

tainly would handle the product carefully, who are exposed very, very little, show that they have absorbed an appreciable amount of lead.

We have in this room, I find, two diametrically opposed conceptions. The men engaged in industry, chemists, and engineers, take it as a matter of course that a little thing like industrial poisoning should not be allowed to stand in the way of a great industrial advance. On the other hand, the sanitary experts take it as a matter of course that the first consideration is the health of the people. Now lead—as many sanitary experts here can tell you vastly better than I can—lead is the commonest industrial poison, or was until the production of the automobile. Recently carbon monoxide has displaced it. But it seems probable on the basis of the evidence that we have heard this morning that lead will soon recover its leadership, and that if leaded gasoline comes into use, lead will again take not only first place, but by far the first place as the greatest industrial problem.

I have talked with many chemists and engineers, and I do not think they have any appreciation of the place that lead occupies. Lead poisoning to-day is, in the eyes of industrial physicians, comparable to typhoid fever. It is almost comparable to tuberculosis in its character as a disease. It is a form of poisoning of a peculiar type. It is cumulative. It is already fairly common. We do not know what percentage of the population, how many tens of thousands of people in America, are carrying a greater or less quantity of lead in their bodies now. We have every reason to believe that it is a very considerable number. I can well understand that the Ethyl Gasoline Corporation may say, "We are not responsible for the lead in the bodies of typesetters, printers, and house painters," but the sanitarian has to look at the matter from another side. He knows that if a painter or a typesetter has in him already such a quantity of lead that he can just keep it down—he can just keep it in his bones or just keep it excreted at the rate he takes it in—then the addition of a little more is going to increase enormously the number of cases of lead poisoning in the community. We have to look at the thing from that side. So while we want to be as considerate as we can in regard to the industrial standpoint, we must also ask that our standpoint should be understood and considered.

There is a matter upon which I touch with hesitation, because I am afraid that I may cause offense, and yet I have to. This is not the first poisonous substance that has been developed. In modern industry more and more frequently we have poisonous chemicals of one sort or another developed. This was particularly the case during the war. There I can speak from personal experience. When the war started I was assigned to the physiological or medical side of

the development of war gases. I got a very capable man and put him in charge of the sanitary supervision of production. Very considerable amounts of phosgene and mustard gas were produced in America during the war; and we did not poison the people who made it. Such substances can be handled so that you do not kill people. On the other side we have a list, according to different counts, of between 11 and 15 men killed by tetraethyl lead. They died in a terrible form of insanity. Furthermore, somewhere between 50 and 100 other men have been poisoned more or less severely. It is probable that not all the cases have been reported. I was surprised this morning not to hear the Whiting plant in Indiana mentioned, because I have a letter here from a man whose son was severely poisoned in the laboratory at Whiting, Ind. This indicates that we have not heard of all the cases. Chemists and engineers surely have no desire to kill people; and if that is the case, then there is something about the manufacture of tetraethyl lead, something about its lack of odor, something about its other qualities, which renders it peculiarly liable to result in severe poisoning. That is a very important point. Chlorine, although a very irritating substance, seldom causes death. Hydrogen sulphide, although as toxic as cyanide, seldom kills a laboratory worker. The reason is that chlorine is so irritating and hydrogen sulphide smells so bad that a man gets out of the way. I am going to read one or two communications showing how people are poisoned by tetraethyl lead. Before I do so I want to say that I am not combating what was said this morning about the special merits of lead for automobiles. I am simply trying to show that there is another side. I have asked some of the chemists, my colleagues in Yale University, and I have found that lead is not by any means the only substance which, on theoretical grounds, or even on the basis of experiments, can be used as an antiknock medium. I find from the engineers in the mechanical engineering laboratory of Yale University, where they work quite largely on automobiles, that they have a feeling that even with the present fuel it will be possible to develop engines that will make use of the rapid form of explosion, which is called detonating. I do not offer an opinion on that matter. I simply quote it as showing that men who are competent to have an opinion believe that there are other chemical and engineering possibilities.

The subject of masks was mentioned. I had a good deal to do with the developing of the gas mask during the war. It has now been developed into the Burrell mask, now used in industry. I think it is very doubtful whether you can permanently protect men by means of masks under industrial conditions. A man will put on a mask and go into ammonia, but you can not depend on masks

to protect men under constant working conditions. It is not known, I believe, whether the masks will stop tetraethyl lead.

