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Industrial Pentachlorophenol Poisoning in Winnipeg

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ABSTRACT

Enquiry into the occupational history of a patient presenting with stupor, hyperpyrexia and profuse sweating, and dying at a Winnipeg hospital a few hours later in coma, finally led to the identification of pentachlorophenol—a substance widely used as a wood preservative—as the cause of death of this worker and the cause of non-fatal intoxication in four other workers engaged by wood-processing plants. In these latter four cases the prominent clinical symptoms were sweating, weight loss and gastrointestinal complaints. A review of the literature revealed that pentachlorophenol exerts its toxicity following cutaneous absorption or inhalation by interference with oxidative phosphorylation, resulting in excessive release of heat. This substance has been the cause of several deaths in other countries. Observance of simple precautionary measures that ensure adequate ventilation and skin protection should suffice in making this industrially useful product safe.

SOMMAIRE

Un malade stuporeux hyperpyrexique et en diaphorèse meurt quelques heures plus tard dans le coma. L'enquête menée à cette occasion aboutit finalement à l'identification du pentachlorophénol, agent largement utilisé pour la conservation du bois—comme ayant causé cette mort et entraîné une intoxication, non fatale cependant, chez quatre autres ouvriers, travaillant dans des usines de transformation du bois. Chez ces quatre malades, les symptômes cliniques les plus marquants étaient: transpiration, perte de poids et malaises digestifs. La revue de la littérature met en évidence que le pentachlorophénol a entraîné plusieurs décès en d'autres pays. Ce produit devient toxique après absorption cutanée ou inhalation, par le mécanisme d'une phosphorylation oxydante et se traduit par la libération excessive de chaleur. Il suffit, pour rendre atoxique ce produit industriel utile, de prendre certaines précautions simples qui assurent une bonne ventilation du milieu et la protection des téguments.

COMPOUNDS containing pentachlorophenol (PCP) have been widely used for agricultural and industrial purposes, as a wood preservative, as a termite deterrent, as a weed killer and as a molluscicide.

Pentachlorophenol is a chlorinated hydrocarbon with toxic effects similar to those of dinitrocresol and dinitrophenol. These agents interfere with the enzymes controlling oxidation within the body, thus producing a marked increase in basal metabolic rate with all the effects of heat accumulation.

A small number of cases of PCP intoxication, one of them fatal, occurred in Winnipeg during the summer of 1963. The manner in which this problem was encountered and dealt with by clinicians and public health authorities will be described in the following report.

CASE REPORT

CASE 1.—On July 13, 1963, at approximately 1:00 p.m., a 58-year-old man was admitted to hospital in a semicomatose condition. The environmental temperature that day was over 90° F. His clothing was so wet that admitting examiners surmised, incorrectly, that he had been dragged from the nearby river. The family said that he had been feeling unwell for a week and had been taken home from work that morning breathing heavily, looking pale, and perspiring profusely. His temperature was 104° F. on admission and later rose to over 106° F. There was slight neck stiffness and a few rales over the right posterior basal area of the chest. The cardiac rhythm was irregular owing to episodes of sinus arrest and nodal premature beats. The blood urea nitrogen was 65 mg. %; blood sugar was normal; hemoglobin was 12.6 g. % and the leukocyte count was 14,300 per c.mm. with 86% polymorphonuclear cells. Urine specific gravity was 1.033 and the urine contained 100 mg. % of protein. A lumbar puncture yielded clear fluid under normal pressure, without cells or excess protein.

The clinical diagnosis was heat exhaustion, right lower lobe pneumonitis and possibly septicemia. The patient was treated with antibiotics, ice packs and intravenous fluids, but there was no response. He lapsed into coma with laboured respirations and died about five hours after admission. Attending physicians who were examining him at the time his respirations ceased and cardiac action became undetectable started closed chest cardiac resuscitation with mouth-to-mouth respiration. Within seconds profound rigor mortis became evident.

Autopsy revealed cardiac dilatation, pulmonary congestion, slight centrilobular degeneration of liver cells and mild renal tubular degeneration. Blood and cerebrospinal fluid cultures showed no growth. The physician treating this patient was unsatisfied concerning the exact cause of this man's death and, suspecting

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something out of the usual, reviewed the case and discovered the following pertinent information.

The patient had been employed at his new job for only one week. This was at a factory where he was engaged in the fabrication of window sashes and other wooden frames. Enquiry at the factory revealed that before being shipped, all wood was treated by dipping in a wood preservative. This wood preservative consisted of PCP 4.1%, other chlorophenols .9%, petroleum solvent 85.0% and inert ingredients up to 100.0%. The patient had previously been subjected to a prefrontal leukotomy for mental illness and was of low intelligence. He had been hired at the plant because of a temporary work overload. Since he had no particular skills, he was assigned the job of dipping all the wood into the preservative solution. Although the workers and management had no appreciation of the potentially lethal effect of the chemical involved, a few pairs of gloves had been provided because the solution was irritating to the skin. He preferred to do the dipping with his bare hands. Since starting his new job he had been anorexic and complained of fatigue and marked sweating and thirst. After three days of work, his family noticed that he had persistent flushed cheeks.

