HEALTH & SAFETY LABORATORY

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Investigation of Saliva as an Alternative to Blood Samples for the Biological Monitoring of Inorganic Lead

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Background

Although environmental blood lead levels have dropped dramatically there are still concerns that lead exposure is a contributor to intellectual impairment in children and a contributing factor for other diseases. Blood is the preferred matrix for inorganic lead exposure however the invasive nature of blood sampling and many other factors make blood far from ideal for environmental public health sampling. Salivary lead is a potential non-invasive alternative although literature reports are conflicting.

Previous work by the Health & Safety Laboratory (HSL, in partnership with the Health Protection Agency) demonstrated a relationship between blood and saliva but the correlation was not strong (correlation coefficient 0.65, $p<0.001$) and was based on log-transformed data. Coventry Diagnostics have also developed a lead salivary method using commercially available saliva samplers and nitric acid digestion. Their work on samples from environmental lead exposures (blood lead <10 µg/dl) showed good agreement between blood and saliva measurements (mean results agreed within a 97.5% confidence interval) and demonstrated a 1:1 relationship.

This study aims to collect paired samples of blood and saliva from workers occupationally exposed to inorganic lead.

Methodology

Twenty-two workers provided a saliva sample, using a Statsure sampling device (Figure 1), at the same time as a routine blood sample (provided under the Control of Lead at Work Regulations, 2002 as amended).

Prior to analysis, each sampling device was vortexed for 10 seconds. An aliquot of sample (0.5ml of the saliva/buffer mixture) was hydrolysed for 1 hour at 100°C using 0.5ml concentrated nitric acid. After cooling, the mixture was diluted ten-fold in diluent (1% nitric acid, 10µg/l Pt internal standard), resulting in an overall dilution of saliva of 1 in 40. Spiked saliva quality control material (2 µg/l) was prepared and an aliquot extracted through a sampling device prior to analysis.

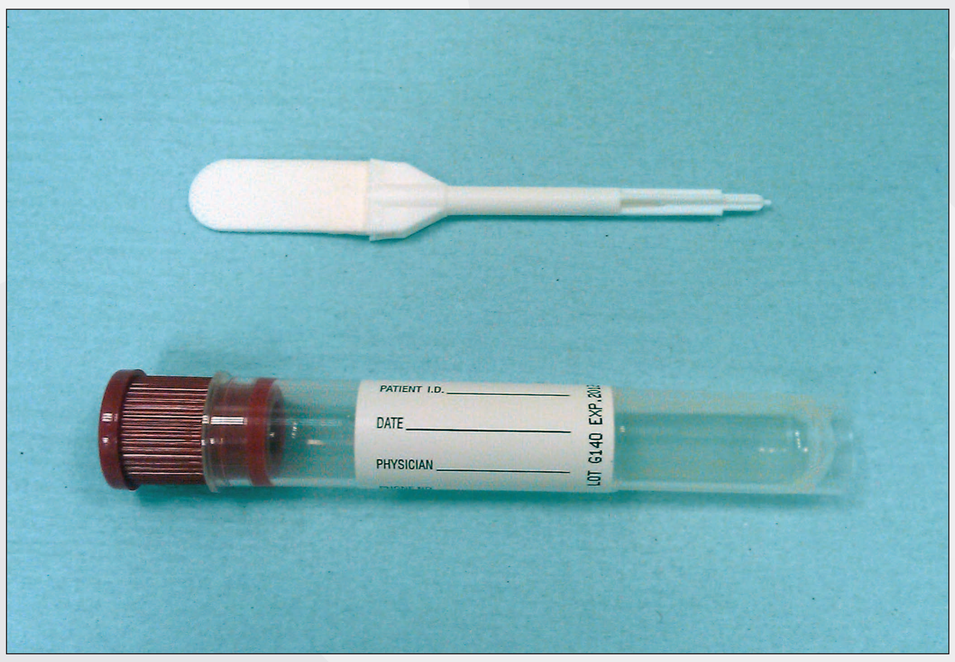

Figure 1. Statsure sampling device showing sampling paddle with volume indicator (top) and collection bottle with buffer

Analysis was by inductively-coupled-plasma mass spectrometry (ICP-MS, Thermo X7 Series 2) in normal mode measuring ^{208}Pb and using ^{195}Pt as an internal standard.