I had occasion this morning to mention in connection with Doctor Sayers's remarks that his use of the standard of four parts of carbon monoxide is not well founded. In the streets of New York it is true that the concentration of carbon monoxide runs from 1 to a little more than 1 part of that gas in 10,000 parts of air; but in garages the concentration of carbon monoxide runs up to 10 or 12 or more parts of carbon monoxide. So we would have to multiply Doctor Sayers's figures by 3 or 4 in order to estimate what the effects will be in garages.

I have already talked longer than I meant to, but I want to mention one or two cases I have collected to show how careless people become, and also to show the really terrible responsibility—I am sorry to have to say this—which rests upon the gentlemen who have developed this substance in not having warned more effectively the people who have used it. I received this letter only a day or two ago, dated May 8, from West Virginia.

In the early stages of the sale of ethyl fluid they were not able to furnish ethylizers and we filled thousands of 1-ounce bottles with the fluid. In serving the customer we would pour the contents of the bottle in his tank and run the gasoline in on top of it. In filling these bottles the writer took an active part, and I have had my hands and arms up to my elbows covered with the fluid. This not only happened once, but a number of times before we knew there was any danger.

At least we should have some guaranty that in future people will be adequately warned.

I have here also a quotation from a report of Doctor Shrader, in Baltimore, describing the mixing of the ethyl fluid to make ethyl gasoline. I believe this mixing is now done at the works, so I will leave out the first part of the report in which the men he interviewed mention having had the liquid often splashed over their faces and arms. This passage, however, applies. He says:

One service man reports that he gets it all over his hands and coat sleeves, and that the company issues instructions that in all such cases I was to wash it off with gasoline and tincture of green soap; but we do not bother with that any more, we just wipe it off.

This service operator had it splashed upon his face and reported that "it smarted some," and another that it splashed up his nostrils and that "he nearly sneezed his head off."

In this connection I should like to mention one other point. I have spent my summers for some years motor boating, and I find it the regular practice of the men on motor boats when the gasoline pipe plugs up to first blow into it to blow it clear; and if they can not blow it clear, to suck until they suck it clear. I have seen

men time after time squirt mouthfuls of gasoline overboard. We have to keep such conditions in mind. I think it is sufficiently well known to everybody that gasoline is spilled around garages, and I would merely instance one or two collateral points. Methyl alcohol is much less poisonous than tetraethyl lead, yet cases have been reported of men poisoned by inhaling the fumes from the radiators of cars using alcohol in winter. This shows that considerable amounts of fumes are inhaled by men, particularly those driving trucks, and that men have been seriously affected, even by the present fumes. There are also cases on record where the atmosphere in a closed car has become so charged with carbon monoxide as to cause death. I quote this fact to illustrate the point that exhaust gas is sometimes discharged inside of cars.

The main calculation which I want to contribute to this discussion is this: Doctor Haggard, my associate here, and I have published extensive work on automobile gases in the streets. We know the amounts of carbon monoxide in garages; we know that the figures run to 1 or 2 parts in the streets and 8 to 10 or 12 parts in garages, and more than that in repair shops. Now, taking the data obtained by Mr. A. C. Fieldner, of the Bureau of Mines, and combining them with other data we have, it appears that in an automobile every kilo of gasoline burned involves 12 kilos of air. In the exhaust gas there would then be about 1 milligram of lead for each 0.8 liter of carbon monoxide produced, or 1.4 milligrams of lead per liter of carbon monoxide. From this we can calculate the amount of lead in a 1 to 10,000 mixture of carbon monoxide, or the amount of lead in a 10 to 10,000 mixture. If, then, a man breathes four to five thousand liters of air in 10 hours, and the air contains 1 part of carbon monoxide in 10,000, as in the streets, he would inhale in the course of 10 hours one-half milligram of lead. That, of course, sounds to a chemist like an exceedingly small figure. To the man interested in industrial diseases the daily inhalation of half a milligram of lead is a serious matter. In a garage, where often there are 10 parts of carbon monoxide, the worker would inhale daily $2\frac{1}{2}$ milligrams of lead. Of course, this would be reduced in proportion as the lead sticks in the muffler. We come up to the high figure, in proportion as all of the lead is discharged. As processes improve, more will probably be discharged. It seems to me that the Surgeon General, or some officer of the Government, should have general supervision, so that in future the regulations can be adjusted to actual conditions. Even now we often have 200 cars per block in Fifth Avenue, and if they each burn 2 gallons of gasoline per hour it runs up to about 200 pounds of lead in Fifth Avenue between Twenty-third Street and Central Park. Even one-fifth of that amount as volatilized lead is a very large amount. These figures are based on

