See file of Sundry material and Ethyl Gasoline for other material, including notes of P... address in handout to newspaper men

TABLE OF CONTENTS

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PROGRESS REPORT NO. VI OF THE COMMITTEE UPON THE MEDICAL ASPECTS OF TETRAETHYL LEAD POISONING

April 1, 1925.

F O R E W O R D

The first very full report of the Committee was presented August 20, 1924 -

Since that time, minor reports have been presented dealing with the activities of the Committee which has given unremitting study to the problems involved.

The following report presents a summary of Bayway and Dayton cases of poisoning to date, with other matters to date of importance and interest, with the exception that no formal statistical reports thus far have been obtainable from the du Pont plant.

I N D E X

NUMBER OF CASES OF POISONING

At Bayway	71	
At Deepwater	?	
At Dayton	49	- on whom there are records. There have been several others on whom there are no records (probably about 10 cases) i.e. occurring before Dr. Kehoe came to Dayton as physician.
		There were no cases from August, 1924, until October. All told, the cases in Dayton run to about 60. There are no cases at present at Dayton.
	18	cases since October 1st - all mild early cases.
	138	Total reported cases.

NUMBER OF DEATHS

At Bayway	5	
At Deepwater	6	
At Dayton	2	
	13	Total.

BAYWAY CASES

Number of recoveries	66
Number of men returned to normal or part time work	55
Number who have left the service of the Company	11
Number sent to hospitals	51
Number treated at home	20

DEEPWATER CASES

DAYTON CASES

Number of recoveries	49	- all Dr. Kehoe's cases.
Number of men returned to work at plant	7	- all others are elsewhere at work.
Number remaining incapacitated - none		- No delayed results have appeared.

Number sent to hospitals	none
Number treated at home	all

NUMBER OF CASES OF EACH SYMPTOM OBSERVED IN 68 PATIENTS ESPECIALLY STUDIED

Symptoms	Number of Times Noted
Insomnia	68
Headache	37
Nervousness	30
Prostration	43
Vertigo	33
Dreams	41
Nausea	38
Vomiting	24
Anorexia	47
Constipation	7
Diarrhea	5
Thirst	16
Dry Mouth	17
Nocturia	14
Pains in groins	7
Abdominal pain	20
Other pains	6
Metallic taste	18
Loss of weight	41
Marked pallor	5
Low blood pressure	46
Slow pulse	25
Delirium	6
Stippling	23
Lead in stools	17
Lead in urine	1
Lowered temperature	19
Hyperacidity	18
Acetone	1
Albumen	2
Skin test	12
Tremors	6
Scotoma	3
Increased muscular reactions	7
Enlarged pupils	1
Itching	4
Mucous membrane irritation	1

NOTE: Not all these patients had the urine, sweat and stools examined.

Among 29 patients whose stools were examined, lead was present in 17. The urine was examined in 3 cases and lead was present in only one case, although in the two instances in which lead was absent from the urine it was present in the stools.

SYMPTOMS AS PRODUCED BY DIFFERENT TYPES OF EXPOSURE

The behavior of grouping of symptoms varied somewhat in connection with different processes. For example, the man first poisoned at Dayton showed little, if any, granulation or "stippling" of the red blood corpuscles, whereas, later on, in connection with a different process, a number of patients presented this symptom. About one-half the patients examined at the Reconstruction Hospital also showed it. When the ethyl chloride process first was developed by the chemists at Bayway, they felt quite confident that it might prove less hazardous than the ethyl bromide process, but animals poisoned with both substances, in experiments made for the Committee at Bayway, showed that the reverse appeared to be the case. Moreover, at the du Pont plant the original bromide process was simultaneously conducted while the newer ethyl chloride process was operated, yet it was in the latter work that the recent sudden out-break of poisoning occurred.

The well-known stimulating effect of inhalation of ethyl chloride was evident in some of the workmen; that is, men who were perhaps feeling tired and a little out of sorts, would feel temporarily better while working in the plant, as if they gained some slight exhilaration from traces of the vapor in the air, but on going home they would collapse again. Men working on the night shift appeared to suffer more than those employed during the day, in many instances.

