Dangers in Using and Handling Sodium Pentachlorophenate as a Molluscicide

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In Southern Rhodesia sodium pentachlorophenate (NaPCP) has been in use as a molluscicide in the control of the snail intermediate hosts of bilharziasis since 1953. Until 1959 it had been used on an experimental basis and applied under fairly strict supervision. In 1959, however, it became more easily available through commercial channels and was used as a molluscicide, sprayed on rivers and dams, by farmers using their own labourers. Fatalities occurred and a description of the signs and symptoms to be expected show that the intoxication should be easy to recognize before the condition has gone too far.

It is possible with relatively simple precautions to eliminate most of the dangers and there would seem to be no reason on these grounds why NaPCP should not continue to be used on a wide scale as a molluscicide.

INTRODUCTION

Compounds of pentachlorophenol (C₆Cl₅OH), and particularly the sodium salt, have been widely used for a variety of agricultural and industrial purposes, as a wood preservative, as a termite deterrent, as a weed-killer and more recently as a molluscicide.

Since the early days of its introduction in industry and agriculture it has been recognized as an irritating substance to the skin, the eyes and the mucous membranes of nose, mouth and pharynx. Barnes (1953) noted that the lethal dose for animals is about five times that of dinitro cresol and that the toxic effects of the two chemicals were similar. They are believed to interfere with metabolism, and have been shown (Parker, 1958) to disturb the normal complex phosphorylating enzymes which are so essential to many vital functions and at the same time to increase the oxidative mechanisms.

The warning signs of intoxication in human beings exposed to pentachlorophenol (PCP) appear particularly when hard physical work is being done in high temperature conditions. These signs are a general feeling of weakness and an intense thirst. Up to the date of Barnes' monograph, serious intoxication in man from pentachlorophenol had not been observed. It was, however, at this stage being handled with great care during manufacture and its use as a wood preservative does not seem to have created conditions of close contact with the handlers of the chemical.

Truhaut, Epée & Boussemarte (1952) describe two fatal cases of poisoning among men dipping timber in 3% PCP solution. On first exposure there is irritation of the skin, the upper air passages and the conjunctivae. When exposure is prolonged and sustained, the subjects complain of signs of asthenia, loss of appetite, dyspnoea on exertion and profuse sweating. Analyses of urine specimens from 16 men who had been working with PCP for two months showed the substance to be in the urine in concentrations varying from 3 mg/l to 10 mg/l. It would seem that PCP is eliminated from the body almost entirely in the urine.

Nomura (1953) describes an acne-like skin lesion resulting from exposure to PCP during manufacture. He notes that despite its widespread use as a wood preservative since 1943 there had not been any reports of poisoning or serious illness attributable to PCP. He then goes on to report three cases, one of which had fatal issue. These occurred during hot weather and the patients were perspiring profusely. The following signs and symptoms were noted: general weakness, dizziness, headache and very profuse sweating and, referable to the gastrointestinal tract, nausea, vomiting and an appetite for sugar. In the most acute case, there was a very sudden onset of symptoms and death supervened rapidly.

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Gordon (1956) drew attention to the use of PCP as a weed-killer in pineapple farms and sugar plantations in Queensland, and suggested that the substance was much more dangerous than previous reports indicated. Nine cases occurring from 1953 to 1956 are described in detail. All but one of these were reported in the four hot months, December to March inclusive; this period is, of course, the time when PCP is most widely used as a sprayed weed-killer on pineapple farms and sugar-cane plantations. Five of the cases died between 9 and 30 hours from the onset of symptoms. The description given of the symptoms is indicative of a common sequence of events. The usual onset reported is of abdominal symptoms, pain, nausea, and vomiting; later profuse sweating was reported in each case and the patient complained of an intense thirst. The general condition of the victim changes rapidly for the worse and in a few hours a patient not apparently very ill becomes moribund. The body temperature is generally only moderately raised, but the pulse and respiration rates are proportionately very rapid. Profuse sweating has been noted in all cases by different observers, and patients admitted to hospital for treatment are soaked with sweat and require frequent changes of bed linen.