the carbon monoxide content as we have found it in streets and garages. Carbon monoxide is a true gas; it diffuses rapidly. Lead does not act as gas; it hangs in the air so that one would expect a very considerable concentration of lead dust as compared with the rapid escape of the carbon monoxide. Thus it seems to me, on the basis of all the data that we have at the present time, that the ordinary conditions in thoroughfares in heavy traffic would afford about one-half of a milligram of lead a day for a man to absorb. Kobert estimates that the amount of lead, day in and day out, which would almost certainly result in distinct lead poisoning is 1 milligram. Garage workers and repairers would absorb very much more.

Now, I put it to the gentlemen on the industrial side of this conference that they, no more than any sanitarian, would approve of having a milligram of lead in every gallon of the city's water supply. Yet if the city's water supply contained 1 milligram per gallon we would take daily from it just about the amount of lead which, as nearly as we can figure it on the basis of such facts as we now have, the people of New York, especially in the denser parts, would be expected to inhale.

I have here somewhere—I will not read it now—a paper by Dr. Alice Hamilton in the last Journal of the American Medical Association. She is here and will speak for herself. In that article Doctor Hamilton expresses the matter as fully and as clearly as anyone possibly can. In the last sentence of her paper she sets up this very simple proposition that this substance, this new industrial hazard, should not be put into general use, or its use should not be extended until we have adequate and full information assuring us that we are not introducing another health hazard into our daily lives.

The CHAIRMAN. I am going to ask Doctor Thompson if he will follow.

Doctor THOMPSON. There are others here very much more competent to discuss this subject than I, and I should like to yield my place to Doctor Edgar. Will you call on him?

The CHAIRMAN. Doctor Edgar.

Doctor EDGAR. With Doctor Thompson's permission, I also, not being a physiological chemist or even a physician, would like to have Doctor Kehoe answer the questions, not myself.

The CHAIRMAN. Doctor Kehoe.

DR. ROBERT A. KEHOE

College of Medicine, Cincinnati, Ohio

Mr. Chairman and gentlemen, there are one or two items of Doctor Henderson's talk that I should like to speak of first, beginning particularly with that one which refers to the experiments which were conducted by myself, in that the controls in our animal experimentation showed that they had absorbed lead. I should like to point out the manner in which those animals were exposed to lead. The condition was such as does not and could not conceivably occur in the industrial handling of gasoline. Now, to make that point clear I should like to recite the exact conditions to which these animals were exposed. At the time when it was decided, on the initiative of the Ethyl Gasoline Corporation, to remove completely from the industry that hazard which was regarded by the medical committee as a most important one, namely, the handling by garage men and filling station employes of concentrated fluid, all of the material which was then out on the market was returned to the Ethyl Gasoline Corporation. This came in in varying quantities and at different times over a period of a number of weeks, and it came in in such quantities that the immediate disposal of it was a matter of some difficulty. Various storage rooms in and about the buildings used for the blending and distribution of this material were filled for a time with the cases containing these small cans that had been returned, and it was only in that situation that the overflow took place into the room in which we were experimenting. Under these conditions an exposure on the part of these animals was had, not to the dust of dilute gasoline, which appears on the public market, but to the dust which arose from the decomposition of concentrated tetraethyl lead, a situation which presented opportunity for absorption of an enormously greater quantity than could occur under other conditions. It was under these conditions that our animals absorbed lead—conditions which, let me emphasize, have no relationship to the hazards existing from the handling and distribution of diluted tetraethyl lead in gasoline.

