Routledge
Taylor & Francis Group

Archives of Environmental Health: An International Journal

ISSN: 0003-9896 (Print) (Online) Journal homepage: http://www.tandfonline.com/loi/vzeh20

Absorption and Excretion of Mercury in Man

Morris B. Jacobs Ph.D. , Arthur C. Ladd M.D. & Leonard J. Goldwater M.D.

To cite this article: Morris B. Jacobs Ph.D. , Arthur C. Ladd M.D. & Leonard J. Goldwater M.D. (1963) Absorption and Excretion of Mercury in Man, Archives of Environmental Health: An International Journal, 6:5, 634-637, DOI: 10.1080/00039896.1963.10663452

To link to this article: https://doi.org/10.1080/00039896.1963.10663452

Absorption and Excretion of Mercury in Man

III. Blood Mercury in Relation to Duration of Exposure

MORRIS B. JACOBS, Ph.D.; ARTHUR C. LADD, M.D., AND LEONARD J. GOLDWATER, M.D., NEW YORK

Introduction

In previous reports in this series, data have been presented dealing with relationships between mercury in blood and urine [1] and urinary mercury in relation to duration of exposure.[2]

Most of the evidence presently available leads to the conclusion that determinations of urinary mercury have little or no value in helping to predict the onset of toxic manifestations. It has been aptly said that mercury in the body is more dangerous than mercury in the urine. As mentioned elsewhere,[1] the limited value of urine studies in preventive programs naturally turned attention to the blood.

A significant report, bearing on the questions at hand, has come to the attention of the authors since the time when the first 2 papers in this series were written. This report [3] covers observations on 58 workers exposed to mercury vapors and discusses correlations between intensity of exposure, blood and urine mercury levels, and clinical manifestations of poisoning. Symptoms of chronic mercurialism (tremor, erethism, etc.) were found in 15 of the 58 subjects. There was little correlation between the mercury levels in blood and urine and the degree of exposure and little between blood and urine mercury and clinical symptoms. The frequency of toxic manifestations, however, did show some correlation with intensity of exposure. These findings are partly in agreement and partly at variance with those discussed in the first paper of the current series.[1]

While it is obviously true that any mercury which appears in the urine following ingestion, inhalation, or skin absorption must first have been in the blood, the exact manner and time in which the blood in humans is cleared of mercury is not known, except, perhaps, to a limited extent in the case of mercurial diuretics.[4,5] It appears, however, that, in general, absorbed mercury disappears from the blood quite rapidly, even up to 100% in 24 hours.[6,7,8]

The present report is concerned with examining the value of blood mercury determinations in predicting toxic manifestations under conditions of occupational exposure to certain mercury compounds.

Materials and Methods

The human subjects forming the basis of this study were the same as those described in earlier reports.[1,2] They were employees of 2 factories (Plant A and Plant B) which process a variety of inorganic and organic compounds of mercury.

Chemical analyses of blood samples were done by the method of Jacobs [9,10] and statistical analysis of the data by the rank correlation method of Spearman.[11] Data published by Benning in 1958 [12] were also subjected to statistical evaluation.

Results

The findings are presented in a series of Tables (1-5) in which the rank of each subject in terms of mercury concentration in blood is compared with the rank in terms of

Submitted for publication Nov. 1, 1962.

From the Division of Occupational Medicine, School of Public Health and Administrative Medicine, Columbia University.

This investigation was supported in part by a Public Health Service research grant No. OH-61 (formerly RG-5977) from the Division of Occupational Health, Public Health Service, Department of Health, Education, and Welfare.