CASE 2.—As the circumstances that led to the first patient's death were being slowly uncovered, another worker from the same industrial plant was admitted to the same hospital on August 13, 1963. This 36-year-old man was referred to the admitting doctor because of a weight loss of 30 lb., excess sweating and polydypsia. His appetite was normal. He required a change of pyjamas two or three times each night and was uncomfortable wearing a thin shirt both at work and at home. There was no goitre or other abnormal physical findings. Extensive investigation had been carried out before admission to rule out the most obvious conditions, hyperthyroidism, diabetes, Hodgkin's disease or other lymphomas, tuberculosis and occult infection. His hemogram and urine were normal. The sedimentation rate was 3 mm. per hour. The serum albumin was 4.9 g. % and serum globulin 1.5 g. %. The protein-bound iodine was 4.7 μg. %. A radiograph of the chest was normal.

The patient remarked several times about the odour and upper respiratory irritation associated with the vapour at his place of work, but because the physician was unfamiliar with the toxic agent this complaint was temporarily ignored. The finding of a basal metabolic rate (BMR) of +47%, a chance discussion of Case 1 with the doctor concerned, and the fact that the patient was a carpenter at the same plant and did his own "dipping" without gloves made a difficult diagnosis rather obvious. Admission to hospital, without treatment, was followed by subsidence of his symptoms and he soon began to gain weight. Urinalysis, carried out after he returned to work, showed the highest concentration of PCP of all the cases studied. Two days after removal from exposure the concentration decreased markedly but PCP was still detected (Table I).

CASE 3.—A 21-year-old carpenter was admitted about two weeks after Case 2, complaining of sweating and weight loss. He had vomited several times at work. Physical examination, blood studies, urinalysis and a radiograph of the chest were normal. His BMR was +37%. Urine studies, done later, showed a significant amount of PCP. He is now well.

TABLE I.

	Pentachlorophenol in urine, mg./l.		
Subject	*4/9/63*	*30/9/63*	*15/10/63*
T.K. (Case 2)	10.8	17.5	1.8*
C.B. (Case 3)		3.8	
C.A. (Case 4)	5.4		0.6**
U.H. (Case 5)	2.4	10.0	0.1**
W.C.	0.4		
N.G.			0.6
M.C.			0.7

*Two days after removal from exposure.
**After institution of proper precautions.

CASE 4.—A 38-year-old man had been employed in the same plant for two years. During the winter months of 1962-63 he experienced epigastric discomfort and drenching sweats with evening fever. He claimed that he had lost 20 lb. Because spontaneous improvement had occurred, he had never consulted his doctor. When he was examined by us, he had PCP in his urine.

CASE 5.—A 30-year-old man who had worked in the plant for three months complained of anorexia, sweating and a 5-lb. weight loss. His urine showed the presence of PCP.

Table I shows the results of PCP estimations on several urine samples from workers engaged in dipping. Symptomatic cases are indicated as Cases 2-5; the others were selected from the same general work area.

MANAGEMENT BY PUBLIC HEALTH AUTHORITIES

The City Health Department was notified of Case 1 and Case 2 during the hospitalization of Case 2. Investigation was started at once.

The first step was a visit to the plant where the intoxications had taken place. The material was used in a dipping vat located in one corner of the workshop area. A drying pan with a fan above it was provided, where the wood dried at room temperature, but there was a distinct odour in the room and ventilation appeared to be inadequate. This impression was later confirmed by special ventilation studies. The dipping solution was prepared by diluting a concentrated solution with a petroleum solvent. On the barrel containing the concentrate, a label with the trade name was found, but there was no mention of toxicity or indicated precautionary measures. A few pairs of gloves were available and a sign on the wall urged their use. This measure was obviously insufficient. The manager and plant foreman were interviewed and the dangers of this chemical were fully explained to them. Plans for avoiding future poisonings were discussed. A written notice was prepared for factories, pointing out the potential hazard and stressing the following precautions: installation of the tank in a well-ventilated area with an exhaust fan above the tank, covering of the tank when not in use, provision and enforcement of the use of protective gloves and protective apron in good condition, and immediate medical attention and

notification of the Health Department if a worker complained of stomach upset or vomiting, severe sweating, weight loss, high fever or skin rash.