There is one other point that I should like to make with regard to the poisoning of certain persons who were experimenting with tetraethyl lead, whose specimens of feces and stools, or feces and urine, later showed lead. Anyone who experiments in any way at all with concentrated tetraethyl lead is bound to absorb a certain amount of vapor of tetraethyl lead into his body. I see no possible escape from that condition. One may work with a very good hood, but in the very business of treating the animal with concentrated tetraethyl lead and staying in the same room with it there would be a certain absorption of lead. It seems to me that the absorption

of lead which will occur under those conditions is also not a matter relating to the absorption through the skin or inhalation of such lead as occurs in the dilute form of 1 part of lead to 1,300 parts of gasoline. In addition to that, I should like to point out the quantity of lead found in these specimens is no greater than the quantity found in the specimens of control persons whom we have examined, whose excreta we also examined, whose history, so far as we are able to find out, presented no exposure to the industrial hazards which bring about lead poisoning. The quantities, therefore, in these excreta are, to my way of thinking, of no particular importance to the matter in question.

As to the question whether or not all the poisonings which have occurred from tetraethyl lead have been reported, if there have been any poisonings which occurred other than those which have been reported, they have not come to my knowledge. As a matter of fact, there is no manufacturing or blending plant at Whiting, Ind., and I do not know how anybody could have been actually poisoned at that place. I might say this, however, that due to the hysteria which arose from certain items which appeared in the newspapers there was a considerable number of men scattered over the country, some of whom may have happened to be in Whiting, who conceived the notion they had been violently poisoned by tetraethyl, and I have had occasion to examine a number of these persons. Such persons will be found in almost any community, and up to the present I have not been able to find evidence of any foundation in the claims made by them. For example, a man reported to me, who thought that perhaps he was suffering from tetraethyl poison. He had gone to the dentist, and had a condition of his teeth, which, over a period of some weeks, the dentist was unable to treat with good results, so the dentist suggested, I imagine, as the easiest way out (knowing that this man had worked in a filling station where ethyl gasoline had been sold), that this was probably the reason for his teeth not clearing up. It so happened that this man had an ordinary, typical case of trench mouth, which on proper treatment cleared up in the course of a few days. Situations of that sort have arisen in view of the little knowledge existing as to the actual magnitude of the hazard, particularly so since there has been this newspaper commotion about "looney" gas, and all that sort of thing, and there are those individuals who think they have been poisoned but who have some perfectly definite lesion, recognizable by a good physician, not due in any way to lead.

As to the matter as to whether masks may be used where there is tetraethyl lead, or rather whether they can be used with success, I might say that experiments have been conducted at the research laboratory of the Ethyl Gasoline Corporation which I think are quite

adequate to answer that question. The experiments in question were carried out by Doctor Edgar and it would more properly be answered by him. I may say though, as a matter of practical experience, I have had under observation a considerable number of men who have been exposed to these hazards, and we found that with the introduction of the gas masks we got a very satisfactory diminution in illness among the men, so the question of whether or not the gas masks are of any value may be considered answered on the basis not of theory but of actual experience.

As to the proper warning to the users of gasoline, various cards describing tetraethyl lead, describing ethyl fluid, describing the gasoline, have been sent out with every container which has gone out of the blending plant. The character of the poison and the dangers attendant upon its misuse have been made perfectly plain to all users. Of much more importance, however, since one can not depend on either the intelligence or persistence of persons who would have to handle this sort of material, a thing of utmost importance was done when the concentrated fluid, as originally put out, was taken off of the market. This was done as the result of the advice of the medical committee. Considering this was a hazard, which in the hands of careless persons would not be taken care of, it was felt that the ethyl fluid, in concentrated form, should be immediately taken off of the market and should be handled only in such places as would properly regulate and control the manner of its mixing. The hazards, therefore, from the small containers and from the lack of information on the part of the public have been done away with by one stroke by that simple measure of taking the concentrated stuff off the market. There may be found, as a matter of fact, one or two places yet where some of these small cans can be gotten. If that is true, and I am not in position to say it is not true, it is only because they have not been returned; none has been shipped out and none will be shipped out.