TABLE 1.—*Blood Mercury and Seniority in Plant A, 1961, Arranged According to Rank*

μg Hg/100 Ml. Blood	Blood Rank	Years Employed	Seniority Rank
1.5	1.0	3.5	4.0
5.0	4.0	1.2	1.0
5 0	4.0	11.0	19.5
5.0	4.0	16.0	27.5
5.0	4.0	9.0	12.5
5.0	4.0	12.0	21.0
5.1	7.0	8.0	10.0
5.7	8.5	2.0	2.5
5.7	8.5	9.0	12.5
6.0	11.5	5.0	7.0
6.0	11.5	16.0	27.5
6.0	11.5	10.0	16.5
6.0	11.5	14.0	22.5
7.5	15.0	11.0	19.5
7.5	15.0	16.0	27.5
7.5	15.0	10.0	16.5
9.0	18.0	2.0	2.5
9.0	18.0	15.0	24.5
9.0	18.0	10.0	16.5
10.5	21.5	5.0	7.0
10.5	21.5	9.0	12.5
10.5	21.5	9.0	12.5
10.5	21.5	15.0	24.5
12.0	24.0	10.0	16.5
13.5	25.0	4.5	5.0
15.0	26.0	7.0	9.0
18.0	27.0	16.0	27.5
24.0	28.0	14.0	22.5
32.0	29.0	5.0	7.0

Total Hg in air: range of 0.02-0.76 mg. per cubic meter in 9 locations
Correlation Coefficient = 0.02 $P = > > 0.05$

years of exposure. When more than one individual had the same value, the rank is given as the average for all those in the particular value-group. Observations in each of 2 plants were made in 2 successive years. In Plant B, studies were made in January and in August of the second year.

Little comment is needed other than to state that no statistically significant correlation was found between duration of employment and blood mercury levels. The same was true when Benning's data [12] were analyzed.

Comment

As work in the present investigations on the absorption and excretion of mercury in man progresses, the one feature which becomes increasingly clear is the need for additional study. Apparent conflicts in published data may be due in some measure to the difficulty in making measurements on humans in which a single variable can be tested. Some of these variables have been mentioned in an earlier report.[2] The list includes age and sex of exposed workers, type of mercury exposure (organic, inorganic, or mixed), duration and intensity of exposure, and routes of absorption. There may be additional variables, the importance of which has not as yet become apparent.

In the present paper, evidence is presented that prolonged occupational exposure to mercury compounds does not lead to increasing levels of mercury in the blood. It must be pointed out, however, that this may not apply to all situations but only to those which obtained in the present study and in that

TABLE 2.—*Blood Mercury and Seniority in Plant A, 1962, Arranged According to Rank*

μg Hg/100 Ml Blood	Blood Rank	Years Employed	Seniority Rank
0.0	1.0	8.00	10.0
1.5	2.0	5.00	6.5
2.5	3.0	10.00	14.0
3.0	5.0	9.00	11.5
3.0	5.0	15.00	25.0
3.0	5.0	9.50	13.0
6.0	9.5	5.00	6.5
6.0	9.5	12.00	20.5
6.0	9.5	11.00	16.5
6.0	9.5	18.00	28.5
6.0	9.5	12.00	20.5
6.0	9.5	11.00	16.5
7.5	13.5	11.00	16.5
7.5	13.5	3.25	5.0
9.0	17.0	0.05	1.5
9.0	17.0	11.00	16.5
9.0	17.0	9.00	11.5
9.0	17.0	0.05	1.5
9.0	17.0	14.00	24.0
10.5	20.5	6.00	8.5
10.5	20.5	12.00	20.5
13.5	22.0	12.00	20.5
15.0	23.0	0.16	3.0
18.0	24.0	17.00	27.0
19.5	25.0	1.25	4.0
21.0	26.0	16.00	26.0
25.5	27.0	13.00	23.0
36.0	28.0	6.00	8.5
40.5	29.0	18.00	28.5

Total Hg in air: range of 0.1-2.4 mg. per cubic meter in 13 locations
Correlation Coefficient = 0.145 $P = > > 0.05$

reported by Benning.[12] Further observations may confirm or refute this conclusion.

Even if mercury levels in the blood do not increase with prolonged exposure, it cannot be concluded that there has been no accumulation of mercury in the body. Evidence on this point can be adduced only by measuring concentrations of mercury in organs and tissues or by mercury balance studies. Both of these approaches in humans offer great, but not necessarily insurmountable, difficulties.