At Dayton, with the reduction of exposure to tetraethyl lead, and with the greatly decreased rate of absorption of lead, there has been a change in the clinical picture of the poisoning. The subjective symptoms do not appear in such pronounced form, in fact, in some cases they do not appear until after the signs of

lead absorption have put in their appearance. In several cases in which no complaint has been made, it has been possible to find slight stippling of the blood cells, as the first indication that lead was being absorbed. It is necessary, therefore, to look for the signs of ordinary lead poisoning as well as the symptoms of tetraethyl lead poisoning before pronouncing a given employee free of lead absorption. This situation makes it possible to recognize the danger of poisoning before the subject is conscious of any illness. Because of this, it seems likely that the danger of any protracted illness in employees in the Dayton plant may be overcome completely. A practice is made of removing from all exposure any employee who shows any of the signs of lead absorption. The signs which appear are as follows: Slight drop in blood pressure, subnormal temperature, slow pulse, an occasional stippled erythrocyte (i.e. granular red blood corpuscle) in the blood. Symptoms may or may not accompany these signs. A slight drop in the blood pressure and temperature is not significant when the subject has a cold or any other infectious or other immediate cause for fatigue. However, in the absence of these things, and if the subnormality be persistent it is considered sufficient cause for cessation of exposure. In such cases stippling almost invariably appears. Its appearance, with or without the other signs is considered an indication of lead absorption. Needless to say, the appearance of definite symptoms of sleeplessness or of disturbing dreams, if they occur in more than the most fleeting manner, is always considered seriously.

CONVALESCENCE

Convalescence usually has been protracted and although many

patients were able to be up and walking about, they nevertheless felt weak and were slow in regaining appetite and weight. Insomnia also was a usual symptom as well as low blood pressure.

The psychological effects of the disaster at Bayway received considerable study at the Reconstruction Hospital. In general, it was found that many patients who showed very few genuine symptoms while at home were so excited by the alarmist talk which was circulated by the public press and otherwise, that they were on the look-out constantly for symptoms which did not really exist in themselves. When these men were brought over to the Reconstruction Hospital, every effort was made to divert them. They were taken out walking in the opposite Central Park, were given motor bus rides, a radio was installed for their use, and the general atmosphere of cheer in the institution was no small factor in shortening the duration of illness.

AFTER EFFECTS

Deducting the five deaths from the seventy-one patients poisoned at Bayway, there remain sixty-six. Of this entire number, only one, on March 20th, 1925 - nearly five months after the original poisoning - remained in any way incapacitated and his symptoms were practically gone. The other patients have shown no permanent mental or physical symptoms beyond the fact that traces of lead may still probably be found in the stools of a few of them and one or two have occasional gastric disturbances. A great majority, namely 54, of the men have been returned to either full or part time work. Eleven have, for various reasons, left the service of the Company.

RESEARCH

In patients having mild symptoms, it was decided to determine whether lead stored in the body could be caused to be excreted by producing an acidosis. To this end, calcium chloride was given, followed by bicarbonate of soda and in some cases this seemed to increase the lead output.

In all the patients studied, the chief source of elimination was found to be through the bowels. Although lead was found in a number of instances in the urine, it often was absent from that secretion while being eliminated in considerable quantity in the stools. In a few cases tested, slight elimination was found to take place through the skin.

