

ESTIMATE THE UNCERTAINTY
IN Pb MEASUREMENTS

ie DuPont Lake

0 0
DUPLICATE
BLOOD Pb

AZAR ET AL

S = 3.8

McLaughlin et al

S = 3.0

- ① Blood Pb's of the general population are within normal limits

Cite Pasadena
LA office workers
LA Cab Drivers } Safety factor ~ 2

- ② ~~Analytical variation is large~~
~~with Subject + analytical > 85% of variation~~

Blood Pb's > 40

7 Cities only 3/2000

McLaughlin et al 1.8 - 6.9% (AVG = 4.0%)

all due to analytical variation + within Subj

③

LA Cab Drivers
Air Pb = 6.10
off " " = 4.22
on " " = 9.42

~~max~~ Blood Pb = 24.6

max Bl Pb = 33

no problems at Air Pb levels of $10 \mu\text{g}/\text{m}^3$

- ④ $10 \mu\text{g}/\text{m}^3$ represents a safety factor of 5
from occupational std

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A SCIENTIFIC BASIS FOR AN AIR Pb STANDARD

We believe that an air Pb standard should be based on sound scientific evidence. Hence, the first step in arriving at an air Pb standard should be to review the literature and assess the current situation in order to determine whether the current air Pb levels are producing any adverse health effects. The following is a summary of evidence which has appeared in the literature to date.

1. The Blood Pbs of the General Population Are Well Within Normal Limits (ie, 40 mcg/ml).

The best single measure of Pb poisoning is the Pb concentration in the blood. The upper limit on the normal range of blood Pb concentrations in humans is generally accepted to be 40 mcg/100 ml. A review of the data in the literature reveals that the general population is well within normal limits, being less than 40 mcg/100 ml. For example, let's consider the California data collected in the Seven Cities Study and the epidemiological study conducted by Azar et al.

<u>Study</u>	<u>Site</u>	<u>Date</u>	<u>Air Pb (mcg/m³)</u>			<u>Blood Pb</u>
			<u>On Duty</u>	<u>Off Duty</u>	<u>Total</u>	
Seven Cities	Pasadena				3.39	17.5
Azar et al	LA Cab Drivers	11/70	9.42	4.22	6.10	24.6
Azar et al	LA Office Workers	2/71	3.05	3.07	3.06	19.9

The group average blood Pbs of 17.5, 24.6, and 19.9 for Pasadena, Los Angeles cab drivers, and Los Angeles office workers are, respectively, 56%, 39%, and 50% less than the

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upper limit of 40 mcg/100 ml. These differences represent group average safety margins of approximately 2.0 (ie, 2.3, 1.6, 2.0).

The blood Pbs of the individual subjects in the general population are also less than 40 mcg/100 ml. In the Azar et al study the air Pb concentrations of the 150 subjects ranged from .22 to 9.12 mcg/m³.

The Los Angeles cab driver with the 9.12 mcg/m³ air Pb had a blood Pb of 21 mcg/100 ml. The maximum blood Pb of the Los Angeles cab drivers, which was the group in the Azar et al study with the highest average air Pb (6.10 mcg/m³), was 33 mcg/100 ml. Only one of the 150 subjects had a blood Pb > 40 mcg/100 ml. His high blood Pb of 53 mcg/100 ml was attributed to his drinking illicit moonshine whiskey. Of the remaining 149 subjects, none had blood Pbs greater than 40 mcg/100 ml, and only three had blood Pbs greater than 35 mcg/100 ml (the three blood Pbs were 36, 37, and 40).

The Seven Cities Study and the longitudinal Pb study reported by McLaughlin et al provide two large data bases on blood Pb concentrations in humans. In the Seven Cities Study, blood Pbs were obtained from approximately 2000 women who had no known occupational Pb exposure. Only three blood Pbs in this sample were > 40 mcg/100 ml. The maximum blood Pb observed was 43 mcg/100 ml.

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In the five-year study reported by McLaughlin et al, 217 of the subjects participated in the study for all five years. Over the five-year period the percent of the blood Pbs greater than 40 mcg/100 ml varied from 1.8% to 6.9%. As we will see later, the blood Pbs > 40 mcg/100 ml were due to within-subject and analytical variation and not elevated blood Pb levels.

