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The Petersham Clinic is the first rural dental clinic to be put into operation in this country. It is a standard dental clinic of the rural type. The Petersham Plan is an unqualified success. Rural children need dental attention; opportunity to get it should not be withheld from them. Withholding it works unnecessary hardships to those whom we wish most to protect.

TRI-NITRO-TOLUENE POISONING IN MASSACHUSETTS.

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INDUSTRIAL poisoning by the different derivatives of benzene compounds of the coal-tar group of chemicals* has loomed into prominence in this country during the past two years chiefly because of the use of these compounds in the manufacture of high explosives and dyestuffs, as well as because of their use as motor fuel. Among the cases of industrial poisoning due to benzene derivatives reported to the State Board of Labor and Industries since November, 1915, there were 17 cases with 4 deaths, attributed to tri-nitro-toluene. Before taking up the consideration of these cases it may be of interest to set forth some of the fundamentals of industrial poisoning by chemical gases, fumes and dust.

CLASSIFICATION.

No satisfactory classification of industrial poisons, nor of occupational diseases attributed to such, has received general adoption. The difficulty of agreeing to any fixed classification is apparent when we realize the variations in the relative toxicity of the various compounds and of the various processes in which they are used. As a result of dilution with air, most industrial poisons can be absorbed only in very small doses, and yet, notwithstanding this, some are so much more injurious than others that the symptoms described may give no idea of the relative dangers of one or the other. Again, in regard to many substances the term "industrial poison" is a misnomer until the amount absorbed reaches a certain point, *i.e.*, beyond the powers of the individual to eliminate from his system the poison taken in. Individual susceptibility or immunity plays a very important part in this group of industrial poisons. Many poisons affect several organs at the same time, hence any classification based upon such a basis of action would be cumbersome and confusing. However, a classification, based upon the predominating action of the poison, groups the problem quite arbitrarily as follows:

(1) Irritating to skin or mucous membrane, *e.g.*, acids and alkalis;

(2) Destruction of the normal character of the red blood cells, *e.g.*, aromatic series of organic poison—nitro and amido derivative of benzene, arseniuretted hydrogen gas, carbon monoxid and cyanid compound;

(3) Affecting the brain and nervous system, *e.g.*, carbon compounds and carbon bi-sulphid.

Another classification of not only fumes and gases, but of industrial poisons in general, is that founded upon a chemical basis, *i.e.*, organic and inorganic, with a subdivision of the organic into (a) the unsaturated carbon compounds, (b) the aromatic series; and the inorganic into (a) non-metallic, (b) metallic.

The nitro- and the amido-derivatives of benzene, *e.g.*, nitro-benzol, dinitro-benzol, paranitro-chlorobenzene, anilin oil, paranitranilin, dinitro-toluene and tri-nitro-toluene act mainly on the blood, converting the hemoglobin of the red blood cells into methemoglobin and leading to solution of the red cells. While both nitro- and the amido-derivatives resemble each other greatly in their action, nevertheless, there is a distinction in their action that affects markedly the symptoms produced by each. Both are readily absorbed in the form of fumes or dust by the skin and lungs. Taken by the mouth, either produces rapid poisoning. The pathology in each case explains readily the symptoms: the nitro-derivatives dissolve the red cells and the freed hemoglobin reaches the liver, where it is converted into bile coloring matter. The bile becomes more inspissated, hence jaundice. The hemoglobin remaining in the blood becomes converted into methemoglobin, which gives to the workers the ashen gray or cyanotic (bluish) color of the lips and complexion that characterizes this group of workers. The power to take up oxygen is gradually lost, resulting in the development of dyspnea or symptoms of air hunger, nausea, vomiting, headache, giddiness, severe nervous symptoms, feeling of anxiety and, in severe cases, unconsciousness, lividity and death. The unoxygenated blood sets up irritation of the central nervous system, especially in the medulla, and a comatose condition ultimately ensues. Accompanying this blood change is a rapid, small pulse and feeble heart action, noted by many observers. If the destruction of the red blood cells becomes so rapid or increases so extensively that the liver cannot convert the hemoglobin into bile pigment, some will pass on to be excreted as characteristic darkly colored urine. In contradistinction to the nitro-derivatives, it has been observed quite generally that after absorption of the amido compound (anilin), conversion of hemoglobin into methemoglobin precedes the destruction of the red blood corpuscles. This blood may be found in the urine of anilin workers, but rarely bile pigment; a marked reduction of hemoglobin is characteristic of anilin workers. The blood in

* Not to be confounded with *benzine* of the petroleum group.

either case, *i.e.*, in nitro or in amido, whenever the stage of jaundice or cyanosis has been reached, is chocolate in color and shows bands on the spectrum of methemoglobin, granular degeneration of red cells, alteration in their form and color, and after a few days nucleated red cells marking regenerative changes. Many observers have remarked on the prevalence of tumor of the bladder of men exposed to anilin poisoning.

