Spedizione abb. post. - Gruppo IV/70

ISSN 0021-2571
Coden: AISSAW 25 (N. 3) 373-536 (1989)

Annali dell'Istituto Superiore di Sanità

Volume 25, N. 3, 1989

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ISTITUTO SUPERIORE DI SANITÀ - VIALE REGINA ELENA, 299 - ROMA

BIOELEMENTS: HEALTH ASPECTS

Edited by

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This special issue of the Annali *is dedicated*
to the late Professor Francesco Pocchiari
for his encouragement and support
in further developing research on bioelements

Ann. Ist. Super. Sanità
Vol. 25, N. 3 (1989), pp. V-VI

Contents

Ann. Ist. Super. Sanità
Vol. 25, N. 3 (1989), pp. 373-378

PREFACE

The last decade has witnessed the rapidly expanding consciousness within the scientific community of the growing significance of Inorganic Biochemistry, i. e. of that discipline which systematically and comprehensively embraces toxicological, clinical, nutritional and ecotoxicological aspects of element interactions with living organisms. This interdisciplinary branch of science plays a key role in the proper exploitation of human and financial resources aimed at protecting the health and the environment. From this standpoint, failure to recognize the importance of a proper balance between biomedical expertise and analytical awareness would have disastrous consequences on the identification of priorities and expedient research performance.

The experimentalist who plans to undertake a study in this field should devote special care to the need for both biomedical soundness and a strict protocol including all possible phases of the analytical process, in particular sample collection, storage, pretreatment and quantitative determinations. An adequate and self-consistent strategy is, in other words, indispensable to correctly design element-related biomedical investigation, which in turn can generate reliable and useful information, help understand basic phenomena and enhance harmonization of research policies and regulatory activities. Moreover, this overall attitude can optimize the ratio between potential research outcome and the efforts invested in it, especially if one considers that nowadays the comprehension of the active participation of elements in biochemical processes, organic dysfunctions and genesis of various pathologies relies on the capacity of analytical techniques of attaining precision, sensitivity and detection levels simply unheard of only a few years ago.

The numerous activities carried out in the field of Bioelements at the Istituto Superiore di Sanità *(Italian National Institute of Health) are presented in this special issue of the Annals. It is hoped that this survey will convey a stimulating insight into present achievements and future developments to those readers that are interested in exchanging views, thus encouraging collaboration in a still widely unexplored region.*

Sergio Caroli

Studies on the elemental composition of biological systems can be divided into four stages: conception of the experimental design, procurement of valid samples, chemical analysis and data interpretation. All these phases are closely interlinked and an adequate attention to each of these steps is important for the overall success of the investigation.

In earlier investigations, a great proportion of the analytical results obtained for various biomaterials was mainly intended to demonstrate the powerful capabilities of the newly emerging methodologies, e.g., multielement techniques. Unfortunately, during that enthusiastic phase of proving the effectiveness of these extraordinary technical achievements, to some extent multielement analyses assumed a sort of "cure all" posture and little or no consideration was given to the biological basis of the problems studied. An outstanding example in this context is that of hair analysis. Numerous investigations have been carried out on this specimen due to the fact that this material is easy to procure. One wonders if there was any recognized analytical methodology that had remained unused in the determination of some element or other in this hirsute outgrowth and a great majority of these findings have turned out to be of little use.

The position is no better for a number of other tissues and body fluids, since, in most cases, the medical and other health sciences professionals who were involved in supplying the samples were unaware of the spurious analytical implications of uncontrolled specimen collection. In many cases, the analysts who found access to the samples did not have either the insight to assess the biological integrity of the specimens or training to deal with biological collections. The net result was a gross underestimation of the problem of biological validity of the material collected for analysis. In other words, this situation reflects the practice of demonstrating the potentials of newly developed techniques to generate analytical numbers on unplanned investigations, rather than seeking the solution to a credible problem and using the available analytical expertise to solve it, or simply, another case of placing the cart before the horse!

The last decade may be regarded as a crucial turning point in new developments in many areas of biological trace element research (BTER). This is being recognized as a multidisciplinary science which requires a combination of biological insight and analytical awareness in planning the investigations. It is also acknowledged that the complexities involved in dealing with the requirements of trace element research studies in the life sciences demand a comprehensive planning of the investigations and use of various techniques, thus bringing together a variety of talents. Some of the special difficulties are seen in, for example, providing a "total" quality control in the overall context of an investigation. These include experimental design, collection of biologically and analytically "valid" samples, the ability to carry out accurate analytical measuements on those specimens and data evaluation (including data interpretation). It cannot be emphasized sufficiently that accurate analytical measurements on carefully selected meaningful specimens hold the key for success in future BTER studies. Further, team work is an important element in any BTER investigation. Failure in recognizing this at an early stage has affected the overall progress, which is often not proportional to the analytical efforts expended.

BTER will continue to thrive in future. This field is still wide open, practically inexhaustible and is limited only by the imagination of the investigators. However, it is imperative that the analyst is with the problem from the beginning of an investigation since it is difficult to interpret analytical results of samples, over which the analyst had little or no control during sampling. Conversely, if the analyst does not recognize the role of life scientists in choosing the right specimens to answer the problem at hand, this will inevitably lead to another predictable failure!

G.Venkatesh Iyengar

Trace elements in seawater resulting from the geological erosion processes have accompanied the evolution of life from its very beginning. Life forms have developed their own elimination and/or tolerance mechanisms with respect to trace elements in their habitat provided that these last are present in rather constant proportions and subject to little change.

Early human activities, e.g. mining, extraction from ores and minerals, refinement and use released trace elements into the biosphere at increasing rates, augmented later on by the worldwide use of metal-bearing fossile fuels as a source of energy. Atmospheric long-range transport as well as dispersion along the aquatic routes led to the capillary dissemination of trace elements in our environment. Isolated spectacular events such as the Minamata Bay disease would seem to divert the attention from the not less alarming subcritical exposure situations ascertained for the population at large in the most industrialized countries.

The Ispra Joint Research Centre of the Commission of the European Communities dedicated a considerable portion of its Environmental Protection Programme to trace metals. Extended studies were conducted on the multiplicity of pathways of trace metals in the environment, attention being mainly paid to their toxicological effects and long-term low-dose experiments.

Within this framework dose-effect relationship studies need to be supported by systematic work on trace element base-line reference values and investigations on element form-specific effects are certainly one of the most challanging tasks in present and future research.

Herbert Muntau