In Queensland, agricultural workers in the fields often wear only a pair of short trousers and blown spray may have much contact with large areas of sweating skin, thus aiding increased absorption. The autopsy reports do not show any very characteristic signs of damage other than congestion of the lungs and intra-alveolar haemorrhages. Menon (1958) described several fatal cases of PCP poisoning among timber dressers in Sarawak and noted that no further cases occurred after the general hygiene of the process had been improved.

USE OF SODIUM PENTACHLOROPHENATE AS A MOLLUSCIDE IN RHODESIA AND NYASALAND

Sodium pentachlorophenate (NaPCP) has been in use in Rhodesia and Nyasaland as a molluscide since 1953. At first its use was restricted to small-scale field experiments, the substance being used in the form of briquettes of Santobrite (Monsanto). Handling of the briquettes caused tingling of the skin of the hands and nasal irritation. Later, NaPCP was used on a much larger scale in the field and the preparation was in the form of a powder. The local technique evolved for application was to prepare a concentrated solution of NaPCP in water in buckets and then spray the solution by means of a stirrup-pump with a coarse spray nozzle on to the surface of water. In the Federation, particularly in Southern Rhodesia, the substance has come into quite large-scale use as a molluscide against the intermediate hosts of human bilharziasis and of liver fluke disease in cattle. It is applied mainly to small natural water courses, along the shore margins of lakes and big dams and along the margins of larger rivers. In 1959, for example, it is estimated that 80 tons of NaPCP were so used by spray teams employed by a number of agencies in Southern Rhodesia, of which 18 tons were applied by spraying teams under the direct control and supervision of trained responsible staff of the Ministry of Health. In all, about 20 persons were intimately concerned in handling and applying NaPCP during not only 1959 but also the previous season, and there have been no reports of any serious toxic effects. Complaints have been restricted to reports of irritation of the eyes, nose and throat and, when first exposed to the substance, tingling and irritation of the skin of the hands and forearms.

During 1959, by which time it had become easily available commercially, NaPCP had been used to an increasing extent by farmers who, it is estimated, applied about 62 tons using their own labour force.

CASES OF SODIUM PENTACHLOROPHENATE POISONING

The first reports of fatalities arising from the use of NaPCP as a molluscide in the Federation were received in October 1959.

Case 1

T., an African male aged about 14 years, was employed as a farm labourer on a farm 17 miles north of Salisbury. On 31 August 1959 he was one of a gang of three engaged in spraying water courses on the farm with NaPCP solution as a snail control measure. He had been engaged on this duty for eight days in the previous two weeks and his particular duty was to carry a five-gallon (23-l) container of concentrated solution 1:180 (½ pint—0.25 l containing 1.6 g of NaPCP powder). On the day in question some of the concentrated solution splashed on his face; he complained of the irritation and was told to go and wash his face; this he did, in an irrigation furrow which had just been sprayed. He complained of great thirst and sweating and five hours later was given sodium bicarbonate as an emetic, on the telephoned advice of a private physician. Three hours later he was taken to hospital, where he was admitted. On admission he did not
appear to be seriously ill and expectant treatment only was given. He complained only of headache and abdominal pain on admission. On examination, the abdominal wall was soft and relaxed, pulse rate 96 and temperature normal, despite profuse sweating. He died rather suddenly nine hours after admission, on 1 September 1959. At a post-mortem examination on 3 September the pathologist (Dr H. D. Ross) reported that the fauces, pharynx and windpipe were very injected and that both lungs were deeply congested but there was no consolidation. There were no abnormalities in the alimentary tract apart from a few haemorrhages at the fundus of the stomach. Liver, kidneys and bladder showed no abnormalities.

