzer and to a Hewlett-Packard mini-computer for data reduction. All samples were counted in a fixed geometry for 20 minutes.

RESULTS AND DISCUSSION

Mercury contents in head hair of 43 dentists handling with amalgam in dental practice and 41 "normal" individuals were compared with each other. The values ranged from 0.3 ppm to 5.8 ppm for the "normal" people, and from 0.9 ppm to 4.2 ppm for the dentists, giving an arithmetic mean of 2.024 ± 1.36 and 2.25 ± 0.94, respectively. The frequency distribution of the mercury content in the head hair (shown in Fig. 1) increased steeply at about 0.5 ppm for the "normal" people and 1 ppm for the dentists and decreased more slowly in both cases. It can be seen

the differences in mercury concentration were apparently insignificant from one group to another showing no abnormal hair contamination.

The results obtained for the frequency distribution of the mercury contents in the fingernails from 21 dentists and from 22 "normal" people are presented in Fig. 2, except for four cases in which a higher contamination was found: 50.7, 64.8, 96.7 and 208.6 ppm of Hg.

Excluding these data, all the other determinations gave an arithmetic mean of 10.88+8.89 for the dentists (values ranging from 1.0 ppm to 28.2 ppm) whereas for the "normal" people the observed mean was 0.86±0.68 (values ranging from 0.3.ppm to 3.1 ppm).

It is apparent, in this case, that the mercury contents in the dentists fingernails are much higher than in the "normal" individuals. These higher values can be considered as an indication of a mercury contamination, which is more likely to be caused by the direct absorption from the skin due to the direct handling of the element.

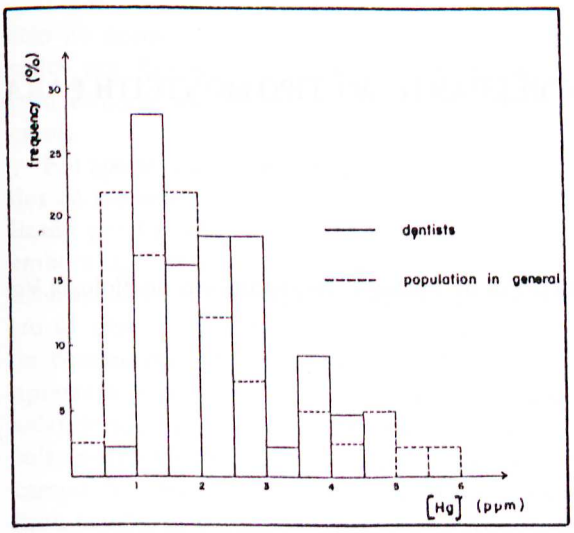

Fig. 1. Mercury content of hair from 43 dentists and 41 individuals of the population in general.

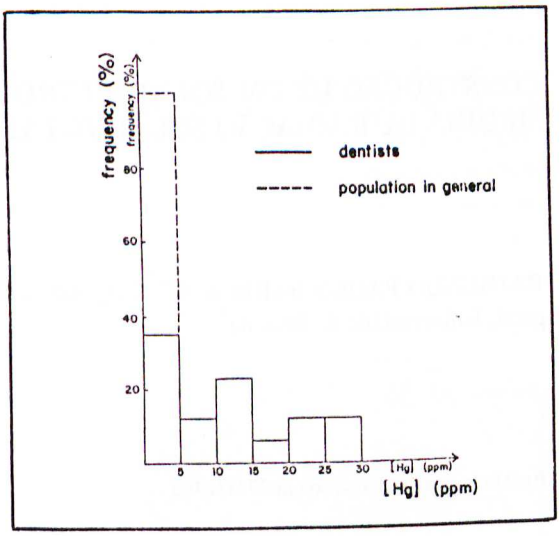

Fig. 2. Mercury content of nail from 21 dentists and 22 individuals of the population in general.

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CONSTRUÇÃO DE UM SOLARÍMETRO SEMELHANTE AO TIPO MONTEITH PARA MEDIDA DE RADIAÇÃO SOLAR TOTAL

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ABSTRACT. *Construction of a solarimeter similar to Monteith type to measure total solar radiation.* The construction of a solarimeter simple and cheap, similar to Monteith type to measure total solar radiation is described. The instrument has 11 X 11 X 7.7cm and weight 320g. Using thermopile with sensitivity of 66 $Wm^{-2}mV^{-1}$ has resistence 93 Ω and response time 74s. This solarimeter could be used with a portable milivoltimeter in ecophysiological studies. Outdoor comparison with Kipp solarimeter showed good performance of the instrument, the desviation from the mean response was small. A short analysis of the error origin showed that most of it is from the milivoltimeter accuracy and instrument sensitivity. Estimation of error gave results between 4 and 3% in the morning and at noon, respectively.

RESUMO. Descreve-se a construção de um solarímetro simples e barato para medida de radiação solar total, semelhante ao tipo Monteith. O aparelho, de 11 X 11 X 7,7 cm de dimensão, pesando 320g, usa junções de termopares com um fator de calibração de 66 $Wm^{-2}mV^{-1}$, com resistência elétrica de 93 Ω, tempo de resposta de 74s. Este solarímetro pode ser utilizado junto com um milivoltímetro portátil, em estudos ecofisiológicos. Comparações no campo com o solarímetro de Kipp mostrou um bom desempenho para o instrumento, a divergência dos pontos entre as duas escalas é pequena. Uma breve análise das fontes de erro indicou que a maior parte do erro é devida à sensibilidade do milivoltímetro e ao fator de calibração. Estimativas do erro deram valores entre 4 e 3% pela manhã e ao meio-dia, respectivamente.

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