Biological monitoring of exposure to industrial chemical (hazardous substances)

Health impairment may, and in most cases will, result from the over exposure to chemicals at workplaces. Biological monitoring is one of the steps in detecting a breakdown in the control methods present to avoid the exposure of the workers to hazardous substances.

By implication the definition of permissible levels of exposure has been determined by consensus based on current knowledge of the effects of chemicals. The list of chemicals covered in the SA Hazardous Chemical substance regulation is only a subset of the chemicals that exist. The SA list of hazardous chemical substances for biological monitoring covers the following chemicals: Analine, Arsenic and soluble compounds, including arsine, Benzene, Cadmium, Carbon disulfide, Carbon monoxide, Chlorobenzene, Chromium(vi), Methylene chloride, N,N-dimethylformamide, Ethylbenzene, Fluoride, Furfural, n-Hexane, Mercury, Methaemoglobin inducers, Methanol, Methyl chloroform, Methyl ethyl ketone, Methyl iso butyl ketones, Nitrobenzene, Organophosphorus choline esterase inhibitors, Parathion, Pentachlorophenol, Perchloroethylene, Phenol, Styrene, Toluene, Trichloro ethylene, Xylene, Methylene chloride. Lead is not included in this list, but is covered by the lead regulations.

Any chemical outside the regulation must be evaluated and checked for possible health implication of workers.

Biological monitoring for a chemical substance, to which one has been exposed, assesses the health risks through the evaluation of the internal dose of the substance or its metabolite. For a certain chemical the biological exposure index (BEI) is an indication of the maximum permissible exposure allowed. (See diagram, Ref. Robert R. Lauwers.)

Biological monitoring is complementary to other monitoring programs which are carried out to evaluate the health risk associated with exposure to occupational hazards, ie, (i) ambient air monitoring, which only gives an average indication of substances in the workplace for a certain period; it cannot measure individual susceptibility to hazardous chemicals and (ii) health surveillance, which is an indication of possible secondary effects due to a certain chemical.

Once absorbed and present in circulation, the chemical is distributed to different compartments on the body. It may be metabolised to a more water soluble substance, eliminated unchanged, accumulate over time, bind irreversibly or reversibly to sites on target molecules. Binding to critical sites may give rise to health effects at concentrations where the body’s repair mechanisms are inadequate or insufficient. This may lead to the development of pre-clinical and clinical lesions. It should be noted that for some substances (eg, methanol, benzene, toluene etc.) the systemic adverse effects do not depend on the binding effect on the sites alone. In these cases the metabolites of the substance may be more toxic or can change the homeostatic mechanisms.

Finally, with the ideal biological monitoring test, the internal dose means the amount of chemicals that bind to the critical sites of action (eg, measuring of carboxy haemoglobin adducts for the exposure of carbon monoxide). However, due to the variation of different critical sites in the body, it is difficult to establish a test that will be able to target all the different sites affected by exposure to the substance.

The inter-individual susceptibility to exposures differs. These inter-individual differences in susceptibility to xenobiotics (toxins) might be due to the limited ability of individuals to reduce certain substances. (eg, slow and fast reducers, the ability to acetylate aromatic amines is genetically determined.)

REFERENCES:
SASOM Guidelines www.sasom.org.za
Ampath website www.ampath.co.za