Several hundred samples of human head hair were analyzed to establish the range and variation of mercury concentration in "normal" people and in persons ingesting organic mercury compounds. Instrumental neutron activation analysis was used. The 77 keV line of $^{197}\text{Hg}$ was counted on a Ge(Li) detector. The pattern of concentration variation along hair was shown to be a more reliable criterion for hair individualization than average concentration values. The hair mercury contents of "normal" people in uncontaminated areas were 0.1-4 and 1-12 ppm, respectively. People who had ingested a mercury compound but showed no symptoms had hair mercury concentrations of from a few ppm to 300 ppm. Mild symptoms appeared with a 120-600 ppm hair mercury level, moderate with 200-800 ppm, and severe with 400-1600 ppm. There was no correlation with sex or age, except that infants showed more severe symptoms than expected, and people over 55 had mild or no symptoms with hair mercury levels of 1000 ppm and higher.

Introduction

Determination of the trace element composition of hair has made a valuable contribution to forensic science. Its principal applications have been in toxicological investigations and in hair individualization.\textsuperscript{1-4}

Abnormal concentrations of toxic elements, e.g. Hg, As, Tl, Th and U, in hair have served in a number of investigations as evidence of ingestion of abnormal amounts of toxic substances.\textsuperscript{5-9} The concentration variation along the length of the hair can be used to reveal the history of the poisoning.\textsuperscript{10, 11} In order to judge whether abnormal amounts of toxic substance have been ingested, it is essential to collect statistically significant data on the concentration of the toxic agent in the hair of randomly selected "normal" persons. It is also of great value to study the pattern of change in the hair concentration of the toxic element in people with known exposure to these elements. Although a few laboratories have been engaged in compiling background data, there is very little in the literature on the concentration variation along the hair and its relation to the history of poisoning.\textsuperscript{5, 11-13}
This study endeavours to present such data for people exposed to organic mercury and to relate the severity of the toxic symptoms to the mercury concentration in the hair.

The study also considers the value of mercury concentration in hair to characterize individuals. Trace element concentrations in hair have been extensively used in the past for hair individualization. Despite the enthusiasm regarding the application of instrumental neutron activation analysis in trace element characterization of hair, there have been reservations as to its absolute validity, mainly because of the wide variation in the concentrations of certain trace elements due to outside influences, e.g. washing, dyeing, swimming, working in a dusty atmosphere, etc. Not all the trace elements are influenced in the same way by outside contaminants and therefore it may not be very useful to group them all together in an individualization study. There are trace elements (e.g. Na, Cl, Mn, Cu, Zn and Cr) that are easily influenced by outside conditions and their concentrations may be changed by natural living habits. They cannot be confidently used, therefore, to individualize a specimen.

On the other hand there are elements (e.g. Hg, As, Tl, Th, U and Au) that, once introduced into hair through metabolic functions, appear to be fixed and not affected by washing or perspiring. Although the concentration of even these elements may change appreciably in the hair of a given individual, the changes are most probably controlled by metabolic functions and are not due to direct outside contaminations.

It has been observed that the range of concentration variation over the scalp of an individual may be of the same order of magnitude as the range between individuals, which makes individualization rather uncertain. In this study we propose that the concentration variation pattern of the elements that are controlled by metabolic processes be used for the characterization of hair instead of the absolute concentration values. Results are presented to show that for a given individual the pattern of change for some elements (e.g. Hg) is very characteristic despite the large variations in the absolute concentration.

**Experimental**

Several hundred samples of head hair were collected from "normal" people and from persons who had ingested organic mercury compounds. Thirty-five samples were sectioned in 1 cm lengths and the variation in the mercury concentration along the hair was studied.

Instrumental neutron activation analysis was used for the mercury determination. Samples of 10-100 mg of hair were washed in alcohol, dried, weighed accurately, and wrapped in aluminum foils. The samples and mercury standards were irradiated for 50 hrs at a neutron flux of $5 \times 10^{12}$ n $\cdot$ cm$^{-2}$ $\cdot$ sec$^{-1}$ at the IRT-2000 ex-