One other point which was brought out and which is of general importance I should like to cover, that is the matter of two attitudes which are said to exist, one on the part of the industrial group and one on the part of the medical group, with regard to hazards which may be said to exist. In the past several months—as a matter of fact, for some time—these hazards attendant upon the distribution, manufacture, and production of tetraethyl lead have been not in the hands of the industries; they have been in the hands of medical men, who have had the interests of the public at heart. I am convinced from the association I have had with the company that has had charge of the distribution of this commodity that their attitude is one of complete regard for facts. They have expressed

themselves repeatedly not so much as being interested in opinions as being interested in facts, and if it can be shown—if it is shown as the result of this discussion—that an actual hazard exists in the handling of ethyl gasoline, that an actual hazard exists from exhaust gases from motors, that an actual danger to the public is had as a result of the treatment of the gasoline with lead, the distribution of gasoline with lead in it will be discontinued from that moment. Of that there is no question.

I make no plea for industrial progress, because in my own opinion industrial progress is not synonymous with human progress at all; but I must say, from the standpoint of industry, that when a material is found to be of this importance for the conservation of fuel and for increasing the efficiency of the automobile it is not a thing which may be thrown into the discard on the basis of opinions. It is a thing which should be treated solely on the basis of facts. That has been our attitude from the beginning, and that will continue to be our attitude.

The CHAIRMAN. We have this discussion divided somewhat arbitrarily, I fear; but are there any remarks by anyone on the experimental phase of this?

Doctor MORTON. I would like to answer Doctor Henderson about the letter he has in regard to a case of lead poisoning. This young man he refers to is the son of the dean of the law department of the University of Kentucky. He was working in the experimental laboratories at Whiting, Ind. A few days after the papers were full of the New Jersey accident, where a number of men died as a result of lead poisoning, this young man took sick. He is a graduate of the University of Chicago, and he was treated by one of the medical staff of the University of Chicago, who did not make a diagnosis of lead poisoning but said that his trouble was nervousness. I saw him, examined him, and had Dr. Ralph Webster, head of the Chicago laboratory, examine the urine for lead. I also had the blood examined. Everything was negative, so that my diagnosis was neurasthenia or nervousness. He went home to Kentucky. His father had three men at Louisville, I believe, take care of him for two or three weeks. We afterwards received a letter from one of the men at Louisville which said that no signs of lead poisoning had been found and that the diagnosis was nervousness, or a neurotic case.

Doctor HENDERSON. This letter states he had been assigned for several months to investigations on the method of developing tetra-ethyl lead. The doctor denied that.

Doctor MORTON. He was experimenting. He was using tetra-ethyl. He was not making it.

Doctor HENDERSON. Had he not been working with ethyl gasoline?

Doctor MORTON. No.

Doctor FLINN. I object to the insinuation just expressed by Doctor Kehoe that quantities of 0.7 and 0.8 milligram of lead are common findings in the normal stool. In an examination of 28 stools of men supposedly poisoned at the Standard Oil plant in Bayway we were able to detect lead in only 18 or 19 cases, and the stools of these men were examined more than once in most instances. Doctor Touart can correct me if my statement is incorrect. As I said this morning, the records of over 500 men showed that lead was present in the urine only in 20 per cent. These men were exposed to lead in their work. I think most medical men will agree that lead is not a common finding in the feces and urine of the normal man.

Doctor AUB. I should like to say a few words about the experimental side. Two or three things struck me this morning quite clearly, which I think men who have not been working in the investigative side would hardly appreciate. First of all, the different types of animals vary tremendously in susceptibility to lead intoxication. Guinea pigs, pigeons, rabbits, and cats are fairly susceptible. Some animals I have not worked with, so I can not say definitely whether goats or monkeys are susceptible or not, but dogs, chickens, pigeons, and rats are only fairly so.

The same thing is true of the blood picture. Some of the blood pictures given this morning might tend to give a false impression, because many animals will not show blood changes, as, for instance, anemia during lead poisoning, and when it is slight stippling does not appear in many animals, such as cats, hens, and pigeons. As one looks over the experimental data one has to be careful to realize that different types of animals give you different results.

Secondly, about the discussion of lead analyses. Lead analyses are particularly difficult when analyzing the bones. When one reports a tremendous variation, as, for instance, a high content of lead in acutely poisoned animals, and then a low content weeks later when there was found to be only an elimination at most of 10 milligrams in the feces and urine, the question arises whether perhaps the discrepancy lies in the difficult analyses. It took us several months to learn how to recover all of the lead present in bone, for it is a very difficult analysis.