Poison may take place from the initial substance used in the process of manufacture (benzene, toluene, etc.); from the elements or compounds employed in carrying out the reactions (*e.g.*, chlorin, nitric acid, sulphuric acid, arsenic acid, sodium sulphid and sulphuretted hydrogen gas); from intermediate bodies formed (nitro and amido compounds, *e.g.*, nitro-benzol, dinitro-benzol, anilin) and, finally, from the end-products themselves (dyes).

The cases of poisoning by the fumes of tri-nitro-toluene (also known as T.N.T. and toluol, as well as triton or trotyl), reported in this paper, occurred in the manufacture of picric acid and benzol by the nitration of toluene. In this process both nitric and sulphuric acids are used. This manufacturing process was begun in Massachusetts late in the fall of 1915. The first case of poisoning reported occurred in November of that year.

Occupational illness in this group of cases is due chiefly to T.N.T. dust and to the escape of nitrous fumes evolved in the nitration and during the dilution of the T.N.T. waste acids, also from the chlorin and its compounds given off in the manufacturing process.

Symptoms may develop quickly, especially when there is exposure in confined space. These may be—

- (1) Persistent cough due to no known cause;
- (2) Unaccustomed shortness of breath;
- (3) Fatigue, not explained by exertion;
- (4) Pain coming on suddenly in legs and feet.

These symptoms may develop in degrees from temporary discomfort, relieved by going into the open air, to convulsions, paralysis and death.

The following cases, taken from the records of the State Board of Labor and Industries, bring out many of the various forms in which industrial T.N.T. poisoning may show itself:

CASE 1. (Fatal.) A carpenter, 42 years of age, employed one week in an establishment where the nitrating of toluene was a part of the process of manufacture, was made dizzy from fumes escaping from a duct under which he was at work. A short stay in the open air revived him. Vertigo and dizziness returned when he remounted the staging. He went home and returned to work the next day. On reaching the working platform he was nauseated, vomited, became dizzy and had to be helped out into the open air. He drove two miles in an open car to his home, during which he was exposed

to cold, damp November air. Seven hours later he suddenly grew worse, had convulsions, passed into coma and died at 11.45 p.m. Autopsy confirmed death by gas poisoning.

CASE 2. (Fatal.) A man, 26 years of age, employed for three months on a nitrator of toluene, reported to the physician on November 4. His symptoms were pallor, dermatitis, general weakness, loss of weight, nausea, cough, palpitation, headache, vertigo, low hemoglobin count. Man left work and after two days' absence appeared to be perfectly well, when suddenly shortness of breath and symptoms of edema of the lungs developed. He died November 10. Death return given as pneumonia due to gas poisoning.

CASE 3. (Fatal.) Man, 26 years of age, employed as a laborer about yard of a chemical works, where the nitrating of toluene was being done, on Saturday worked from 6.30 a.m. to 5 p.m.; did not work on Sunday; reported at 6.30 a.m. Monday and soon requested leave of absence on account of nausea, vertigo and loss of muscular power. Returned to his home at seven o'clock in the morning. Fellow workman visited him in the evening and noticed hallucinations, mental confusion, inability to talk coherently. Man was taken to the hospital, where he died at 11.30 p.m. the same day. Autopsy finding: death from tri-nitro-toluene gas.

CASE 4. (Fatal.) Man, 43 years of age, employed as a guard about a plant nitrating toluene, was transferred to the nitrating department on February 15, 1916. On the following day, while cleaning the inside of the nitrating tank, he was frequently compelled to go out into the air for relief, because of nausea, dizziness and blurred vision. He worked from 10 a.m. until 2 p.m., walked about one mile to an electric car and rode five miles to his home. Early in the evening he was seized with vertigo, hallucinations, spasms, unconsciousness, and died at two o'clock in the morning. Autopsy findings: edema of lungs due to gas poisoning.

A marked characteristic of the foregoing cases was the delayed onset of fatal symptoms and the long interval of apparent good health between the time of poisoning and the onset of serious symptoms. This late manifestation of toxemia from benzene derivatives is a characteristic feature in this group of industrial poisoning. These cases also occurred in cold weather, during which there was much exposure after the onset of the first acute symptoms. Most authors emphasize the necessity of safeguarding against cold, men who have been exposed to gases and fumes. Of this group of poisons, each of the cases described showed the characteristic manifestations of red-cell destruction and, consequently, oxygen starvation, especially of the brain and nervous system. Post-mortem findings showed marked blood destruction and organic congestion.

