

authority is the one and only body possessing that local knowledge of the district so essential before the plans are made. In the interest of general public health it is vitally important that powers over which the civilian authorities have no control should not discharge their sewage effluents into streams in dairying localities without this primary planning co-operation with the local sanitary authority.

Conclusions

The outbreak was due to a combination of factors, the chief predisposing causes being: (1) a hot spell and drought for the previous six weeks; (2) the recent incidence of paratyphoid fever in surrounding districts; (3) the inadequate dilution of the effluent from one of the sewage works at the depot; and (4) the comparative proximity of sewage outfall to ram-intake.

I am very grateful to Dr. Wyndham Parker, county medical officer, for his valued advice on all matters and for kind permission to publish this article. Thanks are due to the local sanitary staff and to Mr. R. W. T. Owen, county sanitary officer, for his indispensable support in carrying out the investigations. I am indebted to all the medical superintendents of isolation hospitals and the district medical officers of health who were good enough to supply me with clinical data, and to the local general practitioners for taking such prompt action to establish an early diagnosis in suspected cases. Grateful acknowledgment is made to Mr. H. E. Monk, county analyst and bacteriologist, and to his staff, for their enthusiastic co-operation. I also wish to express my appreciation of Prof. J. F. D. Shrewsbury's kindly help and criticism.

FATAL PHOSPHORUS POISONING FROM AN EXPLOSIVE BULLET

BY

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It is well recognized that certain types of incendiary bomb may cause local damage to skin or a wound from phosphorus contained in them, but, so far as I am aware, there is no appreciable risk of poisoning from absorption in these cases. The proportion of phosphorus present is, I understand, quite low—only about 4%. The risk of absorbing a lethal amount of phosphorus is apparently very much greater in penetrating wounds caused by a certain new type of explosive bullet. In the case recorded below there seems to be no reasonable doubt that death was due to phosphorus. Similar cases may have occurred without recognition of the cause of death, and I feel that it is important that the medical profession should be on the alert for them.

Case Report

A Canadian airman navigator aged 24 was wounded in the early hours of Sept. 14 in action over enemy territory. His aeroplane landed at a near-by aerodrome, where he was given morphine and his wound was dressed with sulphaniilamide. He arrived at the Norfolk and Norwich Hospital at 9 a.m. There was a ragged entrance wound on the outer aspect of the left thigh, 2 in. long. His abdomen was rigid and tender, with dullness over the lower half. He was suffering from extreme shock. Pulse 144; B.P. 65/0. Three pints of serum were given intravenously and his B.P. gradually rose to 120/60. A radiograph showed a metallic foreign body in the centre of the abdomen, a punch fracture of the wing of the left ilium, and also some small metallic fragments in the thigh above the entrance wound and below the fracture.

Operation was begun at 11.30 a.m. The abdomen was opened and over 2 pints of blood mopped up. A ragged portion of a distorted bullet was found embedded in the upper part of the mesentery. This was extracted, and large torn branches of the superior mesenteric vessels were ligated. A transverse tear in a loop of jejunum was sutured and invaginated. There were no other intra-abdominal injuries, but some scattered fragments of bone were present in the subperitoneal layer of the abdominal wall on the left side. The abdominal incision was closed without drainage. The entrance wound in the left thigh was then enlarged up to the site of the penetrating fracture in the ilium, the edges of the skin and damaged muscle were excised, and some loose debris wiped away with gauze. While doing this it was noticed with astonishment by myself and my assistant that the wound emitted a visible vapour. This vapour was then found to possess the smell characteristic of phosphorus. The wound was impregnated with sulphaniilamide powder and lightly packed with gauze. My first impression on smelling the vapour was that it was due to a tracer bullet, but examination shortly afterwards in a dark room failed to demonstrate any phosphorescence. During the operation a blood transfusion of the same group (O) as that of the patient was started, and it was continued until he had received 3 pints. The blood

pressure at the end of the operation was only 84/40, but by 8 p.m. it had risen to 134/60.

The following day the patient's general condition was fair, with some vomiting. On the 16th he had improved, and his general condition was satisfactory: no vomiting; abdomen soft; no gas in the wound or spread of infection. On the 17th he was not so well, and was slightly restless. Abdomen soft; no vomiting. The wound in the thigh was unhealthy. On the 18th he was obviously deteriorating and very ill—restless and semi-comatose. There was a lemon tint in the skin. A blood count showed 3,000,000 red cells with haemoglobin only 38%. A pint of blood was given. No urine had been passed for 24 hours, and a catheter withdrew less than 2 oz. The blood transfusion was followed by a continuous drip of saline and dextrose. The abdominal wound broke down and was strapped.

On the 19th the patient was comatose. In spite of the many pints of fluid given intravenously the anuria continued, not more than 1½ oz. of urine being withdrawn by catheter. Examination of the blood showed that the haemoglobin had risen to 58%. The blood urea was 453 mg. per 100 c.cm. His pulse remained comparatively slow—92 to 100 during the day—and was of quite good volume. He died at 1.50 a.m. on the 20th—that is, 6 days after being wounded.

