MEDICAL APPLICATIONS OF X-RAY FLUORESCENCE: A STATUS REPORT RELATED TO TRACE ELEMENT RESEARCH

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Many trace elements are essential for the function of the human body whereas others are toxic in higher concentrations and may cause temporary or permanent damage to various organs and tissues. There is thus a basic need to control trace element levels in humans. Valuable knowledge of the relations between observed toxic effects and element concentration may be extracted from measurements in humans, on samples from man and the environment. Applications mainly include occupationally exposed subjects but a growing research area is studies of members of the general population and of patients undergoing therapy for malignant and other diseases, using various metal complexes and more simple compounds.

The presentation will review techniques for estimation of element levels directly in humans (non-invasive in vivo) or in samples (in vitro), e.g. blood and urine from man. Focus will be on the elements iodine, lead, cadmium, mercury, platinum and gold.

Most in vivo XRF studies include subjects occupationally exposed to lead and cadmium. Results have shown very high levels of these elements in bone and kidneys, respectively. Combined data from element concentrations in body fluids have increased our knowledge of the kinetics of these elements. Both techniques are now further developed and useful even for measuring the much lower levels found in subjects of the general population. For example, the detection limit for cadmium in kidney cortex using the XRF technique allows for significant differences between groups of smokers and non-smokers to be observed. In general, the effective dose (mSv) is also less for in vivo XRF compared with in vivo neutron activation analysis. For retired lead workers, a clear association between bone lead and blood lead, due to endogenous lead excretion from the skeleton, has been demonstrated in a number of studies. Longitudinal studies of retired lead workers presented biological half-times for bone lead of several years. Few studies of mercury in vivo have been undertaken, but the technique is capable of detecting mercury K X-rays in the most heavily exposed workers’ kidneys. In vivo XRF in subjects administered with compounds containing platinum and gold in oncology and rheumatology, respectively, have helped understanding how these elements behave in the human body.