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Preface

Biological monitoring and analytical toxicology in occupational and environmental medicine

More than 40 years ago, the systematic and quantitative determination of hazardous chemical compounds and their metabolites in human biological material for the purpose of estimating the individual exposure of workers was established in occupational medicine. This approach of exposure monitoring is called human biological monitoring, or simply biomonitoring. It offers the advantage of detecting the absorbed and toxicologically relevant dose of a hazardous substance. In contrast, ambient and environmental monitoring can offer insight into the effectiveness of industrial hygiene measures for the workplace atmosphere and identify sources of exposure to airborne contaminants, but the decisive measure for estimating the health risk of an exposed individual is the amount of substance that has actually entered the body compartment.

In the meantime, biological monitoring has become an inherent and central part of the occupational medical approach to enhance and maintain workers' health protection. All the more, biological monitoring has found its way into legislation and workplace regulations in many countries, for example in the form of biological limit, tolerance, guidance and exposure indices or reference values to assess and control exposure to chemicals.

Biological monitoring has also become an established tool in environmental medicine and public health strategies worldwide for the screening of the general population with regard to background exposure to hazardous chemicals. In addition, biological monitoring has evolved into a tool for risk assessment and intervention studies. Particularly in recent years, biological monitoring has been increasingly applied in regional or national population studies (biological monitoring surveys) or for the identification of population clusters with a distinctive additional environmental exposure (hot spot studies).

Among the first applications of biological monitoring methods for organic compounds was the determination of organic solvents in blood and their main metabolites in urine. Like other chemical analyses, these applications were based on then-state-of-the-art gas and liquid chromatographic separation and detection techniques, and focused on the determination of analytes in the ppm concentration range. However, the continuous reduction of exposure limit values and workplace exposure levels has stirred an increased interest in the fields of occupational and environmental medicine and public health for more sensitive and specific applications. Also, the interest in minor metabolites that represent toxification rather than detoxification pathways and in biological reaction products such as protein and DNA adducts resulted in the demand for more sophisticated analytical equipment capable of detecting analytes in trace amounts.

The further development of chromatographic techniques, such as capillary chromatography and new stationary phases for liquid chromatography with low particle diameter and tailored adsorbent materials, as well as the implementation of sensitive and specific detectors, particularly mass spectrometers, enabled the realisation of trace analysis methods. The combination of high resolution chromatography and mass spectrometry allows for the specific identification and accurate quantification of chemicals and their metabolites in human body fluids in the ppb and sub-ppb range. In the last decade, the availability of reasonably priced GC–MS/MS and LC–MS/MS systems boosted a distinct shift in biological monitoring methods.

Many recently established biological monitoring procedures in the field of occupational medicine aim at the detection of in vivo reaction products of carcinogenic substances and their metabolites, such as mercapturic acids and haemoglobin adducts. On the other hand, biomonitoring applications in environmental exposure studies often focus on the exposure to pesticides via food products and exposure to hazardous chemical substances such as perfluorinated compounds, phthalates, bisphenol A and acrylamide, which can contaminate food by migrating from food packaging.

This Special Issue of the *Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences*—is dedicated to new developments, applications and insights into biomonitoring methods for occupational and environmental medicine and forensic analyses. According to the technical advances and the shifted scientific interest, the methods and applications presented in this volume deal with the use of sophisticated hyphenated techniques and represent the state-of-the-art in human biomonitoring. They also reflect the shift in analytical technology since the last Special Issue of this journal in 2002 that was dedicated to human biological monitoring [1].

We thank all colleagues who contributed to this Special Edition of the *Journal of Chromatography B: Analytical Technologies in the Biomedical and Life Sciences*—by presenting their current scientific work, either focused on methodology or on application. The papers in this volume report both high quality biomonitoring meth-

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ods and interesting results of workplace or population exposure studies. The topics cover a broad spectrum of analytes such as pesticide metabolites, protein adducts, mercapturic acids and other conjugated metabolites. They also provide new perspectives on established biomarkers. We sincerely thank all reviewers of the submitted articles for their efforts and constructive criticism, which were a significant contribution to ensure and improve the high scientific quality of the manuscripts finally accepted for publication. In addition, we are grateful to Elsevier and to the editors of the Journal of Chromatography B, in particular to our colleague Dimitrios Tsikas, for the opportunity to guest-edit this Special Issue devoted to current aspects of human biological monitoring.