The analyses which have been reported as found in normals I can not corroborate. We have done many determinations in normal individuals in the last three years, and so far as can be made out normal individuals do not have lead in their stools and urine. Nor-

normal lead was reported many years ago by several investigators. Their methods were not very accurate. With modern methods, even as recently as five years ago, manganese has been mixed in lead determinations and has given the picture of positive lead determinations. With the present methods—we use Fairbell's method—the stools from normal individuals contain no lead and the average individual in New England does not have normal lead in his body. We analyzed the bones of 26 individuals, who for one reason or another had to have an amputation. Of these 26 cases, 19 of them had no lead in their bones, and practically all the lead which is stored in the body is to be found in the bones. Seven of them did have some lead storage, and most of these were later found to have had an exposure to lead of some sort previously in their life.

There are one or two other things to speak about. We studied one man who had some symptoms from tetraethyl lead exposure. His excreta showed lead in the urine and feces just as it appears in the usual chronic cases, and it responded fairly well to medication, which suggests that the chronic effect of tetraethyl lead will be similar to that from the absorption of nonorganic lead.

Another point, and that is, in practically all the observations reported on exposure to tetraethyl, although many of them showed no symptoms, practically all showed absorption of lead, and to my mind that is very important because lead is an accumulative poison, and whether they showed signs of poisoning or not is not important in acute experiments, but it is important that these individuals have absorbed lead and retained it. That means in more chronic exposure the amount present will become increased. Besides, the amounts which were found in the experiments reported to-day are not small as one looks at the figures, at least compared to the animals which we have studied; the amounts found in organs are relatively large quantities.

There is one more thing. I do not think, as the problem occurs to me, that the question of the toxicity of tetraethyl lead itself or even the distribution of the product is the problem involved. By far the greater problem is the question of whether distributing lead over communities from the exhaust gas will cause any toxic symptoms in individuals who can not protect themselves. I am not perfectly certain in my calculations, but from what Mr. Kettering said, 15,000,000,000 gallons of gasoline will be used, and if we used tetraethyl lead in all of this it would mean 50,000 tons of lead distributed over the United States in a year. If that is correct, and I think it is, I am not certain that this would cause poisoning, but whether it would cause poisoning is a very serious question. One must give that considerable thought, and it seems to me that it must

first be proved that it is not poisonous, because of the tremendously diffuse results that this amount of lead scattered in fine powder over a long period might cause. It seems to me that this should be very thoroughly investigated before tetraethyl lead is again put on the market.

Doctor EDGAR. With reference to the question of the analysis of lead, as the doctor pointed out, as to small quantities of lead in animal tissue, it is difficult to get strictly accurate data. I do not know what method has been used by the Bureau of Mines. Our own method has been ashing animal tissue at low temperature, 500–600° C., the lead being precipitated by hydrogen sulphide, reprecipitated and dissolved and reprecipitated the third time as sulphide to get rid of various impurities that accumulate, and finally reprecipitated as chromate, and estimated colorimetrically by treatment of chromate with diphenyl-carbozide.

The details of our own method were worked out in the period of a month or so and have been conducted with extreme care. With the addition of known quantities of lead and materials giving blank quantities of lead we have obtained very satisfactory results, and I think we have reasonable certainty of accuracy in our own method—we have worked that over quite thoroughly, because it is an extremely difficult problem. The average person with inexperience in lead analysis can not get accurate data with small quantities of lead without considerable care.

Doctor KEHOE. Whether or not lead is found in normal stools brings up the question of the manner in which these controls were obtained. We looked about for controls who could not in any conceivable way have been exposed to ethyl gasoline.

A community in which ethyl gasoline has never been sold or distributed was selected—Columbus, Ohio. We went to Columbus, Ohio, and originally had the idea of going to a commercial garage of some sort which employed men and subjected them to physical examination and collecting specimens for analysis. This did not appear to be feasible, so that the procedure which was adopted is as follows: We went to an employment agency, and the men were sent to us from the employment agency just as they came in. Careful histories were taken—I have these histories with me—to obtain information as to whether or not these men had ever had any exposure to lead of which they knew. In order to obtain that information leading questions were asked as to their occupations over a period of years.