Report on the Necropsy, by Dr. G. P. C. Claridge, Hon. Pathologist to the Norfolk and Norwich Hospital

At the post-mortem examination a gaping wound was found in the left thigh from which there was a track up into the tissues of the left flank passing through the iliac bone. The edges of this wound showed some necrosis, but not more than one often sees in these war wounds. The peritoneal cavity was clean and the stitching of the intestine sound. The liver was not enlarged, but on section had a homogeneous appearance and the cut surface was of a dull yellow colour. Apart from some slight swelling of the kidneys there was nothing of note in the other abdominal and thoracic organs.

Microscopical sections of the liver show extensive necrosis with fatty degeneration; the lobules cannot be identified, while the liver cells, which can still be recognized as cells, have a hazy outline with absent or shadowy nuclei which take the eosin stain, and a granular and highly vacuolated cytoplasm. Sections of the kidneys show the changes of catarrhal nephritis, the cells of the convoluted tubules being enlarged, granular, and in many cases necrotic. These changes in the kidneys are in themselves insufficient to account for the anuria. The gross destructive lesion of the liver is typical of acute phosphorus poisoning.

Comments

The rapid deterioration in the patient's condition after making good progress for the first three days, with the local condition in the abdomen and thigh satisfactory, was most puzzling at the time. The anuria and uraemia led me to surmise that it might be caused by some incompatibility of blood, although there were no symptoms to suggest that during the transfusions. The microscopical appearance of the kidneys makes it unlikely that incompatibility had any part in the fatal result.

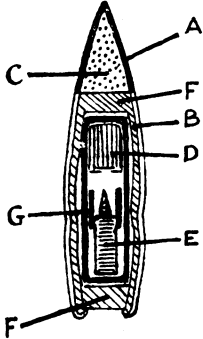
The condition of the liver is not readily explained by anything other than phosphorus poisoning. If that explanation is correct, the important point arises as to what could be done to eradicate or counteract the poison in similar cases in the future. A more extensive excision of the damaged area than usual is indicated, and the application of a chemical antidote. I am ignorant as to whether copper sulphate would be of value. I believe that its use in the treatment of phosphorus burns of the skin is mainly as a colour index of the exact position of the phosphorus, and that the phosphorus has to be scraped off and further copper sulphate applied, to discover if there is any more to remove.

Apart from the evidence of necrosis of the liver and the presence of the vapour in the wound, with its distinctive smell, I have recently collected further and more convincing proof that this case was one of phosphorus poisoning. Lieut. K. M. Wheeler, R.E., has, with much kindness, great enthusiasm, and some risk to himself, done some research work for me. He has matched the distorted remains of the bullet with some identical bullets from a batch found on a wrecked German plane. His investigation proved it to be an explosive bullet—containing a charge of high explosive and also 3¼ gr. of phosphorus—which is double the minimum fatal dose recorded (Sydney Smith, *Forensic Medicine*, 4th ed., p. 472). A replica of the striker of the detonator in the bullet was found in the portion of bullet removed from the patient; and

also traces of phosphorus were detected on this portion by chemical tests. The radiographic evidence of minute portions of metal in the thigh and the ragged large entrance wound suggest that the bullet exploded in the tissues of the thigh, probably on striking the iliac bone, thus releasing and scattering the concentrated phosphorus.

A DESCRIPTION OF THE BULLET, BY LIEUT. K. M. WHEELER, R.E.

It is a 0.312 Mauser pattern bullet. Its total weight is about 10.6 g. The outer case of the bullet is in two layers, except the nose—the outer layer of hardened iron with copper plating (A), the inner layer of lead (B); the whole of which encloses, in the nose of the bullet, a concentration of phosphorus (C); and in the main body a brass sleeve containing a detonator (D), of high explosive, actuated by a striker (E). F, F are lead plugs, and G is a safety device. The total quantity of phosphorus is the equivalent of 3.254 gr., most of which is in the nose, although some seems to have crept up between the inner and outer skins of the casing.



I wish to acknowledge my indebtedness to Lieut. Wheeler, whose research work largely solved the mystery of the death; to Dr. Claridge for his help and advice; to Dr. John Williams of Messrs. Reckitt and Colman Ltd., who supplied the chemical data; and to my house-surgeon, Mr. W. P. Hirsch, who assisted me at the operation and was responsible for the after-treatment and clinical notes.

Medical Memoranda

Urticaria with Pigmentation as a Sequel of Scabies

As an unusual sequel of scabies the following case may be of interest.