The following non-fatal cases of T.N.T. poisoning are quite typical of this group:

CASE 1. Man, 43 years of age, employed with a fellow workman (Case 3) in cleaning the inside of

a nitrating tank, was overcome by fumes, rendering him unconscious. He was removed to the outer air and was resuscitated by artificial respiration with the use of a lung motor. He walked three miles for an electric car and rode seven miles to his home. He was apparently fully recovered from the "gassing." Next morning at two o'clock he was awakened suddenly with dyspnea, suffocation, chills, pain in left chest, dizziness and marked muscular prostration. He also had cyanosis and a thick, sticky, brownish expectoration, slight fever, cloudy urine, dark, sticky ejections, crepitant râles at base of both lungs. Diagnosis: edema of lungs. Made a slow recovery.

CASE 2. Man, 30 years of age, had worked in T.N.T. department for six weeks. During past week had cough, irritation of throat and frequent attacks of nausea and dizziness. Had lost fourteen pounds in weight in six weeks. Found he was not able to do work as formerly, easily fatigued, much muscular weakness; face showed ashen hue. Transferred to outside work, fully recovered.

CASE 3. Man, 24 years of age, an electrician, was sent to a chemical works to make repairs in T.N.T. department. After fifteen days' work he was reported as sallow, nauseated, general weakness, vomiting, cough, rapid pulse, headache, vertigo, unable to continue work because of general muscular weakness and constant recurrence of foregoing symptoms.

CASE 4. Man, 26 years of age, employed one month as mixer in T.N.T. department, was "gassed" by escape from leaky pipes. Felt slight discomfort, transferred to outdoor work. Two days later was seized suddenly with vertigo, headache, nausea, vomiting, loss of power, cough; not able to continue work because of loss of muscular power.

CASE 5. Man, 24 years of age, had been working about one month on T. N. T. nitrator; was suddenly overcome on way home when about half a mile from plant. Was unconscious for two days. Convulsions, muscular spasm, loss of power of legs were followed with some muscular wasting. He also had pallor, cyanosis, dyspnea, cough, pulse of 120, vertigo, mental confusion. Convalescence slow. Never fully recovered complete muscular power of legs.

CASE 6. Man, 25 years of age, had worked six weeks as machinist about T.N.T. plant. Suddenly overcome by fumes from nitrating pot overflowing, remained unconscious four hours. Cyanosis, general weakness, dyspnea, pulse rate of 90. On recovering consciousness was troubled frequently with vertigo and marked loss of power of legs; not able to return to work.

CASE 7. Man, 35 years of age, worked as a laborer about T. N. T. plant. At the end of three weeks reported with pallor, general weakness, loss of weight, pulse 90, "looks poorly," hemoglobin 70-80%, easily fatigued, much loss of muscular power; not able to continue work; left employment.

The State Board of Labor and Industries has furnished a set of rules and regulations for safety in the manufacture of benzene derivatives

and explosives.* These rules provide that a "caution" notice be posted in a conspicuous place in all departments where any of the substances are used, setting forth the common name of the poisonous substance and that the substance named is capable of causing poisonous symptoms if precautions are not observed. This notice also sets forth the signs and symptoms of poisoning, viz.: throbbing of blood vessels, giddiness, dizziness, headache, weakness of legs, palpitation of heart, nausea, blueness, cyanosis and unconsciousness.

The first-aid treatment recommended is:

- (a) Remove poisoned person to the fresh air. Keep him quiet and warm.
- (b) Do not let person walk home until advised by physician.
- (c) Use hot coffee as stimulant.
- (d) If person is unconscious, apply artificial respiration; lungmotor; oxygen inhalation; keep patient warm.

PREVENTION.

- (a) Avoid dust, fumes and chemical compounds on hands, feet and clothes.
- (b) Wash hands before eating and after day's work is finished.
- (c) Do not eat food nor chew tobacco in workroom.
- (d) Do not wear same clothes in workroom and at home.
- (e) Use extra protection on hands, feet and clothes while at work on any of the substances mentioned in these regulations.
- (f) Bathe regularly.
- (g) Consult a physician if losing color or weight.
- (h) Do not enter stoves, vats or retorts for repair work unless in the presence of another workman.
- (i) Have emergency appliances ready for use in all dangerous repair work.
- (j) Watch for leaky joints in pipes, ducts, valves, etc., carrying the gas or chemical compounds.

SOME OBSERVATIONS ON THE BARÁNY TESTS AS APPLIED TO AVIATORS.

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BEFORE beginning the recent nation-wide appeal for men to train for service as aviators, the authorities at Washington, realizing the necessity of sending into the air only men with normal equilibrium, incorporated into the already exacting physical examination, the so-called Barány methods of examination of the semi-circular canals. These tests determine the pres-

* Copies may be procured at the office of the Board, 1 Beacon Street, Boston. (Industrial Bulletin No. 11.)