Specific questions were asked as to whether or not they had worked in an automobile factory, a tire factory, whether there was known exposure to lead, whether they had worked in battery factories or

for battery works of any kind, and so on through the industries which we know presented lead hazard. Histories were taken by one man and physical examination was done by another without any knowledge of the history, and specimens were turned over to the laboratory without either history or physical examination, simply with the names and numbers, and those specimens, both of urine and feces, were examined. The amount of lead which was found uniformly in these specimens was as much a surprise to me as to anybody in this room. This report was presented to me yesterday. I have no reason to doubt its accuracy, and there it is. Take it for what it is. The result is not complete, because we have only data on 10 men out of 30 who had exposure and 10 men out of 64 who had no exposure.

The data on this particular matter will be completed and published later, but it just happens that 10 men on whose specimens I have reports were taken at random by the laboratory group, they having no knowledge of the number of controls or the number of exposed men, and it simply turned out the way I presented it.

Doctor HAGGARD. Doctor Kehoe's report certainly shows a serious hazard. People do not have lead in their excreta unless there has been an exposure to lead. In the past lead has been found only in the excreta of typesetters, painters, and the like. But now Doctor Kehoe finds lead in the excreta of all persons tested. It would appear that such a general exposure could only come from one source, and that is the leaded gasoline which was widely used in the city when he made his study. Doctor Kehoe's work offers an experimental demonstration of what sanitariums had assumed on theoretical grounds.

The CHAIRMAN. Is there any further discussion of the experimental results? If not, I will ask Doctor Edsall, of Harvard, to open the discussion on this subject from the clinical standpoint.

DR. DAVID EDSALL

Dean School of Public Health, Harvard University

I suppose I am asked to speak about the clinical side because I have had some experience in the general question of lead poisoning. I would say that I have not had clinical experience with tetraethyl lead poisoning. I have not seen cases. I have seen the conditions under which it is produced and handled, but my knowledge in the matter is really confined chiefly to the general question of lead poisoning and experience in that for a good many years.

The CHAIRMAN. We want to bring out everything we can.

Doctor EDSALL. I speak then from the standpoint of a clinician somewhat experienced in lead poisoning and in industrial conditions.

In the first place, as regards the manufacture of tetraethyl lead, I am personally prepared to believe that while it is an extremely hazardous thing, it can be made reasonably safe as compared with the manufacture of other very dangerous substances. I would deplore some of the things that were said this morning as regards careless handling of it for a long time without any dangerous symptoms, because the impression might readily get about that that is a safe thing to do. I think the escape from dangerous symptoms in these circumstances was unquestionably a pure piece of luck. There can be no doubt that in the handling and in the manufacture, in the first place, all the mechanical precautions that can be taken should be taken, and in addition to that there should be extremely careful observation of the plant all the time.

I have also very little doubt that the transportation and gross distribution of it can be reasonably safely handled if done very carefully. I was impressed, however, by the numbers that Doctor Kehoe mentioned this morning as showing symptoms. Out of 100 men since last August, 18 had showed symptoms that could be interpreted as being some degree of mild poisoning. That means, it seems to me, that the methods of handling were as yet far from perfect. It is a high incidence of lead poisoning in any kind of occupation where there is exposure to lead to have in that time 18 per cent of workers show symptoms of lead poisoning.

Nevertheless, I think the manufacture and gross handling of it could be made reasonably safe as compared with many other things that are done and must be done. But that means that everything must be done with constant care and watchfulness, because disturbances may occur at any time which might lead to serious results; and under the best circumstances I feel sure there would be occasionally serious cases of poisoning. That, however, is unfortunately necessarily true in the handling of all dangerous chemicals, and it is generally recognized that that does not make the manufacture of them a thing to be necessarily limited or forbidden.

On the other hand, I have been in much doubt about the question of the use of the product in garages and sales stations and in regard to the question of the effect of the exhaust. I have been very much impressed by an examination of the results reported here to-day. The only evidence that I have heard that would indicate that it may be safe is the evidence that Doctor Kehoe mentioned in the group he studied of people exposed to it about garages where it was used. In spite of what Doctor Kehoe has just said, I think that his work will have to be neglected for the reason that the finding of lead in such a large proportion of control people means that however carefully these observations were made there was something wrong technically. Very careful and prolonged work by our group and

other groups has shown that lead in the excretions of apparently normal persons is very unusual and can be traced generally to some previous exposure. Therefore one must feel that with the people that were taken as controls something has been overlooked or there were technical errors, and therefore the results can not be accepted.

