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Editorial

Occupational Biological Monitoring —is now the time?

Biological monitoring, the analysis of a chemical determinant in a biological fluid to assess exposure, has been established for many decades but yet has failed to become a cornerstone of international occupational exposure assessment, despite its advantages of potential simplicity and exposure aggregation. However, recently, a number of initiatives are underway that may allow occupational biological monitoring to achieve its promise.

Occupational biological monitoring (OBM) started with blood lead measurements dating back to at least 1935[1)], initially to determine lead poisoning. The setting of Biological Exposure Indices (BEIs, published by the American Conference of Governmental Industrial Hygienists, ACGIH) began in 1982[2)], giving visibility to the use of OBM and showing how it might be used to assess and hence control occupational exposures. Although BEIs have been published for nearly 40 years, the use of OBM is not widespread in the USA. The BEIs are set by ACGIH, a charitable scientific organisation, not a government institution. There are also legal concerns about the use and consequences of implementing OBM. Nonetheless BEIs have been adopted across the world—but is there evidence that this is resulting in actual monitoring and consequent action and improvement?

The BEIs (and other well-known occupational biological monitoring guidance values, such as the German BATs[3)]) do not necessarily result in active monitoring programmes. They themselves are merely guidance values and without protocols, guidelines and instructions as to how OBM should be implemented, their worth may be unrecognised. There is a remarkable lack of international advice on OBM implementation, and what there is[4, 5)] is often over 20 years old. These facts make the very existence of these guidelines easy to overlook and, even if aware of them, they may be dismissed due to the lack of updating.

Globally, despite the current absence of guidelines and information, there are positive signs of development; with new guidelines expected from the British Occupational Hygiene Society, a proposed new chapter in Patty's Toxicology, a review of existing material by the Organisation for Economic Co-operation and Development (OECD) (as well as proposing mechanisms for setting guidance values) and relevant working groups established within the International Society of Exposure Science[a, b]. All of these initiatives should revitalise the practicalities of doing OBM.

Environmental human biological monitoring (looking at the exposures of the general population, rather than workers specifically) has grown extensively in recent years with several countries (Canada[c], France[6)], Germany[7)], Japan[d], South Korea[8)], USA[9)]) now supporting large, ongoing national campaigns to conduct biomonitoring surveys to inform government chemical policy, determine exposure trends and evaluate the impact of regulations. Within the European Union, the HBM4EU project (www.hbm4eu.eu) is a joint effort of 30 countries, the European Environment Agency and the European Commission, co-funded under Horizon 2020. The project is coordinating and advancing human biomonitoring in Europe, generating evidence of the actual exposure of citizens to chemicals and the possible health effects in order to support policy making. This project is focussed on general population exposures (from diet, consumer products and the environment) but a small component is looking at OBM for some key chemicals (hexavalent chromium, diisocyanates) and increasingly

[a] https://intlexposurescience.org/i-hbm-working-group
[b] https://ises-europe.org/group/exposure-data-production-human-data
[c] https://www.canada.ca/en/health-canada/services/environmental-workplace-health/environmental-contaminants/human-biomonitoring-environmental-chemicals/canadian-health-measures-survey.html
[d] http://www.env.go.jp/chemi/ceh/en/

important industrial sectors (e-waste recycling).

Despite the lack of guidelines, one way to encourage monitoring and the use of OBM is the presence of standards and guidance values (such as BEIs) but some kind of requirement may be necessary for real impact. Internationally, the lack of obligation may have hampered the wider uptake of OBM. Across the world, the only common requirement for OBM is related to lead exposure. In many countries there is legislation requiring blood lead analysis (under certain circumstances) alongside legally enforceable action, including the suspension of workers, as a consequence of those results. The conducting of blood lead monitoring over the years has resulted in significant decreases in exposure. However, action levels continue to be reduced as new health effects are identified at ever-lower exposure levels (e.g. the current (established in 2017) BEI for blood lead is 20 μg/dl based on reducing "the risk of neurological and neurobehavioral effects and reproductive effects associated with lead exposure"[10].

The legal requirement for monitoring obviously drives the amount of testing undertaken. For example, in 2018/19[11] there were 5,875 lead workers in Great Britain under surveillance; more than 85% of blood lead measurements were below 25 μg/dl and only 0.3% of male workers exceeded the suspension limit of 60 μg/dl; no females were suspended due to an excess of blood-lead.

As mentioned, lead is virtually the only common legal requirement for OBM globally but recommendations from regulators can also be influential. Great Britain has a goal-based chemical regulation system under the Control of Substances Hazardous to Health[12], so dutyholders are free to demonstrate their compliance with the regulations in any suitable way. Nevertheless, the Health and Safety Executive has recommended issuing improvement notices where companies using isocyanate-based spray paints are not employing OBM via urinary isocyanate monitoring[13, 14]. HSE recognised that urine testing was the 'only practical way' of measuring exposure. Urine testing was used to demonstrate improvements in exposure control through HSE's training initiative, motor vehicle repair Safety and Health Awareness Days[15], which ran from 2004 to 2008. This initiative significantly increased OBM activity for isocyanates with analysis nationally increasing from around 200 samples per annum to 5,500 samples per annum by 2010[14]. Practical guidance[16] in undertaking OBM for isocyanates was also issued to aid compliance. By 2010, the Institute for Employment Studies[17] reported that 13% of motor vehicle repair companies (from a survey of 501 bodyshops) were doing OBM, rising to 25% amongst larger companies. This rise in testing was also matched by a reduction in the number of asthma cases, demonstrating the value of assessing exposures (and taking improvement action where appropriate).

It therefore seems that some form of recommendation from a regulator helps to drive monitoring, even though the availability of guidance values, for instance, can encourage monitoring. For instance, in the European Union, the potential impact of obligation has led to recent calls for OBM to be incorporated more robustly into European Union legislation[2]; the REACH regulations are starting to incorporate biological limit values into chemical authorisations and restrictions (e.g. benzene, NMP) and phase III of the Carcinogens and Mutagens Directive included a biological monitoring value for cadmium[18]. Additionally, perhaps positive reinforcement schemes could be further explored, such as insurance premium reductions for demonstrating good exposure control, as these have not received much attention to date.

The hope must be that all of the previously mentioned initiatives to introduce refreshed guidelines and protocols, along with new guidance values, can drive an increase in OBM (where appropriate) with a concomitant reduction in exposures, as demonstrated previously for lead[19], isocyanates[20], MbOCA[21]. Many organisations (OECD, European Union, ISES) are currently taking an active interest in OBM and now is the time to make that interest count and normalise OBM as an efficient and effective way to assess exposure and demonstrate successful interventions.

The time is now.

Conflict of Interest

Kate Jones is employed by the Health and Safety Executive, who provided support for this article. Its contents, including any opinions and/or conclusions expressed, are those of the author alone and do not necessarily reflect Health and Safety Executive policy in Great Britain.

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Kate JONES
Health and Safety Executive, UK