

FINAL REPORT

OF THE COMMITTEE

Chemical and Rubber Sections
National Safety Council

ON

BENZOL

May, 1926

WITH THE COMPLIMENTS
OF THE

NATIONAL BUREAU OF CASUALTY
AND SURETY UNDERWRITERS
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I. INTRODUCTION

At the 1922 National Safety Congress in Detroit papers and discussions on benzol poisoning were presented by Mr. C. F. Horan and Mr. W. S. Paine which aroused so much interest that the Industrial Poisons Committee of the Chemical Section was specifically directed to undertake a special study of the problem. Mr. A. L. Watson, Chairman of the Industrial Poisons Committee, cooperating with the Rubber Section, in the spring of 1923, appointed the subcommittee on Benzol to study and report on this important question.

Dr. J. W. S. Brady, on behalf of the committee made an exhaustive review of existing literature on the subject of benzol poisoning and, through the courtesy of Mr. W. S. Paine, of the Aetna Life Insurance Company a questionnaire was sent out to 324 industrial firms which seemed likely to be users of benzol in order to gain some idea as to the extent of its applications and the hazards incident thereto. To the 324 questionnaires sent out, the Committee received 140 replies, indicating that 84 of the organizations in question made use of benzol while 56 did not. The analysis of these returns indicated that the firms canvassed had experienced some 15 cases of benzol poisoning.

At the Buffalo Safety Congress in 1923 the committee made its first progress report presenting a preliminary digest and bibliography of the literature on benzol poisoning and a summary of what had been learned in regard to the extent of the dangers to health involved, with a list of tentative recommendations for safeguarding the use of benzol.

During the next year it was possible to carry the investigation further through the generous cooperation of the Massachusetts State Department of Labor and Industries which provided the services of a factory inspection expert (Mr. John R. Dexter), of the Hood Rubber Company which provided the services of an industrial physician (Dr. J. Newton Shirley) and of the National Bureau of Casualty and Surety Underwriters which made available the sum of \$1500 for the travelling and living expenses of these investigators. During the summer of 1924 Mr. Dexter and Dr. Shirley visited 78 plants using benzol and obtained record of 15 deaths and 83 other non-fatal cases of poisoning due to this substance. They next made an intensive field study of 14 of the plants, including analyses of the factory air to determine the concentration of benzol present and blood counts on the workers to detect the presence of early benzol poisoning. Out of the group of workers examined a substantial proportion showed a white blood cell count so low as to be strikingly suggestive of chronic benzol poisoning indicating that in addition to obvious clinical cases there exists in industry a considerable amount of mild undetected poisoning of this type. These first field studies, however, conducted as they were in the summer time, suggested that with efficient exhaust ventilation such as would keep the concentration of benzol in the workroom air below 200 parts per million, the hazard of benzol poisoning could probably be avoided. These data were presented in a second progress report at the Louisville Safety Congress in 1924.

The Committee felt that further study of the problem, particularly covering the winter season when natural ventilation is decreased, was urgently desirable; and it also desired to conduct an investigation on a laboratory scale of the relative toxicity of benzol and of some of the higher homologues of the

COMMITTEE ON BENZOL

OF

NATIONAL SAFETY COUNCIL

CHEMICAL AND RUBBER SECTIONS

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the fumes of crude benzene or the first runnings appear to be more toxic than the purified product.

In addition to chronic cases of poisoning by inhalation local lesions have been reported from the prolonged handling of compounds containing benzol. Carozzi (67) in the results of his inquiry into the Italian printing trades states that "among linotypists and pressmen we may occasionally observe a peculiar symptomatology, confirmed by the examination of the blood and caused by the continual use of benzol, benzine, mineral oil and benzographtol, "(prickling, numbness in the extremities; the number of blood corpuscles is greatly increased)." Vignolo-Lutati (68) cites two cases of occupational dermatitis in the interdigital webs of fingers. The hands had been frequently wetted in solution of India rubber. Inquiry showed that a number of other workmen had been obliged to give up work because of similar skin lesions. In Harrington's (34) study of 120 men employed in tire building, a tire builder stated that sixteen to eighteen men employed in his department had developed similar lesions to his own. The worker in question had been employed for two years but during the last three months a papular eruption had appeared on his arms, feet, ears and neck. These lesions disappeared when naphtha (presumably petroleum naphtha) was substituted for benzol. Millan (69) also records a case of erythema of the extremities in a worker who handled dyes dissolved in benzene. Simonin (13) noted irritation of the skin with swelling and itching in acute poisoning by swallowing. Benzene erythema and other cutaneous lesions are relatively frequent in workers handling compounds of benzene. Wolff (70) showed a passing disintegrating effect of benzol on the skin when there is prolonged contact.

