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In Quest of New Fingerprints of exposure to Air Toxics

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Background

The term “air toxics” embraces a range of gaseous or particulate pollutants which are present in the air in low concentrations with characteristics such as toxicity or persistence so as to be a hazard to human, plant or animal life. Volatile organic compounds (VOC), particulate matter (PM2.5), polycyclic aromatic hydrocarbons (PAH), quinones and black carbon (BC) are among the several categories of compounds considered as air toxics.

To assess the risk posed by any substance, it is crucial to know how the body responds to different amounts of the substance, both in the short and long term. The concentration of pollutants in the air provides relevant information about exposure to evaluate health effects. However, to assess the effects of a pollutant in the body as a whole, it is necessary to calculate how much of the substance gets inside the body and is metabolised.

Previous work has focused upon measuring personal exposures at or near the breathing zone. However, this would not give a true indication of lung dose, which is arguably more relevant when determining an acute biological response to a pollutant exposure. Lung doses will depend on concentration in the breathing zone (i.e. exposure concentration), duration of exposure and minute ventilation. Estimation of dose will thus provide a more accurate idea of the true lung burden from air toxics. Consequently the use of dose rather than exposure will reduce variability and uncertainty when assessing health effects and when linking biomarkers with exposure burden to assess their suitability as biomarkers.

A major goal of environmental epidemiology is to establish quantitative relationships between exposures to air toxics and the associated risks of disease. Biological monitoring has been increasingly viewed as a desirable alternative to air sampling for characterising environmental exposures, not only because it accounts for all possible exposure routes but also because it covers unexpected or accidental exposures and reflects inter-individual differences in uptake or genetic susceptibility. The recent adoption of human biomonitoring in the Environmental Action Plan 2004-2010 has motivated the research of new biomarkers suitable to biomonitor exposures and effects of chemicals for human health studies.

Whilst some chemical compounds present in the urine are potential biomarkers of biological exposure to air toxics, the variation of endogenous metabolites, i.e. naturally-occurring substances consequence of human biochemistry, can reflect early biological effects of the exposure to air toxics. Metabolomics can determine the profile of metabolites in biological samples. Since detoxification of air toxics involves metabolism transformations; and since many metabolites are ultimately excreted in urine, using a metabolomics approach can be helpful to identify new metabolite pattern profiles that can be used to identify biological effects in low-level exposure scenarios.

We plan to measure the quantity of some air toxics, such as VOCs, PM2.5, PAHs, quinones and black carbon, present in typical indoor environments and to estimate the dose that enter our body and that are metabolised and excreted in the urine. If we can relate the quantity of several candidate substances in the urine with the quantities of air toxics that have entered our body, we will be able to identify new biomarkers, which will be useful to study the health risks of air toxics, specially benzene, at the common low level exposures found indoors.

The new biomarkers will open new opportunities for the medical community to research the potential impacts on health of air toxics, such as VOCs at the low levels of exposures emitted from consumer products in indoor environments or PM2.5, PAH, quinones and black carbon emitted from traffic. This will help industries to formulate consumer products and will help policy makers to produce standards, rules and directives that will protect consumers’ health.

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