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ENGINEERING DEPARTMENT
LOUVIERS BUILDING

July 23, 1981

Dr. James P. Lodge, Jr.
Atmospheric Environment
385 Broadway
Boulder, Colorado 80303

Dear Dr. Lodge:

Re: MS 1920-L "Models for the Relationship Between Blood Lead and Air Lead"

Enclosed are four copies of this paper which have been revised to answer the concerns raised by the referees. Both referees comment on the adequacy of the data base; however, they do not specifically recommend what other data I should consider. This is not surprising because I'm not aware of any other studies in the literature which have used personal air monitor to study the relationship between blood lead and air lead. The Azar and Williams studies are well known and respected and have been relied on heavily by both the EPA and OSHA in setting their standards.

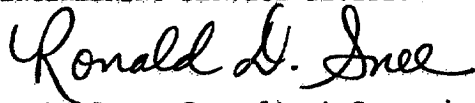
I've shown that my proposed lead exposure model gives a good fit to these data and has boundary conditions which are consistent with the behavior of blood lead at low air lead levels. Contrary to the claims of Referee I, the log-log model, with its predicted blood lead of either zero or minus infinity at air lead equal zero, is not reasonable from a biological viewpoint.

It seems to me that this is sufficient evidence to bring this model to the attention of other workers in the field. Hopefully, they will try it out on their data and evaluate its assumption and boundary conditions. Perhaps this will lead to new studies and insight which will answer the questions raised by the referees.

I'm hopeful that this revised version is acceptable for publication in Atmospheric Environment and look forward to hearing from you.

Very truly yours,

ENGINEERING SERVICE DIVISION



R. D. Snee, Consultant Supervisor
Applied Statistics Group

RDS:cak
Atch

TEH 0470533

Author's Reply to the Comments of Referee I on
"Models for the Relationship Between
Blood Lead and Air Lead"

by
R. D. Snee

General Response

This referee pointed out areas where the exposition was not sufficiently clear. It is hoped that the revised version will answer his/her stated concerns.

The purpose of this paper is to present a new model (ie, lead exposure model) for the relationship between blood lead and air lead. It is shown to give an adequate fit to the best two studies (ie, those which measured air lead exposure by personal monitors). All the data used by the author are either available in the literature or are included in the revised version of the paper. Readers are, therefore, provided with all the information necessary to redo my calculations, if they so desire, and better yet, test out my model on their own data.

Reply to Specific Points

1. The justification for publishing this paper is that it presents a new model for the relationship between blood lead and air lead (ie, the lead exposure model) which is more consistent with the effects on humans of the two main sources of lead exposure (oral and inhalation). The raw data from the Azar data have been published elsewhere (Azar, et al 1975) but have been included here in graphical form. The Williams data have also been included in the revised version of the paper; hence, readers can redo my analyses if they wish.
2. It is a mathematical fact that if the log-log model is used, the user is, de facto, assuming that at air lead equal zero the blood lead either equals minus infinity or zero; neither of which is realistic.

Log-Log Model

$$\begin{aligned}\text{Log (Blood Pb)} &= a + b \log (\text{air Pb}) \\ &= a + b \log (0), \text{ if air Pb} = 0 \\ &= a + (\text{minus infinity}) \\ &= \text{minus infinity}\end{aligned}$$

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Exponential Form of Log-Log Model

$$\begin{aligned}\text{Blood Pb} &= A (\text{air Pb})^b \\ &= A (0)^b, \text{ if air Pb} = 0 \\ &= A (0) \\ &= 0\end{aligned}$$

I can see no justification for these unrealistic boundary conditions which are clearly shown in the plots of the fitted curves (Figure 3 of the revised paper).

3. The figures are numbered in the revised version.

The fitted curves of the two models should not be expected to coincide because of the noise in the data which is characteristic between subject variation and analytic measurement error in blood lead values. The fitted curves are consistently positioned with respect to one another when the variation in the data is taken into account.

Reply to Referee I Detailed Comments

Items which are not addressed above are discussed here. The following five paragraphs parallel the five comments of the referee.

1. As stated earlier, the original contribution of this paper is the proposed "lead exposure" model. We have used the best available data collected with personal samplers to illustrate its adequacy and use.
2. The referee may not agree with the stated reasons for the group differences; however, the fact remains that the data indicate that the differences do exist. It is well known and accepted that socioeconomic differences and oral uptake of lead have important influences on the blood lead levels in humans. The Seven Cities survey was done with stationary samples and was restricted to women.
3. The important point is that differences between groups exist. The lead exposure model is able to account for these differences in a way that is reasonable and consistent with the biology.
4. The differences in overall blood lead level between the office workers (LA and Starke) and the cab drivers (LA and Phila) are the group difference described above. It is unfortunate that we cannot precisely determine the reason for these differences; however, it is rare that any study leaves no questions unanswered.

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5. The comparison between the Williams and Azar studies is developed more fully in the revised version of the paper. It is unlikely that particle size difference is the source of the higher blood lead levels in the Williams study. The hand-to-mouth transfer conjectured by Hammond, et al, is more realistic. Occupational lead exposure has large particle size which is not as easily absorbed through the lungs as the smaller particle sizes of ambient exposures (Hammond, personal communication).

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Author's Reply to the Comments of Referee II on
"Models for the Relationship Between
Blood Lead and Air Lead"

by
R. D. Snee

General Response

The referee has pointed out areas where the exposition was not sufficiently clear. It is hoped that the revised version will answer his/her stated concerns.

The purpose of this paper is to present a new model (ie, lead exposure model) for the relationship between blood lead and air lead. It is shown to give an adequate fit to the best two studies (ie, those which measured air lead exposure by personal monitors). All the data used by the author are either available in the literature or are included in the revised version of the paper. Readers are, therefore, provided with all the information necessary to redo my calculations, if they so desire, and better yet, test out my model on their own data.

Reply to Specific Points

1. The referee's claim that the data base is inadequate is difficult to understand since the data used are the best available and have been used extensively by both the EPA (Azar) and OSHA (Williams) in setting their air lead standards. I would be pleased to include other data sets if they were available.
2. The Delco-Remy occupational study is the only possibility; however, these data have not been published. They are also severely limited in that personal samplers were not always used; the blood samples were not systematically and routinely coordinated with the air samples, and the blood lead data are highly variable.
3. It can be safely assumed that the air lead exposures in the Azar and Williams studies accurately reflect long-term exposure because the subjects were working at their jobs for a long time; hence, their blood lead levels were at equilibrium with their environment. The referee should keep in mind that, while these studies may be criticized, it is generally agreed that they are the best available and they have been relied on extensively by the EPA and OSHA.
4. I would be pleased to look at other data sets if they were in the public domain and available.

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Reply to Referee II Detailed Comments

The author comments further on the adequacy of the data base. As noted earlier, I'm using the best available data. There are, of course, other questions to be answered and it is my hope that the publication of this paper and its lead exposure model will stimulate other workers to think about this problem critically and in a new light. Hopefully, this will result in new data and insights which will answer the concerns raised by the referee.

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