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bcc: B. B. Jacobs - Pet Lab
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IC 31 - Applied Statistics

June 26, 1981

Dr. Russell F. Christian, Editor
Environmental Science and Technology
1155 Sixteenth Street, N.W.
Washington, DC 20036

Dear Dr. Christian:

Re: MS ESO-242 "Development of Air Quality Standard for Lead from Community Studies" by R. D. Snee

Enclosed are four copies of the revised version of this paper which has incorporated the comments and suggestions of the two referees and those of your editorial assistant. Referee 1 raised several concerns which, in my judgment, were already adequately discussed either in the manuscript or in the references which he cited. I have, however, revised the manuscript to hopefully clear up any ambiguity which may exist concerning his points and enclosed detailed replies to the comments of Referee 1. I hope that this paper is now acceptable for publication in Environmental Science and Technology and look forward to hearing from you.

Very truly yours,

ENGINEERING SERVICE DIVISION

Ronald D. Snee

R. D. Snee
Consultant Supervisor
Applied Statistics

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AUTHOR'S REPLY TO THE COMMENTS OF REFEREE 1 ON
"DEVELOPMENT OF AN AIR QUALITY STANDARD FOR
LEAD FROM COMMUNITY STUDIES"
BY R. D. SNEE

General Comments

This paper is original research in the sense that it describes a new methodology for using data from studies of the relationship between blood lead and air lead to develop an air quality standard (AQS) for lead. The methodology is also general and can be used in the development of any AQS for which the appropriate biological guideline is expressed in the form of a cumulative frequency distribution.

1. Dr. Hammond's criticism of the Azar study was that it wasn't representative of industrial exposures (see attached). This concern is irrelevant in this instance because the air quality standard for lead addressed by this article is for ambient exposure, not occupational exposure. Hammond, in fact, has a very high regard for the Azar study and used it extensively in his recent paper (enclosed) "The Impact of Air Lead on Blood Lead in Man - A Critique of Recent Literature", P. B. Hammond, et al., Food and Cosmetics Technology, 1981 in press. It is of interest to note that using different methodology Hammond, et al., developed a relationship for the Azar data whose predicted values differ by less than approximately 4% of the predicted blood lead values of the lead exposure model (Eqn. 1) used in this paper (see Table A attached). It is also noted that the slopes (ie, change in blood Pb/unit change in air Pb) of the two equations are equal for all practical purposes. The slope, rather than the overall level of the curve, is the critical concern in the calculation procedure discussed in this paper.

   The coefficients from any model developed from data will be subject to their variability. Hence, it is unrealistic to reject equation 4 as invalid simply because its coefficients are not known constants.

2. There has been considerable discussion concerning the blood lead-air lead slope. In the case of adults, however, it is my judgment that the majority of the studies are suggesting a slope in the neighborhood of one. I use as evidence for this the paper by Hammond, O'Flaherty and Gartside (enclosed) mentioned above and the work we have done on a combined analysis of eight major studies on the relationship between blood lead and air lead which is described in reference 14. This paper is also enclosed and has been accepted for publication in the International Archives of Occupational and

Environmental Health. It should also be noted that the slope of 3.5 (Rabinowitz, et al.) which the referee refers to is for a single subject. The studies cited above involve many, many subjects.

The referees should also note that we use two models in this analysis. One obtained from the Azar data which is generally believed to be the best study of the relationship between blood lead and air lead in adults, and one with an assumed slope of one. The purpose of this paper is to present a methodology. Other authors may wish to use a different slope. The data in this paper and its references provide them with all the elements they need to make whatever calculations they choose to do.

3. Reference 7 has also been enclosed for the referees' inspection. There have been several models proposed for the Azar data. It is possible that each group of scientists that looks at these data will come up with a slightly different model form. It is unlikely, however, that the predictions of the models will be greatly different because they will all be developed from the same data base. Again, we have presented a methodology which will enable people to use whatever model they so desire in developing an air quality standard for lead from the Azar data and other data bases which may become available in the future.

4. The Pearson system is a family of models which includes among its members the normal, lognormal, gamma, beta, exponential, and Weibull distributions. Each of these distributions has been used at one time or another to model air quality data. The lognormal distribution will be used when it is appropriate; when it is not, the Pearson system has the flexibility to identify another appropriate distribution.