AUTOPSIES

Although thirteen deaths were recorded, only four autopsies were thoroughly made. In two or three instances in connection with all three plants, autopsies were made by outside authorities, which proved so superficial as to be of very little scientific value. In other cases, permission for autopsies was refused. The four accurate autopsies were made by Dr. Charles Norris, Chief Medical Examiner of New York City, upon patients who died at the Reconstruction Hospital. The gross appearances in these cases only have thus far been reported for the chemical and microscopic examinations require several months for their completion. The Medical Examiner is exceedingly busy and although repeated efforts have been made to hasten this work, it has not yet been completed. The Examiner stated that one of the four patients presented no gross appearances at the autopsy from which lead poisoning could have been diagnosed without previous knowledge of the man's occupation. In three

other patients, however, the characteristic findings were as follows: "Extreme congestion of the bronchial mucous membrane" and the lungs showed "extreme congestion and slight edema." The blood vessels on the surface of the brain showed "intense engorgement" and the outer layer of brain substance showed "small hemorrhages." There was also some congestion of the abdominal viscera. In one case there was a peculiar bright red appearance of the muscles. In one case, blood was present in the brain sinuses. In three patients the cause of death was given as "Hemorrhagic Bronchopneumonia." In the fourth case, it was given as "General Visceral Congestion." In the only case in which the partial chemical analysis has been completed, a very large quantity of lead was found in the brain substance, said to be about seven and one-half grains.

TREATMENT EMPLOYED

The objects of treatment were twofold: first, to relieve immediate and urgent symptoms; second, to promote elimination of lead from the body.

The chief symptoms requiring immediate relief were insomnia, delirium, gastric disturbances and abdominal pains. It was found that the insomnia was exceedingly obstinate, although a great variety of hypnotics were employed, most of them proving without effect and morphine particularly made the symptom worse. Paraldehyd and similar drugs also were well-nigh useless. Bromides were given up to the excessive individual dosage of 90 grains with partial relief in some cases. In one case of violent delirium treated at the du Pont plant, apomorphine was given hypodermatically with

marked relief causing sleep which lasted for some hours. When the symptoms subsequently recurred in this patient, the same treatment was again effective. The abdominal pains were relieved by applications of heat and such remedies as codein, with evacuation of the bowels.

To promote elimination, the patients were encouraged to drink large quantities of fluids, plain water, lemonade, milk and vichy, etc. The bowels were strongly evacuated with saline cathartics. Perspiration was induced by hot packs and electric light baths. To the patients at the Reconstruction Hospital sodium thiosulphate was given by injection into the veins. This remedy has been extensively used also in mercury poisoning to promote elimination and in some of the patients treated at the Reconstruction Hospital, it seemed of considerable value.

Alkalies such as soda and magnesium sulphate were given to counteract supposed acidosis.

In the mildest cases the only treatment followed was the removal of the patient from further exposure to the poison and placing him under conditions of abundant fresh air and sunlight with moderate exercise. It was the common experience that patients with mild symptoms who were kept in bed did less well than those who were urged to go out and live in the open air. No antidote for the poison is known.

HAZARDS OF EXPOSURE AT THE BAYWAY PLANT

(a) Chemical experiment plant

(b) Experimental manufacturing plant

(1) Non-segregation of machinery and workmen

(2) Crowding

(3) Construction simultaneously conducted with

(4) Dust

(5) Fumes - Blowouts

(6) Spills

(7) Failure of use of protective equipment

(a) Chemical Experiment Plant.

This plant occupied a comparatively small room, about 30 x 40 feet square. The apparatus was all of experiment size; the chemists were constantly present with the workingmen and only a score or so of men were exposed in all. As they were all under constant careful supervision, no symptoms of any seriousness were observed in this plant.

(b) The Experimental Manufacturing Plant. (Closed by the Medical Department on October 25, 1924.)

This was a much larger room where all the machinery was grouped, with the exception of that for the small part of the work which was conducted outdoors. In this plant there was the obvious fault of non-segregation and of over-crowding, so that any workman might be called during his shift to work in any part of the room, at any part of the process, and the space between the various pieces of apparatus was considerably crowded. Simultaneously construction was going on with production. It therefore happened that a number of patients were among the employees who were not process men at all, but pipe fitters or other mechanics. One man treated at the Reconstruction Hospital had been working only upon a ventilator in the roof. Furthermore, in this Experimental Manufacturing Plant, about one-third of the room was screened off by chicken-wire for the conduct of