Results

Recovery of lead from spiked saliva using the sampling device varied from 102% (2 µg/l spike) to 105% (20 µg/l spike). Quality control material showed intra-assay variation of 5.4% (n=6).

Blood samples from workers showed lead levels ranging from 1 to 25 µg/dl (all below the UK suspension limit of 60 µg/dl). The paired saliva samples showed lead levels between 6 and 398 µg/l. A weak ($p=0.065$), but positive, correlation was seen between blood and saliva lead measurements (Figure 2). Two outliers in particular (shown in red in Figure 2) were noted where one matrix had an elevated level of lead whereas its pair did not. Excluding these two samples improved the correlation to $r=0.68$ with a 1:1 relationship between blood and saliva.

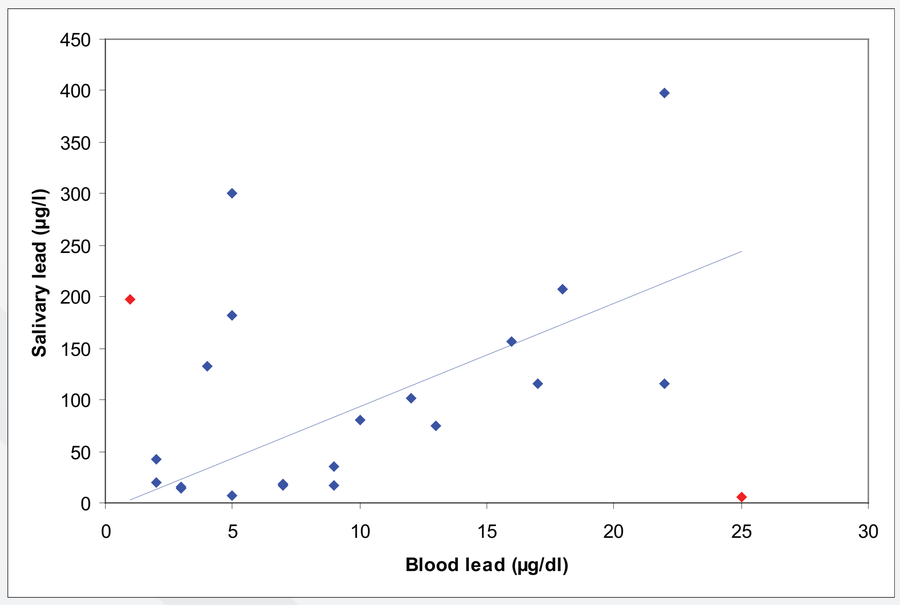

Figure 2. Correlation ($r=0.68$, $p=0.0009$) between blood and salivary lead in lead-exposed workers (N=20, outliers in red excluded).

Conclusions

This poster presents very preliminary results in an on-going study. The initial data suggest a positive correlation between blood and salivary lead levels with roughly a 1:1 relationship. This is in agreement with the previous work of Coventry Diagnostics. The data presented here show quite a weak correlation with significant variability – there may be a number of reasons for this including issues such as variable sample collection volume and kinetic differences between blood and saliva. Whereas the initial work by Coventry Diagnostics was on environmental exposures (where participants might reasonably be expected to be at a steady-state regarding lead exposure) the data presented here are from workers – depending on their working history these workers may not be at steady-state with regard to lead exposure. The differences in lead absorption and elimination kinetics in blood and saliva would therefore potentially have an influence on the correlation in these samples. These variables are currently being investigated, with further recruitment and analysis also taking place.