2. There Is a Large Analytical Variation Associated with Blood Pb Determinations.

It should be noted that while 40 mcg/100 ml is the upper limit of the normal range, blood Pbs in the 40-80 mcg/100 ml range are generally considered acceptable and not necessarily indicative of Pb poisoning. Blood Pbs over 80 mcg/100 ml are generally considered cause for alarm. The undetermined health significance of the 40-80 mcg/100 ml "gray area" is easy to understand when one considers the within-subject and analytical variations associated with single blood Pb determinations. Results of the AIHA Interlaboratory Studies of blood Pb analyses indicate that the standard deviation of the within-laboratory variation associated with blood Pb analyses is $\pm 12\%$. To understand the significance of this large variation, consider a blood sample with a Pb content of 40 mcg/100 ml.)

The AIHA Interlaboratory Studies indicated that if replicate determinations were made on this blood sample in a typical laboratory, 95% of the determinations would fall between 28 and 57 mcg/100 ml.

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3. More Than 85% of the Random Variation in Single Blood Pb Determinations Is Due to Within-Subject and Analytical Variations

McLaughlin, Linch, and Snee reported a study in which blood Pb determinations were made on a large population over a five-year period. Analysis of this study showed that more than 85% of the random variation in blood Pb determinations was due to within-subject and analytical variation. The significance of the within-subject and analytical variations is apparent when one considers the fraction of blood Pb values > 40 mcg/100 ml. A total of 217 subjects participated in the study for all five years. Over the five-year period approximately 4% of the blood Pbs of these subjects exceeded 40 mcg/100 ml as shown below.

McLaughlin, Linch, and Snee Longitudinal Pb Study

<u>Year</u>	<u>No. of Subjects</u>	<u>Blood Pbs > 40 mcg/100 ml</u>	
		<u>Number</u>	<u>Percent</u>
1967	217	15	6.9
1968	217	4	1.8
1969	217	9	4.1
1970	217	7	3.2
1971	217	8	3.7
Total Determina- tions	1085	43	4.0 (average)

A study of the five-year average blood Pb for each of the 217 subjects showed that none of the subject average blood Pbs exceeded 40 mcg/100 ml; only three, or 1.4%, exceeded

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35 mcg/100 ml (35, 37, and 38 mcg/100 ml); and an additional eight, or 3.7%, exceeded 30 mcg/100 ml.

Hence, where single determinations indicate that 4% of these subjects had blood Pbs out of normal limits, the average blood Pbs, which are not as greatly affected by within-subject and analytical variation, indicate that all subjects were within normal limits. This should be expected since these 217 subjects were representative of the general population and, to our knowledge, had no occupational exposure to Pb.

4. The Data in the Literature Indicate That Air Pb Concentration ≤ 10 mcg/m³ Have Not Produced Any Adverse Health Effects.

A study of the data in the literature leads one to conclude that:

- (i) The blood Pb levels of the general population are within normal limits; hence, the current air Pb levels are not producing any adverse health effects.
- (ii) A maximum air Pb concentration of 10 mcg/m³ in the highly congested areas would result in a small fraction of the population being exposed to, at most, 10 mcg/m³ for eight hours/day, five days/week. We found that the Los Angeles cab drivers exposed to this air Pb level all had blood Pbs which were within normal limits, the maximum blood Pb concentration being 33 mcg/100 ml. A maximum air Pb of 10 mcg/m³

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in the congested areas would result in most other areas having air Pb concentrations well below 10 mcg/m³.

This evidence indicates that an air Pb standard of 10 mcg/m³ is sufficient to ensure that air Pb concentrations will not present a health hazard.

5. An Ambient Air Pb Standard of 10 mcg/m³ Represents an 80% Reduction (ie, Safety Factor of 5) from the Occupational Air Pb Standard

It is appropriate to build in a margin of safety when deciding on an air Pb standard. An air Pb standard of 10 mcg/m³ represents approximately an 80% reduction from the occupational air Pb standard of 200 mcg/m³ for eight hours/day, five days/week. The occupational TLV is equivalent to a 24-hour exposure of approximately 48 mcg/m³. Hence, a safety factor of approximately 5 is associated with an air Pb standard of 10 mcg/m³ (see below).

Air Pb Concentration (mcg/m ³)			% Reduction	Safety Factor
On Duty (40 hr/wk)	Off Duty (128 hr/wk)	Total Exposure		
200	2	49	79	4.8
	1	48		
	0	48		
150	2	37	72	3.6
	1	36		
	0	36		
100	2	25	60	2.5
	1	25		
	0	24		

The safety factor is defined here as the ratio of the occupational standard (24-hour equivalent) to the proposed ambient standard of 10 mcg/m³ (eg, 48/10 = 4.8).

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12/29/75

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