entirely different work, such as testing fire brick, etc. Here, two men were poisoned, who merely walked through the rest of the plant to get to their work, having been exposed to the escaping fumes on several occasions, which filled the entire room. In this plant also, the autoclaves were filled with lead alloy from a platform raised some ten feet above the floor. The process was very dusty and from this elevation, dust readily was disseminated. Several so-called "blowouts" occurred at this plant, making it necessary for all the men to rush out of the building and remain outside, sometimes for two or three hours, before all traces of odor of ethyl chloride could be removed. There were various occasions when spills occurred and there was opportunity for skin contact with tetraethyl lead. Owing to this generally mixed character of the work it was impossible to determine from the employees who had been exposed, just what had been at fault for each particular case. There was, for various reasons, failure of constant use of the protective appliances which had been recommended by the Medical Department.

DISMANTLING OF BAYWAY PLANT

On the occasion of the dismantling of the Bayway Plant the Medical Department ordered the strictest protective measures for the workmen. They were clad in rubber from head to foot and the entire plant was thoroughly washed down with water to allay dust. A large gang of men were assigned to the work so that it was conducted intensively while strict supervision was maintained, with the result that no trouble of any sort followed.

HAZARDS OF EXPOSURE AT THE NEW BUILDING OF THE DU PONT PLANT
(This record is incomplete as no data have been furnished the Committee subsequent to its visit on February 16, 1924.)

Most of the poisoning had occurred in the two upper floors of the five-story building. It appeared there might have been some leakage around gaskets or valves and that in the process of emptying the lead alloy into autoclaves, ethyl chloride vapor was released in considerable quantity through an 18 inch cap at the end of the autoclave. Too much reliance had been placed on the supposed perfection of ventilation and the men therefore had not worn masks. Moreover, there were sixteen autoclaves filled, twice each day, and at varying intervals during the day. Therefore, there was the possibility of escape of ethyl chloride vapor at any time containing traces of tetraethyl lead derivable from sixteen eighteen-inch circular openings. The workmen in this process wore no masks. As the two upper floors of the building are separated only by an interrupted flooring, any hazard from escaping vapors might be common to both floors. Inasmuch as ethyl chloride is more difficult to confine than steam, unusual tightness of valves, gaskets, caps, etc. must be secured.

HAZARDS OF EXPOSURE AT THE DAYTON PLANT

1. Filling drums with "Ethyl" fluid.
2. Washing drums
3. Cleaning and decapping small cans in which fluid formerly was shipped. (Hazard here from inhalation of dust.)
4. Analytical and experimental work on tetraethyl lead.

Note: The filling of small cans of "Ethyl" fluid and the handling of them has been completely discontinued, thus eliminating most of the greatest hazards. There will now be no appreciable exposure to the dust of tri-ethyl lead salts.

During the past seven weeks (i.e. prior to April 1, 1925) the hazards at Dayton have been very materially reduced. This is a result of the complete discontinuance of the distribution of "Ethyl" fluid, in small containers. At one stroke the most important hazards at this plant have been eliminated. First, the filling of the small containers provided an exposure to the risk of spillage and inhalation. Second, the return of these containers to the plant for cleaning and refilling brought about an exposure to the inhalation of dust. Third, both of these operations required the employment of a considerable number of men. With this operation discontinued the actual danger of exposure has been greatly reduced, and the number of employees also has been reduced.

The hazards which now remain to be considered are as follows:

1. The filling of drums of "Ethyl" fluid. This is being done in a well ventilated room. The constituents are piped into this room and are not handled in any way by the employee. Their delivery into the drum is carried out by automatic filling devices which reduce the possibility of spillage and inhalation to a minimum.

2. The unloading of tetraethyl lead into storage tanks. This, too, is accomplished with a minimal amount of danger from exposure. The slight inhalation of vapor, which might be had, is prevented by the use of masks.

3. The washing of drums. This is being done in a specially devised chamber, by means of automatic machinery, and appears to be a safe process.

4. Analysis of tetraethyl lead. The process, which is carried out by a single chemist, involves a slight amount of exposure.

