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# Biomarkers of Exposure to Metal Dust in Exhaled Breath Condensate: Methodology Optimization

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**ABSTRACT.** In occupational assessments where workers are exposed to metal dust, the liquid condensate of exhaled breath (EBC) may provide unique indication of pulmonary exposure. The main goal of this study was to demonstrate the quality of EBC to biological monitoring of human exposure. A pilot study was performed in a group of metal dust–exposed workers and a group of nonexposed individuals working in offices. Only metal dust–exposed workers were followed along the working week to determine the best time of collection. Metal analyses were performed with inductively coupled plasma mass spectrometry (ICP-MS). Analytical methodology was tested using an EBC sample pool for several occupationally exposed metals: potassium, chromium, manganese, copper, zinc, strontium, cadmium, antimony, and lead. Metal contents in EBC of exposed workers were higher than controls at the beginning of the shift and remained augmented throughout the working week. The results obtained support the establishment of EBC as an indicator of pulmonary exposure to metals.

**KEYWORDS:** metal exposure, biomonitoring, ICP-MS, lead, TXRF

Exhaled breath condensate (EBC) is a matrix in which numerous volatile and nonvolatile substances can be detected, where biomarkers of effect (eg, occupational assessments) and response (eg, pulmonary pathophysiology assessments) have been described.[1–4] EBC collection can be carried out easily and noninvasively by breathing into the condenser, using portable equipment in any setting, such as workplace, home, etc. As the procedure does not induce an inflammatory reaction, it is especially suited for the sequential and longitudinal sampling of individuals at any age.[5–7]

The analysis of EBC might be extremely useful for biological monitoring. In most occupational approaches the exposure occurs by inhalation, therefore the respiratory tract is the primary organ of exposure for pollutants, such as metals. Blood and urine are the matrices currently used for the biological monitoring of workers exposed to metals. These 2 matrices do not provide direct information about lung tissue levels of metals, which may cause local damage and inflammation in the respiratory system. The exhaled air gives the exhaled dose, which may reflect the lung dose responsible for eventual airway adverse effects.

EBC has been used in clinical studies, and several markers have been measured as indicators of pulmonary physiology and pathology.[8–11] The use of EBC in occupational assessments has been considerably less. Few studies focusing exposure to metals have been published so far. In chromium-plating workers, EBC matrix was adequate to investigate

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