It transpired that after his admission to hospital the patient stated that when he went to wash his face he was very thirsty and drank some of the concentrated solution prepared ready for spraying and that he vomited immediately. It is hard to believe that anyone, however thirsty he might be, could stomach drinking a solution of NaPCP deliberately. There was plenty of water available to drink in the irrigation furrow which was being treated. It would seem therefore that any ingestion was accidental and from the account given, promptly vomited. Specimens taken at the post-mortem examination were studied by Mr N. G. Shirley at the Government Analyst's Laboratory, Salisbury, who excluded the possibilities of other poisons, including arsenic, cyanide and parathion. Traces of pentachlorophenol were present in all specimens. A semi-quantitative extraction of the stomach wall produced 2.7 mg of NaPCP. By quantitative analysis the following proportions of PCP were recovered (in mg per 100 ml or 100 g):

- Liver ............. 6.2
- Lung ............. 7.6
- Kidney ........... 8.4
- Blood (from lung) .... 9.7
- Blood (from liver) .. 4.6

The molecular concentration of PCP in these tissues may be calculated as being from 3 to $4 \times 10^{-4}$ M. This was compared by Barnes and Parker (private communication, 1959) with the concentration known to be poisonous to tissue metabolism studied in their laboratories. They had found that, in vitro, $1 \times 10^{-6}$ M of PCP caused disturbances in cellular metabolism.

It may be worth while to quote the following from their communication:

"The figures for the specimens from K. are higher than those obtained (Government Analyst's Laboratory) in an acute poisoning case during the following winter (mid-July 1960) of an adult African who consumed food accidentally contaminated with NaPCP powder. The concentrations for the post-mortem specimens expressed as mg PCP per 100 g were:

- Stomach ............. 7.8
- Liver ............. 5.9
- Kidneys ........... 6.3"

In the police investigations of the death of K. it was stated that NaPCP had been applied as a powder directly to the water surface, which is, of course, quite contrary to all instructions. It is thought, however, that owing to the need for statements to be translated during the police interroga-
tion the statements may have been misunderstood and that in fact the powder was blown about by the wind as it was being mixed with water in a container, and it is very unlikely that in fact the labourers would have attempted to throw NaPCP in powder form directly on to the water surface, particularly in a high wind.

Case 3

S., a young adult African, was admitted at the same time as Case 2 (K.) and his history has already been described. He recovered completely after a mild illness and was discharged after a short stay in hospital. On his admission he complained of intermittent pains in his joints, particularly knees and wrists; he was apyrexic, pulse rate 96, but sweating profusely.

COMMENTARY

It is interesting to note that in Australia, where NaPCP was in use as a weed-killer, the deaths occurred in the hot season, when, of course, weed growth is greatest. The three cases now reported also occurred at a hot time of the year, the month of September. This time of the year is characterized by high winds and it is likely that this was a more important factor than heat in causing the illnesses.

Labourers employed by the Ministry of Health have been applying concentrated solutions of NaPCP by means of stirrup-pumps for longer periods and in conditions when humidity and temperature were even greater with no evidence of any toxic effects.

Exposure to blown powdered NaPCP in the process of preparing the concentrated solution would seem to be the most dangerous form of contamination. Contact of the solution with the skin, particularly moist skin, causes a good deal of irritation and absorption is probably assisted. Many farmers own and use knapsack sprayers in their farming operations and use these for the application of molluscicide. Knapsack-type sprayers are more likely to produce gross contamination of the skin of the sprayer than would be the case with stirrup-pump equipment. The Federal Ministry of Health uses stirrup pumps exclusively for this work and direct contamination by the concentrated solution is easy to avoid. The equipment used is complete with long lengths of pressure hosing and a spray lance so that contact with wind-blown concentrated spray solution is in practice very slight indeed.

During 1960 NaPCP was used on an even greater scale than in the previous years but with the difference that the labour used was always trained and under strict supervision and the precautions now to be mentioned were enforced. No deaths or even cases showing early signs of intoxication were reported in 1960.