Some months ago a great number of small pumps which had been used at Dayton for dispensing the concentrated fluid, were returned to the plant. In an attempt to clean these quickly and get them out of the way, a number of men were poisoned by the inhalation of the dust of tri-ethyl lead salts. This single operation carried out for a little more than a week brought about more than half of the cases of poisoning which have occurred in Dayton since October.

The reduction of the magnitude of the hazards at Dayton has been followed by a gratifying decrease in the number of cases of poisoning. Since October first, 1924, there have been but eighteen cases of all kinds, (including the above group poisoned by inhalation of dust). A number of these patients reported herein as cases of "poisoning" never became ill, but were relieved from their employment because of the discovery of objective signs of lead absorption. Such men did not lose time, but were either released or transferred to other positions. None of the eighteen were seriously ill, though a few of them had symptoms which persisted for several weeks at a time.

DISTRIBUTING TETRAETHYL LEAD

The Committee has formulated definite and comprehensive

rules applicable to all employees handling tetraethyl lead in transportation, in filling stations, delivery tank wagons, etc. Printed posters of warning also are displayed in the filling stations and any one purchasing ethyl gasoline is furnished with a printed card of warning against its use for any other purpose than the legitimate one of a motor fuel. Copies of these rules, regulations and warnings are appended to this report. The Medical Department of the Standard Oil Company of New Jersey furthermore employs a special inspector who is borrowed from the service of the United States Bureau of Mines and who visits all the filling stations where tetraethyl lead is supplied. He makes weekly reports to the Medical Department concerning the faithfulness with which the rules are carried out and reports any errors in construction or failure to observe literally the rules and regulations. Thus far, the reports have been eminently satisfactory and no cases of poisoning have been discovered.

EXPERIMENTS

The experiments instituted by the Committee in the Industrial Hygiene Laboratory of Columbia University under Professor Flinn and the United States Bureau of Mines Laboratories at Pittsburgh have been closely supervised by the Committee who made frequent visits to these laboratories. The work of the two laboratories also has been coordinated by correspondence and personal interviews. The main object of the experiments from the economic and public health point of view is to determine the possibility and degree of hazard for the public in handling Ethyl Gasoline. This object has been

kept strictly in mind although there are, of course, many scientific features of the subject which are of collatoral interest. Neither one of the laboratories is yet ready to make a final report but it would seem to be established thus far that daily skin contact of Ethyl Gasoline through a period of a few weeks is capable of causing such degree of tetraethyl lead absorption that lead may be determined in the stools of the animals experimented upon. Some of them already have shown symptoms of chronic lead poisoning. It does not seem to the Committee, once this fact definitely is established, that it is necessary to prosecute this line of experimentation further. Details of the rate of absorption in different animals in relation to the surface exposed, their body weights, etc. to determine maximum and minimum dosage are interesting scientifically but can hardly be applied to human beings. The whole question is whether lead may be absorbed and stored in the human system through prolonged or frequent skin contact with Ethyl Gasoline. Once that fact is determined it matters little, in the individual case, how much or how little lead is absorbed, or over how large a surface it be applied.

EXHAUST GAS EXPERIMENTS

With exhaust gas, experiments were instituted by the General Motors Chemical Company before the Ethyl Gasoline Committee was appointed and have now been conducted for about a year. After eight months of experiments, a public report was issued by the Bureau of Mines, practically completely exonerating the fumes from any hazard for the public. Nevertheless, there is a group of scientists at Yale, Harvard and

Cornell Universities, who have seen fit to criticize severely these experiments without any personal knowledge of them and without any attempt to repeat them themselves. They have sent a number of communications to the Public Health Committee of New York Academy of Medicine disparaging these experiments. It is the opinion of the Tetraethyl Lead Committee that if these men could be induced to visit the laboratories themselves and learn at first hand what they are criticising, their antagonistic views might in great degree be modified. Surgeon General Cumming of the United States Public Health Service has promised to call a conference upon the whole subject of tetraethyl lead poisoning from the public health point of view. He has, however, been dissuaded from doing this until such time as the laboratory experiments may be completed.