Summary

An attempt has been made to correlate duration of exposure and blood mercury levels in men working with a variety of mercury compounds, predominantly organic.

TABLE 3.—*Blood Mercury and Seniority in Plant B, 1961, Arranged According to Rank*

μg Hg/100 Ml Blood	Blood Rank	Years Employed	Seniority Rank
0.0	1.0	14.00	18.0
1.5	2.0	9.00	12.5
2.7	3.5	15.00	20.5
2.7	3.5	1.50	6.5
3.0	5.0	0.15	1.0
4.5	6.0	0.25	2.0
5.0	7.5	15.00	20.5
5.0	7.5	0.40	3.0
6.0	9.5	11.50	17.0
6.0	9.5	9.00	12.5
7.5	11.0	10.50	15.0
8.7	12.0	16.00	21.0
9.0	15.0	16.00	23.0
9.0	15.0	19.00	25.0
9.0	15.0	18.00	24.0
9.0	15.0	11.00	16.0
9.0	15.0	19.50	26.0
10.5	18.5	8.00	10.5
10.5	18.5	1.50	6.5
12.0	20.0	8.00	10.5
13.5	21.0	31.50	28.0
15.0	22.0	1.50	6.5
16.5	23.5	20.00	27.0
16.5	23.5	1.50	6.5
18.0	25.0	2.50	9.0
24.0	26.0	0.50	4.0
31.5	27.0	10.00	14.0
33.0	28.0	14.50	19.0

Total Hg in air: range of 0.2-1.2 mg. per cubic meter in 11 locations
Correlation Coefficient = 0.088 $P = >>0.05$

TABLE 4.—*Blood Mercury and Seniority in Plant B, Jan. 1962, Arranged According to Rank*

μg Hg/100 Ml Blood	Blood Rank	Years Employed	Seniority Rank
1.5	1.0	0.16	5.0
2.1	2.5	16.50	28.5
2.1	2.5	0.05	2.0
2.4	4.0	0.05	2.0
3.0	6.5	15.50	26.0
3.0	6.5	14.50	24.0
3.0	6.5	12.00	23.0
3.0	6.5	2.00	12.0
3.6	9.0	20.00	32.0
3.9	12.0	0.64	9.0
3.9	12.0	5.00	14.0
3.9	12.0	19.00	31.0
3.9	12.0	1.50	11.0
3.9	12.0	20.50	33.0
4.5	16.0	10.00	18.0
4.5	16.0	0.16	5.0
4.5	16.0	9.50	17.0
5.1	18.5	0.05	2.0
5.1	18.5	11.50	21.5
5.3	20.0	11.50	21.5
6.0	21.0	11.00	20.0
6.8	22.0	0.16	5.0
7.5	23.5	16.50	27.0
7.5	23.5	7.50	15.0
8.7	25.0	3.00	13.0
9.0	26.0	1.20	10.0
12.0	27.5	0.20	7.0
12.0	27.5	32.00	34.0
12.6	29.0	9.00	16.0
18.9	30.0	10.50	19.0
24.0	31.0	15.00	25.0
24.9	32.0	18.50	30.0
30.0	33.0	16.50	28.5
49.6	34.0	0.25	8.0

Air studies not done
Correlation Coefficient = 0.13 $P = >>0.05$.

No statistically significant evidence was found that blood levels of mercury increase as a function of prolonged exposure.

The absence of build-up in the blood does not necessarily rule out accumulation of mercury elsewhere in the body.

The reported findings do not necessarily apply to all types of mercury exposure.

Leonard J. Goldwater, M.D., School of Public Health and Administrative Medicine, Columbia University Faculty of Medicine, 600 W. 168 St., New York 32, N.Y.