Michael Bader *
BASF SE, Occupational Medicine & Health Protection, GUA/CB – H 308, 67056 Ludwigshafen, Germany

Thomas Göen [1]
Institut und Poliklinik für Arbeits-, Sozial- und Umweltmedizin der Universität Erlangen-Nürnberg, Schillerstraße 25/29, 91056 Erlangen, Germany

* Corresponding author. Tel.: +49 (0)621 60 45360; fax: +49 (0)621 60 43322.
E-mail addresses: michael.bader@basf.com (M. Bader), thomas.goeen@ipasum.med.uni-erlangen.de (T. Göen)

[1] Tel.: +49 09131 85 26121; fax: +49 09131 85 22317.

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[1] J. Angerer, H.U. Käfferlein, J. Chromatogr. B 778 (2002) 1.

Michael Bader studied chemistry at the Westfälische Wilhelms University of Münster (Germany). In 1996, he finalised his doctoral thesis on protein adduct analysis at the Institute of Occupational, Social and Environmental Medicine of the University of Erlangen-Nuremberg (Germany) in the working group of Prof. Dr. J. Angerer. From 1996 to 2000 he worked as a research scientist on biological monitoring in the Institute of Occupational and Social Medicine at the Heidelberg University Hospital (Germany). In 2000 he moved to the Institute of Occupational Medicine of Hannover Medical School (Germany) as a research scientist and head of the Analytical-Toxicological Laboratory. Since July 2010, he is head of the Biomonitoring Laboratory and Center of Excellence of the Occupational Medicine & Health Protection Department of BASF SE in Ludwigshafen (Germany). Michael Bader was habilitated at Hannover Medical School in 2007 and pursues his *venia legendi* as a university lecturer on occupational medical and environmental medical toxicology at the same university. His scientific objectives comprise exposure assessment, development of biomarkers for hazardous chemicals and quantitative evaluation of dermal absorption of chemicals. Michael Bader is a member of the Senate Commission for the Investigation of Hazardous Compounds in the Work Area of the Deutsche Forschungsgemeinschaft (DFG) and chairman of the working group “Skin Penetration”.

Thomas Göen studied chemistry at the University of Paderborn (Germany). He finished his doctoral thesis on the development and testing of molecular catalysts for enantioselective reactions at the Institute for Inorganic and Analytical Chemistry of the University of Paderborn in 1991. He went for a 6-year post-doctoral term to the Institute of Occupational, Social and Environmental Medicine of the University of Erlangen-Nuremberg, in which he researched on the performance of biomonitoring parameters and on quality assurance systems. In 1998 he moved to the Aachen University of Technology (RWTH) as head of the analytical and toxicological laboratory in the Institute of Occupational and Social Medicine. In 2005, he returned to the Institute of Occupational, Social and Environmental Medicine of the University of Erlangen-Nuremberg, where he is heading the analytical and toxicological laboratory. Thomas Göen habilitated in 2005 and pursues his *venia legendi* as a university lecturer on occupational medical toxicology at the Aachen University of Technology. His scientific interest is focused on the development of biomarkers for hazardous chemicals and the metabolism of such substances in human. Thomas Göen is a member of the Senate Commission for the Investigation of Hazardous Compounds in the Work Area of the Deutsche Forschungsgemeinschaft (DFG) and chairman of the working group “Analyses of Hazardous Substances in Biological Materials”. He is also a member of the Human Biomonitoring Commission of the German Federal Environmental Agency and member of the organizing committee of the German External Quality Assessment Scheme for biomonitoring parameters (G-EQUAS).