Trace Metals in Teeth at Birth (1957-1963 and 1972-1973)

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POKLIS and FREIMUTH (1975) reported the mean lead concentration in human trachea specimens to be twice as high as that observed in similar specimens from the same community fifteen years earlier. It was considered that samples from the trachea could provide an index of the 'body burden' of lead. Mature primary teeth have also been used to provide such an index, and a relationship between concentrations of lead in teeth and blood has been confirmed by DE LA BURDÉ and SHAPIRO (1975). Concentrations of lead in developing primary teeth have been reported by BURKITT et al. (1975). A significant upward trend was apparent over a time interval comparable with that of the above trachea lead observations. However, in this survey the dental specimens were analyzed at the same time.

The demonstration of a trend for data on lead as an urban pollutant is fortified when analytical values for several other trace elements not showing the trend can be provided in the same specimens. Analyses of nickel, zinc, cadmium, manganese, iron, and copper, as well as lead, are summarized in this report, the data being derived equally from 'stored' (1957-63) and 'recent' (1972-73) specimens of partly formed teeth dissected at autopsy.

Materials and Methods

Developing teeth were dissected (MVS) in 26 cases of stillbirth and neonatal death. Samples of enamel and dentine were prepared by using blunt steel dental burs to remove the soft enamel from the hard dentine shells. Dry samples were dissolved in high grade perchloric acid (5cm 70% acid/g sample), diluted, and glass filtered before analysis by atomic absorption spectrophotometry (Varian Techtron AA-5). Analytical values (AJB) for lead and zinc were within 4% of those found by colorimetric methods. Replicate analyses on mature teeth had been shown to match to within 3% for nickel and zinc, but by up to 9% for cadmium and copper. Only 3 of the 22 values for copper fell within the range 80-120% of the median, whereas in a parallel series of analyses using similar groups of specimens a more typical distribution was seen (Table II), 10 out of 22 values being within the above range. Each frequency shown in Table II is based on a mean of separate determinations on enamel and dentine sub-samples.

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TABLE I

TRACE METAL CONCENTRATIONS IN ENAMEL AND DENTINE
OF DEVELOPING TEETH FROM FOUR FETUSES
(Values in parts per million)

Specimen Number		Pb	Ni	Zn	Cd	Mn	Fe
133	E	28	12	48	2.7	6	26
	D	26	11	95	2.7	8	13
168	E	31	16	61	4.7	4	29
	D	18	14	50	2.0	2	15
295	E	31	16	59	3.1	6	(47)
	D	27	18	87	3.0	7	15
319	E	32	20	65	1.9	8	32
	D	24	19	87	0.9	5	14

TABLE II

DISTRIBUTION OF CONCENTRATIONS OF TRACE METALS
ACCORDING TO PERCENTAGE RANGES BASED ON MEDIANS
Pairs of frequencies show 'recent' ('stored') data

Range*	Pb	Ni	Zn	Cd	Mn	Fe
40- 80%	2(6)	2(6)	0(1)	3(5)[u]	4(3)[u]	1(2)
80-120%	11(5)	4(4)	8(6)	5(4)	5(7)	7(6)
120-160%	0(0)	5(1)	2(5)	2(2)	4(0)	2(3)
160-200%		2(1)	2(1)	3(2)		
Totals[‡]	13(11)	13(12)	12(13)	13(13)	13(10)	10(11)
Median (p.p.m.)	39	21	80.5	3.8	6.5	21.5
Mean[Φ] (p.p.m.)	39	23	83	4.2	6	22.5
S.D.[Φ]	4.4	7.2	29	1.6	2	7.2

*Percentages of median values. [u] Including 1(1) values in the 0-40% range. [Φ]Mean and S.D. of 'recent' group. [‡] Overall totals 74(70)

Results and Discussion

Table I records typical data for dentitions from four fetuses. The total data were examined for correlations and to assess values that might be classed as extreme. Correlation coefficients for paired enamel and dentine samples were examined for each of the metals, and several of these appeared significant (Cd; Mn; Ni). Similar calculations were made for pairs of metals, but only three correlations of this type were of probable significance (Pb/Zn; Zn/Ni; Ni/Pb).

Means and medians differed typically by 10%, and except for the continuous type of distribution seen for copper analyses in this series of observations the ranges of values were consistent with normal distributions. Logarithmic distributions have been found applicable in other surveys when lead was determined in mature teeth. There were no indications of high burdens of trace metals in individual specimens. This was examined by expressing values in terms of their standard deviations above or below the means; the sums of transformed values for each specimen were found to be no greater than those totalled from random assemblies of such values from the groups available.

Means for lead and nickel (Table II) were about one standard deviation greater in the 'recent' group than in the 'stored' group. A high probability of a difference for lead analyses had been suggested (BURKITT et al., 1975) by applying the Mann-Whitney U test to the data for such groups. This was confirmed for the data now including more specimens in each group. A lower probability of difference (at the 2.5% level) was assessed for the nickel values. No significant trend was observed for the other metals, except for copper (mean 10.5 p.p.m.), for which a Fisher exact probability test was positive.

An apparent increase in lead concentration by about 20% in a mineralizing tissue during half a generation has been demonstrated. A similar increase in nickel concentration is consistent with data from other biological samples collected in the region, but the trends for other metals were not significant.

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