REFERENCES

1. Goldwater, L. J.; Jacobs, M. B., and Ladd, A. C.: Absorption and Excretion of Mercury in

TABLE 5.—*Blood Mercury and Seniority in Plant B, Aug. 1962, Arranged According to Rank*

μg Hg/100 Ml Blood	Blood Rank	Years Employed	Seniority Rank
0.0	1.0	1.00	13.0
0.6	2.0	12.00	25.5
0.7	3.0	0.17	2.0
0.8	4.0	0.40	4.5
0.9	5.0	0.60	10.5
2.1	6.5	11.50	24.0
2.1	6.5	2.50	18.5
3.0	8.0	15.50	28.0
4.5	9.0	0.50	8.0
5.1	10.0	2.00	17.0
5.4	11.5	1.25	14.0
5.4	11.5	0.40	4.5
5.7	13.0	0.40	4.5
6.3	14.0	15.00	27.0
6.6	16.0	11.00	23.0
6.6	16.0	16.00	29.5
6.6	16.0	0.40	4.5
8.7	18.0	16.00	29.5
9.9	19.0	19.00	32.0
11.3	20.0	9.50	22.0
12.0	21.0	17.00	31.0
12.6	23.0	20.00	33.0
12.6	23.0	8.00	21.0
12.6	23.0	0.60	10.5
13.2	25.5	32.50	35.0
13.2	25.5	2.50	18.5
13.8	27.0	0.50	8.0
15.6	28.0	0.50	8.0
16.2	29.0	0.75	12.0
16.8	30.0	3.50	20.0
17.4	31.0	21.00	34.0
18.9	32.0	1.50	15.0
21.0	33.0	0.08	1.0
24.9	34.0	1.70	16.0
38.7	35.0	12.00	25.5

Total Hg in air: range of 0.04 to 0.97 mg per cubic meter in 8 locations

Correlation Coefficient = 0.138 $P = >0.05$

Man: I. Relationship of Mercury in Blood and Urine, Arch. Environ. Health 5:537, 1962.

2. Ladd, A. C.; Goldwater, L. J., and Jacobs, M. B.: Absorption and Excretion of Mercury in Man: II. Urinary Mercury in Relation to Duration of Exposure, Arch. Environ. Health, 6:480, 1963.

3. Turrian, H.; Grandjean, E., and Turrian, V.: Industriehygienische und medizinische untersuchungen in quecksilberbetrieben, Schweiz. Med. Wschr. 86:1091, 1956.

4. Hughes, W. L.: A Physicochemical Rationale for the Biological Activity of Mercury and Its Compounds, Ann. N.Y. Acad. Sci. 65:454, 1957.

5. Schoemaker, H. A.: The Pharmacology of Mercury and Its Compounds, Ann. N.Y. Acad. Sci. 5:504, 1957.

6. Pitts, R. F., and Sartorius, O. W.: Mechanism of Action and Therapeutic Use of Diuretics, Pharmacol. Rev. 2:195, 1950.

7. Mayer, J. H.; Handley, C. A., and Seibert, R. A.: An Analysis of the Excretory Products of a Mercurial Diuretic (Meralluride) by Column Chromatography, Ann. N.Y. Acad. Sci. 65:511, 1957.

8. Vogl, A.: The Use of Mercurial Diuretics in Congestive Heart Failure, Mod. Conc. Cardiov. Dis. 24:263, 1955.

9. Jacobs, M. B.; Yamaguchi, S.; Goldwater, L. J., and Gilbert, H.: Determination of Mercury in Blood, Amer. Industr. Hyg. Ass. J. 21:475, 1960.

10. Jacobs, M. B.; Goldwater, L. J., and Gilbert, H.: Ultramicrodetermination of Mercury in Blood, Amer. Industr. Hyg. Ass. J. 21:276, 1961.

11. Snedecor, G. W.: Statistical Methods, Ed. 5, Ames, Iowa State College Press, 1957.

12. Benning, D.: Outbreak of Mercury Poisoning in Ohio, Industr. Med. Surg. 27:354, 1958.