   The Pearson model also provides a good fit to the data because it uses the first four moments of the observed data to define the distribution model. It uses the mean, standard deviation, skewness and kurtosis, while both the normal and the lognormal model only use the mean and the standard deviation. In this sense it provides a better fit to the data.

5. I don't see how the referee can conclude from Table 6 that on most occasions lognormal distribution seems to be perfectly valid. In 9 of the 16 cases summarized in this table, the lognormal distribution is shown not to give an appropriate fit to the data. Of course, this really isn't a concern because the Pearson system is a general family of models and can model distributions which deviate from the lognormal distribution.

The referee seems to be overly concerned about this point. The AQS based on the lognormal distribution are given in Tables 4 and 5. Hence, the results have been provided for those readers who want to assume the lognormal distribution rather than let the data define the appropriate distribution.

6. Good scientific reporting requires that the findings be compared to the work of others in the field. One cannot, therefore, discuss the development of an air quality standard for lead without relating one's work to the standard which was developed by the Environmental Protection Agency. As the referee has pointed out, I have described how the two approaches compare and what considerations should be taken in account. It is almost impossible to stay away from the political implications. I have, however, tried to deemphasize the politics of this subject. Clear evidence of this desire is the fact that, in the abstract of the paper, I have said nothing about how the value of the air quality standard developed in this paper relates to that developed by the EPA. The purpose of this paper is to describe a methodology. This is so stated in the abstract. The development of the standard has been emphasized rather than the final number which the methodology produces.

Summary

The referee has pointed out a number of places in which the paper is unclear. His comments have been taken into account in constructing this revised version and it is hoped that the revised version will clear up his concerns.

## TABLE A

COMPARISON OF THE PREDICTED BLOOD LEAD LEVELS OF LEAD EXPOSURE MODEL AND THE MODEL DEVELOPED BY HAMMOND, ET AL.

| Air Pd (1) $\mu g/m^3$ | Predicted Blood Lead Level ($\mu g/dl$) | | |
|---|---|---|---|
| | Lead Exposure Model (2) | Hammond, et al. Model (3) | Difference (%) |
| .2 | 16.9 | 16.2 | 4.1 |
| .5 | 17.3 | 16.5 | 4.6 |
| 1.0 | 17.8 | 17.1 | 3.9 |
| 1.5 | 18.4 | 17.6 | 4.3 |
| 2.0 | 18.9 | 18.1 | 4.2 |
| 5.0 | 21.3 | 20.7 | 2.8 |
| 10.0 | 24.1 | 24.3 | 0.8 |

(1) Air Pb range in Azar Study was 0.2 to 9.1 $\mu g/m^3$

(2) Lead Exposure Model

$$\text{Blood Pb} = 12.1(\text{Air Pb} + 3.28)^{0.2669}$$

(3) Hammond Model

$$\text{Blood Pb} = [-0.098 + 0.197(\text{Air Pb} + 3.46)^{-0.104}]^{-0.9814}$$

AUTHOR'S REPLY TO THE COMMENTS OF REFEREE 2 ON
"DEVELOPMENT OF AN AIR QUALITY STANDARD FOR
LEAD FROM COMMUNITY STUDIES"
BY R. D. SNEE

1. It is noted in the discussion section of the paper that the EPA has identified young children as a high risk population and it is recommended that the analysis described in this paper be applied to data on child population when such data become available.

2. The EPA has adopted the Center for Disease Control recommendation that blood lead levels of children should not exceed 30 mg/dl. Studies of the relationship between blood lead and air lead indicate that the blood lead/air lead slope is approximately one and may be a little higher for children but isn't as high as the slope of 2 used by the EPA. This concern is outside the scope of this paper.

3. The time constant for blood lead is long in relationship to 24 hours. It is generally recognized that peaks of air lead during high traffic periods and other types of exposure do not represent a hazard. It is the long-term exposure which is the concern.

CC: IC 13

Date: September 10, 1980

TO: R. D. SNEE

MANUSCRIPT - Subject: DEVELOPMENT OF AN AIR QUALITY STANDARD FOR LEAD FROM COMMUNITY STUDIES

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