Assessing lead levels in occupational health: a mini-review

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ABSTRACT

Lead is a well-established toxin that continues to pose a health risk. Blood lead levels (BLLs) and urinary chelatable lead are the tests of choice for assessing acute and chronic toxicity. We highlight some of the other tests available. As occupational exposure to lead is often accompanied by other toxic heavy metal exposure, measuring whole blood heavy metal levels should be considered for workers with chronically elevated BLLs.

Keywords: **lead, occupational health, toxicity, analysis, blood lead**

INTRODUCTION

Lead, a heavy metal, is a major public health risk because of its deleterious effects, and there continues to be significant exposure to it via occupational and non-occupational routes.[1-2] A blood lead level (BLL) of 10 µg/dL has been identified by the WHO/CDC as a medical action level but research indicates that there is no level below which risk does not exist. Occupational exposure to lead can be significant, with 89% of occupationally-exposed workers in Nairobi having BLL > 10 µg/dL in one study.[3]

The major routes of lead absorption into the body are the GIT and respiratory systems.[4] Most of the body's lead burden is stored in bone, and a small fraction circulates in the blood. Lead can diffuse into most organs and penetrate the blood-brain barrier. The principal route of elimination is via urine.

BLOOD LEAD LEVELS

The half-life of blood lead is ~ 30 days as lead binds the proteins of circulating erythrocytes. Although blood lead is in equilibrium with bone lead, there is also a contribution from recent intake. Therefore, BLL reflects both recent exposure and lead that has been mobilised from tissue stores.[5] A study of 803 workers exposed to lead identified BLL as correlating better with neurobehavioural abnormalities than either bone lead or urine chelatable lead.[6] In addition, the presence of other heavy metals should be considered when testing for lead toxicity as exposure to more than one heavy metal may exist. One of the authors (VS) has noted increased levels of antimony, manganese, chromium, nickel, cadmium, aluminium and zinc in a sample of approximately 100 workers with occupational exposure to lead (unpublished data).

PLASMA LEAD LEVELS

The utility of measuring plasma lead has been investigated as it represents that part of the body's pool that is potentially free to cross various membranes, such as the placenta and blood brain barrier. Either serum or plasma is acceptable.[7] However, plasma lead levels are very low – 1% of whole blood lead – necessitating new techniques, such as inductively coupled plasma mass spectrometry (ICP-MS). Furthermore, measuring heavy metals in plasma is prone to false increases if the sample is haemolysed. Additional research is needed before the measurement of plasma lead in routine clinical practice can be recommended.

BONE LEAD

Lead accumulates in the body when intake exceeds the body's potential to excrete it; thus, bone lead is a marker of cumulative lead exposure and has a half-life of decades. Bone lead levels are difficult to assess outside of a research setting. Alternatively, measuring BLL repeatedly and plotting the value over time can be used to generate a cumulative blood lead index; this correlates well with bone lead.[4]

URINE LEAD AND LEAD MOBILISATION TESTS

Random urine lead levels are not recommended as the values can fluctuate markedly and independently of BLL.[8] Furthermore, there is little prospective research linking urine lead levels with adverse health outcomes. Conversely, lead levels measured in urine collected for a set period following an intravenous ethylenediaminetetraacetic acid (IV EDTA) or oral dimercaptosuccinic acid (DMSA) challenge may be a measure of the body's lead

burden. Lee et al. found that the urinary chelatable lead level in a 4-hour urine collection following an oral DMSA challenge correlated with symptoms of potential lead toxicity in a dose-dependent manner in patients who were exposed to lead via their occupation.[9] Hoet et al. proposed an upper reference limit of 22 µg lead in 4-hour urine following DMSA 1 g administered orally.[10]

HAIR TESTING

Hair is a sample that is being looked at with increasing interest because of the potential benefits it offers. However, there are a number of confounding factors that have yet to be determined adequately. For example, air pollution may contaminate the hair and result in spuriously elevated hair lead levels.[11] Hair lead is reported using different units in various studies which makes comparison between studies difficult. Further, there are no established medical action limits. However, this technique is used in forensic medicine to determine long-term exposure.

OTHER SAMPLES

Lead has been measured in other tissues, including teeth, toenails and even human breast milk.[12-14] Further, lead inhibits a number of enzymes including Δ-amino levulinic acid dehydratase (ALAD). Thus, lead intake results in higher levels of urinary amino levulinic acid (ALA) and reduced ALAD enzyme activity; however, these tests have proved unreliable even in the acute setting.[15] None of these samples can be recommended for use in the occupational health setting.

TREATMENT AND MONITORING

Chelation therapy must be done under controlled conditions and is recommended if baseline BLL exceeds 40 µg/dL chronically. Chelation therapy, such as DMSA 10 mg/kg body weight administered orally three times daily, is given for a one- to two-week period, generally. Repeated lead measurements are recommended before and during treatment. During and immediately after treatment, the BLL may fall dramatically and urinary chelated lead levels may rise; there is a rebound phenomenon following cessation of treatment, although BLL and urinary chelated lead levels remain substantially lower than before the initiation of chelation.[16]

SUMMARY

Although there are a number of exciting new developments in the field, BLL and urinary chelatable lead remain the tests of choice with the largest evidence base. The possibility that aditional heavy metals may be present should be considered as it is a frequent finding. Close collaboration between the clinician and the laboratory allows for the rational use of laboratory tests in this potentially complex setting.

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