Lead Levels in Whole Blood of New Zealand Domestic Animals

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INTRODUCTION

Lead is a particularly serious pollutant because normal levels in the blood of animals and humans are close to levels considered toxic by many health authorities. Although the lead content of human blood seldom falls below 0.20 μg/ml (TINKER, 1971), safety limits ranging from 0.20 μg/ml (HERNBERG AND NIKKANEN, 1970) to 0.80 μg/ml (HUNTER AND RUSSELL, 1954) have been proposed.

For domestic animals, ZOOK et al.(1972) reported 0.19 ± 0.08 μg/ml lead for whole blood of healthy dogs and 0.94 ± 0.64 μg/ml for animals showing symptoms for lead poisoning. ZOOK AND CARPENTER (1971) concluded that values over 0.60 μg/ml were indicative of poisoning, whereas WILSON AND LEWIS (1963) reported a mean of 0.30 μg/ml for healthy dogs and 0.93 μg/ml for animals showing signs of lead poisoning. In a recent study, BLOOM et al. (1976) reported mean values including 0.064 μg/ml for lead in the blood of healthy dogs (considerably lower than those reported by other workers).

Lead data for other domestic animals are relatively sparse. However WILLOUGHBY AND BROWN (1971) reported normal values of 0.11 ± 0.09 μg/ml for horses. Data for cats are somewhat lacking, though BLOOM et al. (1976) reported 0.05 ± 0.04 μg/ml for 26 animals. ALLCROFT (1950) has reported normal levels of 0.14 ± 0.01 μg/ml for sheep and 0.13 ± 0.01 for cattle.

Because lead is an important universal pollutant and as data for blood of domestic animals are sometimes contradictory

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and are unevenly distributed among the various classes of domestic animals, there is clearly a need for a large-scale survey involving a single analytical method applied to large numbers of several domestic animals from a single geographical unit. Such a survey would avoid differences due to climate or interanalyst variability. We have recently carried out such a survey in New Zealand in which 1142 domestic animals (252 cattle, 113 cats, 271 dogs, 258 horses and 248 sheep) were tested for lead levels in whole blood. The results of the survey are reported in this paper.

PROCEDURES

Lead levels in whole blood were determined by use of a Varian Techtron Model 63 Carbon Rod Atomizer attachment for a Varian Techtron AA5 Atomic Absorption Spectrophotometer. Standard curves were prepared by spiking whole blood (containing about 0.20 μg/ml lead) with incremental amounts of lead and then using the 'method of addition' to calculate the original content in the standards. Beer's Law was obeyed in the range 0.1 to 2.0 μg/ml. To avoid interference from matrix effects, Triton X-100 (a detergent) was added in the ratio of 1 vol. to 2 vol. of blood before analysis. Correction for background non-atomic absorption was made by use of a Varian Techtron BC-6 automatic background correcter with a hydrogen lamp. The spectral line at 217.0 nm was used for all lead determinations. Operating parameters (instrumental settings) were as follows:

Drying cycle : 5v 20s
Ashing cycle: 5v 15s
Atomizing cycle: 4.5v 1.8s
Gas mixture: 2 vol. Ar to 1 vol. H_2
Sample vol. : 1 μl

The precision of replicate analyses of the same sample was about 5% for samples containing about 0.20 μg/ml of lead. Concentrations as low as 0.01 μg/ml could be determined under the above conditions.

RESULTS AND DISCUSSION

The Age Distribution of Lead Concentrations in Whole Blood

The age distribution of whole blood lead concentrations (μg/ml) in domestic animals is shown in Table 1. For the sake of clarity, only means and ranges are given. Standard deviations are shown in the text wherever necessary.

TABLE 1

The age distribution of whole blood lead concentrations (μg/ml) in New Zealand domestic animals

Animals	No		Lead concentrations by age (years)			
			1.5	1.6 - 4.0	4.1 - 8.0	8.0
Cattle	252	Mean	0.12	0.19	0.18	0.23
		Range	0.06–0.21	0.05–0.24	0.04–0.28	0.06–0.32
Cats	113	Mean	0.23	0.21	0.22	0.19
		Range	0.06–0.32	0.07–0.40	0.08–0.32	0.06–0.28
Dogs	271	Mean	0.21	0.23	0.25	0.23
		Range	0.08–0.36	0.10–0.40	0.06–0.35	0.06–0.42
Horses	258	Mean	0.13	0.17	0.23	0.23
		Range	0.04–0.22	0.04–0.20	0.03–0.30	0.03–0.40
Sheep	248	Mean	0.18	0.21	0.20	0.21
		Range	0.07–0.24	0.06–0.26	0.08–0.26	0.05–0.26

The data show no significant differences for cats, dogs and sheep, but the larger ruminants (cattle and horses) consistently show lower lead levels (0.12 and 0.13 μg/ml) for animals in the first age group compared with those over 18 months. Results of a t test for differences in mean values for older and younger groups within each animal classification were: 4.67 (250 d.f.) for cattle and 5.81 (256 d.f.) for horses and indicated a very-highly significant (P less than 0.001) difference between them.

Mean lead concentrations (for all ages) were : 0.18 ± 0.10 for cattle, 0.21 ± 0.05 for cats, 0.23 ± 0.06 for dogs, 0.19 ± 0.10 for horses and 0.20 ± 0.05 for sheep. These values are similar to those obtained by most other workers although in the case of cats and dogs they are considerably higher than the values obtained by BLOOM et al. (1976).