In the meantime, health inspectors searched for similar industrial operations and in a few days located four other plants in which PCP was extensively used. These were visited and in one of them the operation was as hazardous as in the plant where the original case was identified. Here, no gloves were provided and workers were dipping with bare hands. One of the workers gave a highly suggestive history of mild poisoning. All plants were notified and necessary precautionary measures discussed. City health inspectors and officials of the Department of Labour undertook responsibility for carrying out recommended precautionary measures. The Department of Labour is preparing appropriate legislation to cover the uses of this chemical in the Province of Manitoba.

Investigation of several workers, as indicated in Table I, was carried out during the institution of proper precautions. As might be expected, this rather dramatic illness caused apprehension in several of the workers, who complained without apparent cause. All possible precautions were taken to allay their apprehension and no interruption of production occurred. The case of fatal poisoning was reviewed by the Workmen's Compensation Board and we have learned that compensation has been awarded.

Subsequent visits indicate that for all practical purposes the hazards of this form of industrial poisoning have been eliminated in Winnipeg. A few further changes, including improvement in ventilation, have still to be completed, to ensure complete safety and to comply with the new standards to be adopted by the Department of Labour.

DISCUSSION

PCP is one of the aromatic hydrocarbons which are believed to interfere with metabolism by inhibiting oxidative phosphorylation. Other related compounds, dinitrophenol (which was once used therapeutically for weight reduction but later abandoned because of toxicity) and dinitro-ortho-cresol (used as a herbicide in the United Kingdom), are perhaps better known.

Parker[8] has demonstrated three well-established biological actions of these compounds, namely, the inhibition of oxidative phosphorylation, the stimulation of oxidation of various substrates, and finally the stimulation of adenosine triphosphatase activity. This radical uncoupling of oxidation and phosphorylation cycles in tissues produces a marked increase in BMR and, depending on the body's ability to disperse its metabolic heat, hyperpyrexia and all the effects of heat accumulation. The compounds are particularly toxic during hot weather because the body is less able to disperse heat and the liquid is more volatile.

PCP can enter the body by inhalation or cutaneous absorption. On the skin it has an additional irritating effect producing a dermatitis. The vapour, air-borne dusts or mists may irritate the eyes and upper respiratory tract. The manifestations of systemic toxicity may occur acutely or more slowly, and consist of epigastric discomfort, nausea and vomiting, rapid respirations, fever, sweating and weakness. Gross hyperpyrexia can occur in instances of acute overwhelming toxicity. Marked weight loss may result; coma and convulsions may occur; and death may result from hyperpyrexia, dehydration or heart failure. Pathologic features are hepatic cellular death and renal tubular damage.

Since their introduction, compounds of PCP have enjoyed widespread acceptance and use in industry and agriculture. Early reports of toxicity were concerned wholly with their local irritant properties. In the last decade case reports of fatal poisoning have been recorded and it has become apparent that the use of PCP may be just as hazardous as that of dinitro-ortho-cresol. Barnes noted that the lethal dose for animals is about five times that of dinitro-ortho-cresol.

Truhaut, L'Epée and Boussemart[3] described two fatal cases of poisoning among men dipping timber in 3% PCP solution. Nomura[4] reported three cases resulting from exposure to PCP during manufacture, one of which was fatal. The similarity between these fatal cases and our Case 1 is striking.

Gordon[5] reported nine cases occurring during use of a weed killer from 1953 to 1956 in pineapple and sugar plantations in Queensland. Five of these patients died between nine and 30 hours from the onset of symptoms.

Menon[6] described several fatal cases of PCP poisoning among timber dressers in Sarawak and noted that no further cases occurred after the hygienic aspects of the process had been improved. Blair[7] reported three cases, two fatal, occurring in Southern Rhodesia where sodium pentachlorophenate has been in use as a molluscicide in the control of the snail intermediate hosts of bilharziasis since 1953. He concluded that with relatively simple precautions most of the dangers associated with it can be eliminated and its use as a molluscicide can continue on a wide scale.

The following features common to all of these reports warrant emphasis. All fatalities occurred in instances in which the worker involved was ignorant, careless or grossly negligent in observing a few simple protective and precautionary measures. The environmental temperature during the time of the poisoning was high, usually above 80° or 90° F.

Treatment of the acute fulminating cases has been uniformly unsuccessful, usually because the true diagnosis, with its grave implications, was suspected or proved only in retrospect. Immediate

and heroic efforts to lower the patient's temperature by whatever means available should be instituted, and replacement of fluid and electrolyte deficit started at once. Theoretically, corticosteroids and chlorpromazine may be of some value in acute cases.

SUMMARY

Five cases of industrial PCP poisoning, one of them fatal, are reported.

The investigations and corrective measures instituted by public health authorities are described.

The nature, uses and toxicology of PCP are reviewed.

A review of reported fatal cases is presented, emphasizing that simple precautions are all that is required to prevent further poisoning.

Recognition of the widespread use and potentially lethal toxicity of PCP should prevent any further unfortunate fatal cases.

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