CASE RECORD

In February of this year an airman aged 20 complained of paroxysmal irritation, localized to small pigmented papulo-macules, which when rubbed became elevated as in urticaria pigmentosa. His history was that in July, 1941, he was treated with sulphur ointment for scabies. As the irritation did not disappear he then received treatment with benzyl benzoate on four different occasions up to September, 1941. Late in August, 1941, he noticed that the irritation was confined to a small, flat, brownish pigmented lesion on the site of an old scabietic burrow on the left axillary fold. A week or so later he noticed similar pigmented lesions on the abdomen, left upper arm, and trunk; all were about the size of a silver threepenny-piece. The irritation was paroxysmal, in bouts, nocturnal and diurnal, lasting some minutes and confined to the lesions, which, when rubbed, became definitely more prominent and raised above the surface. This swelling would last a few minutes and then decrease, with a consequent extinction of the irritation. The majority of the lesions were on the abdomen. There were also a number of small dark-brown pigmented non-hairy moles on the abdomen and arms which had been present since birth.

The patient was above average intelligence and there was no evidence of a psychogenic factor. He was medium in colour of complexion and hair, and stated that he sunburned slowly. As a child he had had "heat spots" occasionally, after eating porridge. There was no dermatographism.

During the four months under observation there has been some decrease in the pigmentation. The urticarial response and the paroxysmal irritation are now absent. Biopsy showed a consistent intracellular increase in the melanin throughout the lesion in the lowest two cell layers at the base of the stratum malpighii; melanoblasts were normal in distribution and pigment content. The epidermis and dermis were normal in thickness. The hair follicles, sweat glands, and sebaceous glands were all normal, but around some sweat glands, and around all capillaries, superficial and deep, was a definite round-cell infiltration; no eosinophils were seen. The cells lining the capillaries gave the impression of slight swelling, but all were empty of blood.

COMMENT

The absence of mast cells in the biopsy excludes urticaria pigmentosa. One would suggest that the lesions represent a peculiar sensitization response to local results of scabietic infestation.

I wish to thank Dr. J. T. Ingram of Leeds for his advice.

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Reviews

DRUGS OF ADDICTION

National Research Council. Report of Committee on Drug Addiction 1929-1941, and Collected Reprints 1930-1941. (No price given.) Washington, D.C.

This huge volume of 1,581 pages contains, besides the report of the committee, reprints of numerous papers embodying the results of researches made on the chemical, pharmacological, and clinical aspects of addiction during 11½ years. To read it through would be, as Sir Thomas Browne might say, "a work not to be performed on one leg," though only a captious critic would complain that "more authors are quoted in one work than are needed in a whole world." As a book of reference it will be found invaluable, and it is indispensable as an exhaustive record of the very important researches on addiction which have been carried out in the U.S.A. during more than a decade. The hope expressed that the foundations thus laid "may be of value not only to contemporary research but to posterity" can fairly be grouped among those hopes which are "sure and certain."

It is, of course, impossible to do adequate justice to a book so rich in content within the exiguous space at our disposal. While the chemical and pharmacological studies will deeply absorb specialists in those branches, it is to the clinical papers that the practising physician will chiefly turn. As regards the two former aspects, it will perhaps suffice to say that, while the ultimate goal is still far off, proof has been afforded of the possibility of so manipulating the morphine molecule as to produce substances which exhibit, in a certain degree, less of the undesirable and more of the desirable effects of morphine. Especial mention may be made of two morphine derivatives, desmorphine and metopon, which have been found to possess greater analgesic powers than morphine and, as regards the latter, less liability to addiction. Hopeful as such results seem to be, yet the conclusion is regretfully reached that while one of the two (metopon*) is an excellent analgesic for chronic pain and has promise of being a real addition to our armamentarium—especially in the field of terminal cancer—yet morphine, in spite of its disadvantages, still holds its position as the most satisfactory phenanthrene derivative in the majority of cases when used with due caution. A promising field of research has also been opened up among the amino-alcohols, for it has been found that the phenanthrene nucleus is not essential for analgesia. It was found also that the most convenient method for assessing the addiction factor in new compounds was observation of their capacity or incapacity to maintain pre-established physical dependence upon morphine.

Coming to the more clinical aspects of addiction, Treadway estimates the proportion of addicts to the general population in the U.S.A. as about 1 per 1,000. Himmelsbach and Small, in another paper, usefully clear the ground by demonstrating the uselessness of certain remedies much lauded by some. Thus, e.g., "rossium," the barbiturates, and insulin were found to be without any real beneficial effect upon the abstinence syndrome. Kolb, in another paper, gives reasons for his belief that belladonna treatments, pilocarpine, the endocrines, and immunity treatments are of little or no value, and, indeed, states that all treatments based upon theories of addiction mechanism have been failures, since that mechanism still remains obscure. All may not go with him quite so far, but his arguments deserve careful study. The chief positive contributions to treatment are contained in the papers by Kolb and Ossenport and Kolb and Himmelsbach which describe the method used at Lexington Hospital. The drug is first withdrawn, then physical and mental rehabilitation is undertaken within the institution, and, lastly, the patient is adjusted to outside conditions in preparation for his return to society. Intensive psychotherapy is given only to selected patients, but occupational therapy, recreation, and a grade of custody or supervision loom large. Drugs play a minor part. As regards withdrawal, the plan recommended for the generality of cases is a rapid but not abrupt withdrawal, helped out sometimes by a few

* Metopon (methyldihydromorphinone) is, however, not yet available commercially.