Determination of Lead in Human Lungs by Direct Flameless Atomic Absorption Analysis of Small Tissue Samples

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INTRODUCTION

The use of lead as an additive to gasoline may cause a serious problem of airborne contamination of lead from automobile exhausts. There are several reports of lead contamination in plants (H.SKAAR et al.1973) animals (R.F.LUTMER et al.1967) and man living in auto exhaust contaminated areas (H.V.THOMAS et al.1967).

The respiratory system provides the main entry to the human body for trace elements in the atmosphere,and lung lead levels may therefore be an indicator of man's exposure to airborne lead.Some reports have been given of the concentration of lead in lung tissues (H.A.SCHROEDER and I.H.TIPTON 1968, P.S.I.BARRY and D.B.MOSSMAN 1970) and attempt has been made to detect significant variation in pulmonary lead concentration in human beings with respect to sex, age and place of residence within an urban community (C.A. STRINGER et al.1974). In studies of this kind the need for a sensitive,rapid and reliable technique for analysing a large number of samples is obvious.

The present paper describes the determination of lead in human lungs by means of flameless atomic absorption spectroscopy. The analysis was made directly of dried tissue samples in the "carbon cup" without prior chelation and extraction processes.

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METHODS

Formalin fixed and stored lung tissue was used for the investigation. The formalin solution was tested for lead before and after fixation and no detectable amounts of lead were found.

Prior to weighting and analysis the tissue samples were dried in the carbon cups for 24 hours at 65° C.

Ten replicas, each weighting approximately 2 mg, from lung tissue of the apical segment of right lower lobe were analysed by means of a Hilger and Watt Atomspek H 1170 equipped with a Varian Techtron carbon rod atomizer Mod.63. The operation of each preselected sequence of drying, ashing and atomization cycles was made with the water-cooled carbon cup placed in a continous flow of inert gas (N_2). Evolution of smoke took place during the process of ashing, but ceased before atomization started. The atomization cycle was operated in the "ramp mode". The optimal instrument setting was as follows: dry-voltage 0.6 V, dry-time 12 s, ash-voltage 2.4 V, ash-time 10 s, ramp atomize cut-off voltage 2.25 V and ramp rate 0.4 V/s. The lead levels were measured at 217 nm wavelength using a hollow cathode lamp as a light source with lamp current 9 mA. The monochromator slit width was fixed at 100 microns, and peak signals were registered on a Philips PM 8100 recorder. The recorder sensitivity was set to 10 mV full scale deviation, with balancing time less than 1 s f.s.d. The absorption peak size was normally in the region of 3-6 cm, which is roughly 10-20 % of f.s.d.

Controls of possible interference from matrix effects showed negligible nonspecific absorption at the nonresonant 220.4 nm line.

The number of ten replicas in this investigation was chosen to keep the standard deviation of the mean within ten per-cent of the mean value.

A linear calibration curve was made with standards of 5 microliters volumes of lead nitrate (p.a.) in distilled water in the range 0.1 ppm to 0.8 ppm lead.

RESULTS

Samples of lung tissue obtained by autopsies from ten individuals aged from 17 to 79 years were analysed for lead. All subjects had been living in the city of Trondheim (120 000) in the middle of Norway,with no known occupational exposure to lead except no.3 , who was a former taxi-driver. The result of this analysis is given in Table 1. All values are presented as ppm dry weight.

TABLE 1

Analytical results for lead in human lungs,ppm dry weight.

No.	Age	Sex	Mean concentration of 10 replicas	Range	Standard deviation of the mean
1	40	M	0.20	0.14 - 0.27	0.01
2	78	M	0.63	0.45 - 0.86	0.04
3	79	M	2.14	1.65 - 2.91	0.10
4	17	F	0.30	0.22 - 0.37	0.01
5	70	F	0.15	0.12 - 0.18	0.01
6	49	M	0.58	0.44 - 0.78	0.04
7	73	F	0.35	0.25 - 0.44	0.02
8	64	M	0.17	0.13 - 0.23	0.01
9	72	M	0.92	0.61 - 1.31	0.07
10	53	F	0.67	0.47 - 0.87	0.05

The variation of lung lead level in the ten subjects analysed in this study (0.15 to 2.14 ppm) is close to that reported in an investigation (C.A.STRINGER et al. 1974) of sixty-six individuals in an US urban community (0.10 to 3.04 ppm).

To test our method the lead concentration in gross lung samples from two of the subjects was investigated by an other laboratory here in Trondheim using conventional flame AAS methods. The result obtained was within fifteen per-cent of our reported mean values.

DISCUSSION

A report has recently been given of an atomic absorption spectroscopic technique using direct atomization from the solid state for the determination of lead in dental material (F.I.LANGMYHR et al.1974).

The present paper shows that this technique also may be applied to analysis of lead in lung tissue. The method provides a sensitive,rapid and reliable technique to estimate the lead content in small samples of lung tissue.

The method may be applied to other soft tissues as well,provided the heavy metal in question shows a uniform distribution throughuot the sample,and even gives the possibility of determining the lead distribution within gross tissue samples,when the distribution is not uniform.

As it is very easy to run parallelles,the analysis can be performed with great accuracy when the distribution is uniform.

Although the lead concentration in lung tissue from one individual seems to vary between different lung segments (unpublished observation), the distribution of lead in the microsamples used in this investigation seems to be relatively uniform when blood vessels and large bronchii are avoided.

When lung lead levels are reported, care should be taken to define precisely the lung segment from which the specimen is taken.

SUMMARY

The direct-atomization technique of flameless atomic absorption spectroscopy has shown to be a useful and accurate method when applied to determination of the concentration of lead in human lung tissue. The analytical results are highly reproducible and agree with those obtained by the conventional flame atomic absorption technique.

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