The Sex Distribution of Lead Concentrations in Whole Blood

The sex distribution of lead concentrations in whole blood is shown in Table 2.

TABLE 2

The sex distribution of whole-blood lead concentrations (μg/ml) in New Zealand domestic animals

Animals		Lead concentrations by sex		
		Male	Female	Neutered
Cattle	No.	118	92	42
	Mean	0.14	0.18	0.19
	Range	0.06–0.22	0.06–0.26	0.07–0.31
Cats	No.	44	46	23
	Mean	0.21	0.23	0.22
	Range	0.08–0.25	0.08–0.26	0.08–0.24
Dogs	No.	156	90	25
	Mean	0.22	0.22	0.20
	Range	0.05–0.28	0.08–0.30	0.06–0.28
Horses	No.	87	90	49
	Mean	0.24	0.23	0.20
	Range	0.04–0.34	0.04–0.30	0.08–0.26
Sheep	No.	148	100	-
	Mean	0.19	0.21	-
	Range	0.08–0.24	0.08–0.26	-

There was some evidence that male cattle have significantly lower lead levels than female or neutered cattle. There was a very highly significant difference in the mean of male cattle considered as one group and female and neutered animals considered as another. A t test gave 3.85 (250 d.f.). No other differences according to sex were noted for other domestic animals.

Variation of Whole-Blood Lead Concentrations among Different Breeds

The variation of whole-blood lead concentrations among different breeds of domestic animals is shown in Table 3. There were no detectable differences among different breeds of sheep, horses or cats. However sheep dogs from rural areas had only just over half the lead content (0.15 ± 0.08 μg/ml) of pedigree dogs, 87% of which were from city areas and which had a mean lead content

of 0.27 ± 0.07 μg/ml. This difference was very highly significant (t = 3.1 for 80 d.f.). It should be noted that only 82 dogs were included in this survey because it was restricted to sheep dogs and the three commonest breeds among city dogs. Data are shown in Table 3.

TABLE 3

Variation of whole-blood lead concentrations (μg/ml) among different breeds of New Zealand domestic animals

			Lead concentrations by breed	
Animals	No.	Breed	Mean	Range
Cattle	46	Angus	0.28	0.08–0.36
		Friesian	0.13	0.06–0.30
		Jersey	0.17	0.04–0.24
		Friesian/Jersey X	0.29	0.08–0.40
Cats	23	Siamese	0.20	0.07–0.25
		Others	0.19	0.06–0.24
Dogs	82	Corgi	0.26	0.10–0.33
		German Shepherd	0.29	0.14–0.38
		Labrador	0.25	0.11–0.32
		Sheep dogs	0.15	0.06–0.22
Horses	66	Standard breed	0.20	0.05–0.26
		Thoroughbreds	0.21	0.06–0.26
Sheep	60	Perendale	0.20	0.06–0.26
		Romney	0.20	0.04–0.26
		Southdown	0.19	0.06–0.28

The significantly lower lead level in farm dogs compared with city dogs has already been observed by BLOOM et al. (1976) who reported mean values of 0.045 and 0.068 μg/ml respectively. These values are very similar to our own ratiowise but in absolute terms are considerably lower. Lower lead levels in the blood of rural dogs must surely be a reflection of reduced pollution from motor-vehicle exhausts, since other forms of pollution such as lead from piping and paints would presumably not be greatly different in both types of environment.

Among different breeds of cattle, there was a significant (P less than 0.05) difference in the means of Angus and Friesian/Jersey X cattle considered as one group and the remaining breeds

considered as another. Mean values were 0.29 ± 0.07 and 0.15 ± 0.08 μg/ml respectively and the value of t was 1.87 for 44 degrees of freedom.

Whole-blood Lead Concentrations in Domestic Animals with Suspected Lead Poisoning

Table 4 gives data for a number of domestic animals suspected of having died from lead poisoning.

TABLE 4

Whole-blood lead concentrations (μg/ml) in New Zealand domestic animals with known histories of lead poisoning

Animal	Source of poisoning	Pb in blood	Normal Pb
Dog			
2-yr Corgi (M)	Water (Pb piping)	3.67	0.26
2-yr G.shep.(M)	Water (Pb piping)	4.82	0.29
5-yr G.shep.(M)	Service station area	6.42	0.28
7-yr Labr. (F)	Service station area	7.40	0.25
Cattle			
1-yr Fries.(M)	Water (Pb piping)	0.52	0.13
3-yr Jersey(F)	Water (Pb piping)	0.70	0.17
Horse			
5-yr Std (M)	Water (Pb piping)	0.54	0.20

In all cases lead levels in whole blood exceed 0.50 μg/ml and the highest values were in dogs from service station areas. These high values must surely result from poisoning from leaded gasoline either from fumes of idling motors or by contamination of food or water.

There were no recorded cases of poisoning of sheep or cats, probably because they tend to be less highly regarded than dogs or larger ruminants so that post mortems are seldom carried out them. The significantly higher lead levels found in dogs compared with larger animals may be because dogs will require much less lead to give elevated concentrations in the blood than will cattle or horses. The high values found in animals near service stations must cause some concern about the health of humans working in these areas, and it is hoped that the data presented here, will stimulate further work in this direction.

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