In summarizing this review of the literature the following factors should be emphasized in regard to chronic benzol poisoning.

It occurs with greater frequency in cold weather or the winter months when natural ventilation is usually reduced to a minimum by closed windows and doors so that the concentration of the poison in the atmosphere reaches a maximum. Atmospheric conditions of temperature and humidity also plays an important part. At times of high heat and high humidity, other things being equal, spontaneous and sporadic outbreaks are most apt to appear. Young girls are especially predisposed to benzol, as are also pregnant women. Conditions of general ill health, tuberculosis, chlorosis (a type of anemia) and other conditions lowering the general vitality or interfering with free function of the eliminative organs exercise a strong predisposing effect. The early symptoms comprise headache, dizziness, malaise, loss of appetite, ready fatigue, shortness of breath and burning of the eyes, throat and respiratory membranes. Later nausea and vomiting, with epigastric burning and pain may appear, sensations of chilliness, and general weakness with bleeding from the mucous membranes of the nose, mouth, gastro-intestinal tract and genito-urinary tract. Too frequent menstruation with prolonged and uncontrollable bleeding from the vagina is very common. About this time petechiae and purpuric hemorrhages may appear on the body and extremities. Burnet (71) regards purpura as a more serious prognostic sign than bleeding from the membranes. Other lesions of the skin may appear in the form of itching erythema, dry scaling, or vesicular papules. Later complications affecting the central and peripheral nervous system may develop. Various forms of neuritis with lesions affecting the dorsal columns and the pyramidal tracts may appear giving rise to parasthesias,

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anaesthesias, impaired locomotion, tremor and trophic disturbances (63). The blood changes are typical.

A leucopenia or decrease in white blood cells develops in most cases after exposure and increases in severity, although in some cases this is not absolute. The leucopenia may be extreme, reaching almost a complete absence of white blood cells. A reduction in the red cell count then appears but somewhat later than the leucopenia. The resultant anemia may become extreme, the red cell count being lowered to less than 500,000 per cmm. A corresponding reduction in the hemoglobin occurs down to as low as 15 per cent. A considerable reduction in the platelet count appears especially in the later stages of poisoning. Blood smears present the picture of an aplastic anemia showing but slight changes in the appearance of the red cells. Some pallor and anisocytosis is common. Almost complete absence of regenerative forms with very few megakaryoblasts and normoblasts are noted, with scantiness of platelets. A marked diminution of the granular types of white blood cells is seen with a relative increase in the mononuclear forms. The leucotoxic effect is first noticed and is more pronounced on the myelocytic than on the lymphatic elements so that an inversion of the leucocyte formula results. This gives a relative increase in the lymphocytes and a lowering of the polymorphonuclear forms.

In rapidly developing cases, however, this inversion of the leucocyte formula may not appear according to Pontana (72). A relative increase in the large mononuclear cells is common. Eosinophilia has also been noted in early poisoning but this disappears rapidly on cessation of exposure (13), (73). The urine may show albumin, fat, casts, hemoglobin and conjugated sulphobodies. On autopsy the typical findings consist of hemorrhages in the skin, mucous and serous surfaces and the viscera, pallor of the organs with muscles of a deep red color. Submucous hemorrhages along gastro-intestinal tract, in the pleura, pericardium, endocardium. The marrow of the long bones present the typical picture of an aplastic anemia.

The treatment in chronic benzol poisoning consists of change of employment in the very early cases, preferably to open-air work together with the observance of general hygienic measures. These early cases generally respond very promptly to treatment. In the severe cases of advanced poisoning where hemorrhages and anemia have occurred, treatment consists of rest, fresh air, sunshine, iron-containing foods, and the general hygienic measures that are used in combating secondary anemias, tonics, hydrotherapy, ultra-violet ray, etc. In advanced anemia with purpura and hemorrhages McClure emphasizes the value of frequent and repeated blood transfusions. It is well to bear in mind that the anemia and other signs frequently continue and progress for long periods after removal from exposure, so that carefully adjusted treatment and prolonged convalescence is essential.

V. THE EFFECT OF BENZOL UPON THE BLOOD CELLS AND ITS USE AS A THERAPEUTIC AGENT

The most characteristic pathological effect of benzol is perhaps its destructive influence upon the cells of the blood and the blood-forming organs. This effect is so important that it deserves somewhat more detailed consideration. It seems also desirable to refer to the use of this property of benzol in the treatment of certain diseases characterized by an excess of white blood cells,