RESEARCHES BEING PROSECUTED AT DAYTON

1. The Absorption of Tetraethyl Lead from Gasoline.

In view of the fact that the application of the gasoline and a subsequent possibility of absorption of concentrated tetraethyl lead, experiments have been performed to determine whether or not tetraethyl lead may be absorbed out of the liquid gasoline. This is obviously the manner in which exposure may take place in man.

The manner of experimentation and the details of the results are not included in the present discussion. However, it has been shown that tetraethyl lead may be absorbed by experimental animals out of gasoline, when the exclusive exposure of the animal is to the solution of tetraethyl lead in gasoline; i.e. when care is taken to prevent the possibility of evaporation of

the solvent.

This indicates the probable futility of attempting to protect against skin absorption by the application to the skin of oils and greases which will be solvents for tetraethyl lead.

These experiments are being continued with concentrations of tetraethyl lead in gasoline more nearly comparable to those occurring in "Ethyl Gasoline."

2. The Secretion of Lead by Men Poisoned by Tetraethyl Lead.

A series of observations have been made on the secretion of lead in patients. It has been shown that lead is excreted both in the faeces and in the urine of most poisoned men, in quantities varying from a fraction of a milligram up to five milligrams, for a twenty-four hour period. In one case the quantity excreted in the urine exceeded that in the faeces for a corresponding period.

In all others the quantity secreted in the faeces was greater than that in the urine. Somewhat inadequate, (because incomplete) study has been made on the influence of various salts on the excretion of lead. In three out of four cases the administration of sodium bicarbonate in a dosage of twenty grams per day increased the quantity excreted in twenty-four hours. The increase in the rate of secretion varied from thirty to fifty percent. In one case no effect was produced. In the one case in which it was employed, calcium chloride, at the rate of fifteen grams daily, increased the secretion of lead in both urine and faeces to almost double its former quantity. In one case, sodium chloride and sodium citrate each failed to increase secretion.

Experimentation both in man and in animals is being

continued along this line. If secretion can be obtained and maintained at a high enough level no accumulative effect will be produced by lead, at least in the case of employees under direct medical control.

3. The Hazard from "Ethyl Gasoline."

A considerable number and variety of animals is being used to determine the hazard from the above source. Experiments are in such a stage as to make report on this matter of little value at present.

Submitted for the Tetraethyl Lead Committee by
Dr. W. Gilman Thompson, Chairman /s/ W. Gilman Thompson
and Dr. Robert A. Kehoe.

TETRA-ETHYL LEAD CASES AT THE RECONSTRUCTION HOSPITAL.

Total cases	44	(There was an additional fatality which occurred not at the Reconstruction Hospital in NYC, but in Elizabeth.)
Delirious cases	6	
Deaths	4	
Other discharges	33	

R.A.K.

SYMPTOMS AND PHYSICAL SIGNS.

First symptom:-

Insomnia	28
Headache	2
Nervousness	2
Prostration	2
Vertigo	3
Dreams	1
Anorexia	3
Pains in groin	1
Abdominal pain	5
Other pains	3
Metallic taste	1
Loss of weight	1

Chief symptoms and physical signs:-

Symptom	Number of times noted	
Insomnia	40	
Headache	30	
Nervousness	30	
Prostration	27	
Vertigo	25	
Dreams	30	
Nausea	20	
Vomiting	14	
Anorexia	29	
Constipation	7	
Diarrhoea	4	
Thirst	16	
Dry Mouth	17	
Nocturia	14	
Pains in groins	7	
Abdominal pain	8	
Other pains	6	
Metallic taste	12	
Loss of weight	33	
Marked pallor	3	
Low blood pressure	26	
Slow pulse	18	
Delirium	6	
Stippling	23	
Lead in stools	12	: Not all
Lead in urine and sweat	0	: patients
Kidney Lesion	0	: had these tests

12/10/24
JEM