Reference has been made earlier in the paper to the concentrations of PCP in an African who died as a result of consuming food accidentally contaminated with NaPCP in July 1960. The deceased, an adult male African, prepared food (the usual maize meal porridge) for himself and a friend, collecting maize meal from a grain storage bin in the dark. They both partook of the meal of cooked porridge and remarked that it tasted "sour". Early next morning the African, now deceased, called for help, was found to be sweating profusely and complained "his heart was being pulled down". He did not vomit or have any convulsions and died about an hour later.

His friend, who had partaken of the same meal, began to exhibit the same symptoms at about 10 a.m. but was taken immediately for treatment at a nearby rural hospital and made a speedy recovery. In the grain bin was found a small tin of "insecticide" employed as a deterrent against rodents and insects. This was in fact found to contain technical NaPCP.

The maize meal porridge residue was analysed and found to contain 21.6 mg of NaPCP per gram of porridge.

PRECAUTIONS

Steps have been taken to draw the attention of all users of NaPCP to the dangers which may arise in the mixing and application of the molluscicide in the open air, particularly in windy weather and a warning notice as follows has been issued to all concerned:

"1. Spraymen should be issued with two sets of overalls, the best type being the one used by motor mechanics—one piece with long legs and sleeves.

"2. Overalls should be washed after each day's spraying duties.

"3. The labourers engaged in mixing NaPCP powder into concentrated solution must wear a gauze mask over nose and mouth when actually engaged in this operation.

"4. Measuring-tins for scooping out powder from bags or containers must be fitted with handles to reduce contact of the skin of the hands with the powder."
“5. All mixers must be warned of the dangers of inhalation of NaPCP dust and should arrange whenever feasible to carry out this operation in a sheltered place; if this is not possible, they must ensure that all persons stand to windward.”

CONCLUSIONS

Despite the unfortunate incidents described and the experience in Queensland, it is felt that there is no justification for avoiding the use of NaPCP as a molluscicide. The principal danger to persons handling the substance is the inhalation of the powder in windy conditions in the course of preparation of concentrated spray solutions.

Drinking quantities of the concentrated solution is also dangerous, although it is inconceivable that anyone would drink this from choice. However, if the person concerned is experiencing extreme thirst such natural inhibitions may be blunted.

Persons handling, mixing and spraying NaPCP who show signs of excessive sweating and who complain of thirst should be removed from their duties at once. Persons whom events prove later to have been seriously affected show few signs apart from intense sweating and extreme thirst in the early period of their intoxication.

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RÉSUMÉ

Le pentachlorophénol est utilisé depuis longtemps, surtout sous forme de sel sodique, dans divers secteurs de l’agriculture et de l’industrie — pour protéger le bois, comme détrusor des termites et herbicide — et plus récemment comme molluscicide. Dès le début de son emploi, son action irritante sur la peau, les yeux et les muqueuses a été reconnue; plus tard, l’altération qu’il provoque dans le fonctionnement des enzymes phosphorylantes a été étudié. L’auteur résume la littérature parue sur le sujet depuis une dizaine d’années.

Le pentachlorophénate de sodium a été utilisé comme molluscicide en Rhodésie & Nyassaland depuis 1953, d’abord à titre expérimental, sur des espaces limités, par du personnel qualifié surveillé avec soin. Depuis 1959, le produit se trouve dans le commerce courant; des propriétaires l’ont fait appliquer sur les cours d’eau et les bassins, par des employés qui ne prenaient pas toujours les précautions voulues. Des cas d’intoxication, quelques-uns mortels sont survenus. L’auteur estime que ces cas, dus à la non-observance des précautions — qu’il décrit dans cet article — ne justifient pas que l’on renonce à employer cette substance. Des signes prémonitoris (démangeaisons, transpiration, soif) signalent le début de l’intoxication. Le risque d’intoxication le plus sérieux réside dans l’inhalation de pentachlorophénate pulvéruent, lors de la préparation de solutions concentrées. Dans les opérations organisées par le Ministère de la Santé, seules des pompes à étrier sont utilisées. Grâce à l’observation des précautions nécessaires et à l’emploi de personnel formé à cet effet, aucun cas d’intoxication n’a été signalé en 1960.

REFERENCES