On the other hand, I am impressed by Doctor Sayers's report of a large amount of lead in the dust of the chamber in which animals were exposed and in which an extremely high degree of ventilation was being carried out. Of course larger amounts of tetraethyl fluid were used than are used commercially, but, on the other hand, Doctor Henderson is technically correct in saying that the standard dilution of carbon monoxide in the experiments to 1 in 10,000 is not correct, for the conditions in garages often provide a higher proportion of carbon monoxide.

Those two things will probably balance each other, so I think we can take Doctor Sayers's results as indicative of what may occur in garages, not necessarily as what will occur but as the only evidence we have as to what may occur.

We are dealing here not with tetraethyl lead but with lead, so that the observations in regard to lead that have been made for many years are observations that can be directly transferred to this question. For 100 years and more observations have been made as to the effect of having a noteworthy amount of lead dust around in any occupation. We know what happens to some of the people exposed to it. It is not a question, then, whether there is or is not a hazard. There is a hazard, if these observations of Doctor Sayers and the observations of Professor Flinn are correct. The question is, how great is the hazard? Judging from other conditions in industries in which lead dust occurs, I am disposed to believe that the hazard is a noteworthy one. How severe I am not prepared to say. The only way in which one can determine how serious it is would be through a very large number of extremely carefully carried out observations as to what the effects are upon a large number of human beings with ethyl gasoline in general use in the neighborhood in which these people live.

It has to be remembered, and this can be repeated in occupation after occupation, that even where there is a noteworthy hazard only a limited number of people show clinical symptoms of lead poisoning that are clearly recognizable. A very much larger number, if you examine carefully, will show signs of ill health of an indefinite character, and these are the things that are very likely to be overlooked. They show chronic disease, as of the gastrointestinal tract, anemia, and vague chronic disorders of health much more frequently than they show the commonly recognized effects, namely, lead colic or paralysis or mental symptoms of lead poisoning. I accept with

the greatest skepticism general statements as to lead hazards, such as reports that "nobody has been sick" or "nobody has shown any symptoms of lead poisoning."

That kind of testimony is negligible. The only kind of testimony that would show whether there was lead poisoning or not would be based on extremely careful and highly experienced observation, including carefully carried out examinations of the excreta and including also the recent methods that Doctor Aub's group have been carrying out of producing artificial acidosis and determining whether this leads to lead excretion in exposed people who have been carrying lead quietly in their systems without having symptoms and without excreting any of it under ordinary conditions.

That is one of the most striking things in regard to this whole question, that persons may be absorbing lead and keeping in their systems a large portion, and yet have no obvious symptoms. Then these persons may develop symptoms or show excretion, owing simply to alterations in their diet, or to other simple circumstances. Under ordinary conditions you may say that besides those people who show definite lead poisoning in consequence of exposure to lead there are a much larger number that are carrying lead and are therefore potentially liable to symptoms of poisoning.

The only conclusion that I can draw from the data presented here to-day is that in the question of the exhaust and to a certain extent in the question of the effects of the ethyl gasoline mixture, we are dealing with a matter that has to be judged by the accumulated experience of many years now as to lead poisoning in whatever circumstances or occupation it occurs. And I can not escape feeling that a hazard is perfectly clearly shown thus far by what has been reported here to-day, that it appears to be a hazard of considerable moment, and that the only way that it could be said that it is a safe thing to continue with that hazard would be after very careful and prolonged and devoted study as to how great the hazard is.

In occupations in which there are lead hazards it has been the increasing viewpoint not only of public health men but of industries themselves and of governments, for many years now, that a hazard having been discovered must be relentlessly struggled against and essentially eliminated before the conditions are passed as being approved. When we are dealing with industry, with a manufacturing process, that is nearly always a feasible thing, and it has been done in some of the lead processes that at first looked as though they were perfectly impossible to control. But there you have a group of workers entirely controllable as a group. Regulations which can be put upon them can be carried out with care and the whole matter is within the control of the individuals who are responsible for it.