The increased rise in the rectal temperature could not be attributed to the diminished sweating, as there was always more sweat produced than could be evaporated, and in Thomson's experiments considerably greater reduction of sweat, after ultra-violet irradiation, did not affect heat tolerance. A systemic disorder must therefore be postulated, which would also account for the lassitude and debility. The subject was, in fact, a mild but typical case of Ladell, Waterlow, and Hudson's Type II heat exhaustion. To adopt Selye's (1950) terminology, Type II exhaustion might be called, as a working hypothesis, a "disease of adaptation." To some extent this concept is supported by accumulating evidence that the adrenal cortex may be involved in the control of sweating (Ladell, 1945b; Conn and Louis, 1950); on this theory, prickly heat would be the stress which, added to the several already imposed by a tropical climate, would rapidly lead to what Selye calls the "exhaustion stage," so that even after apparent recovery the heat tolerance remains markedly diminished. A somewhat similar hypothesis has been advanced elsewhere (Ladell, 1948b), but positive evidence for it has not yet been obtained.

Summary

An otherwise healthy subject on recovery from prickly heat showed a diminished tolerance to heat and an increased rate of chloride loss in the sweat, as compared with his figures obtained before prickly heat developed. The implications of these findings are discussed in relation to a certain type of heat exhaustion.

I wish to thank the Director of Medical Services, Nigeria, for his permission to publish this report.

REFERENCES

- Conn, J. W., Johnston, M. W., and Louis, L. H. (1946). *Fed. Proc.*, **5**, 230.
 — and Louis, L. H. (1950). *J. clin. Endocrinol.*, **10**, 12.
 Egerton, M. E. (1950). *British Medical Journal*, **2**, 1292.
 Horne, G. O., and Mole, R. H. (1949). *Lancet*, **2**, 279.
 Ladell, W. S. S. (1945a). *Brit. med. Bull.*, **3**, 175.
 — (1945b). *J. Physiol.*, **104**, 13P.
 — (1948a). *Ibid.*, **107**, 465.
 — (1948b). *Proc. Fourth. Int. Congr. Trop. Med. and Malaria*, **1**, 165. Dept. of State, Washington.
 — (1951). In preparation.
 — Waterlow, J. C., and Hudson, M. F. (1944). *Lancet*, **2**, 491, 527.
 MacArdle, B. (1944). Quoted by Ladell (1945a).
 O'Brien, J. P. (1947). *Brit. J. Derm. Syph.*, **59**, 125.
 Robinson, S. (1949). In *Physiology of Heat Regulation*, edited by L. H. Newburgh, p. 193. Saunders, Philadelphia.
 Selye, H. (1950). *British Medical Journal*, **1**, 1383.
 Smith, E. C. (1927). *Trans. roy. Soc. trop. Med. Hyg.*, **20**, 344.
 Thomson, M. L. (1951). *J. Physiol.*, **112**, 22.
 Van Heyningen, R., and Weiner, J. S. (1950). *Ibid.*, **112**, 13P.
 Wolkin, J., Goodman, J., and Kelley, W. E. (1944). *J. Amer. med. Ass.*, **124**, 478.

One of the main aims of treatment at the Cassel Hospital for Functional Nervous Disorders is to prevent desocialization and accustom the patients to community life and responsibilities (*Medical Director's Report, 1948-50*). The team of workers mainly concerned with this aspect of treatment is called a social therapy unit, and is composed of nurses, two psychiatric social workers, and a psychologist. They are responsible for everything except the actual psychoanalysis. A great deal of emphasis is placed on the patients' social life while in hospital, and patients' committees are made responsible for their welfare, entertainment, and other activities. Subcommittees deal with messing, and regularly meet the hospital staff concerned; the housing committee allocates bedrooms, and this method greatly avoids displays of neurotic behaviour. Patients who are fit to do so clean and look after their own rooms, and some are attached to the housekeeper to help with her duties, or assist the administrative, clerical, and maintenance staff.

ACTINOMYCOSIS IN THE NORTH-EAST OF SCOTLAND

BY

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Although clinical accounts of actinomycosis in man had been given by Ponfick in 1882 and by Israel in 1886, it was not until some years later that the causative organism of the disease, *Actinomyces israeli*, was isolated by Wolff and Israel (1891). Wright (1905) obtained a similar organism from 13 cases of actinomycosis in man and two in cattle. Since then these findings have been repeatedly confirmed by other workers.

Within recent years it has been recognized that actinomycosis, although not a common disease, cannot be considered rare. In a period of six weeks from February to March, 1949, three specimens of pus containing sulphur granules and showing on microscopical examination the branched filaments of *A. israeli* were examined in the University Department of Bacteriology, Aberdeen. That three cases of actinomycosis had occurred in such a short space of time was considered unusual, although it is generally held that the infection is not uncommon in this area of Scotland. Examination of the literature revealed few reports of the incidence of actinomycosis in Britain and none for Scotland. Accordingly, it was decided that an investigation of actinomycosis, with special reference to its incidence in the north-east of Scotland, would be of interest.

Scope of Investigation

The survey was restricted to actinomycosis which had occurred in residents in the counties of Aberdeen, Banff, Kincardine, Moray, and Nairn from 1936 to 1948. To ensure that the list was as complete as possible the records of admission to the hospitals in the area and the bacteriological and pathological records of the Aberdeen Royal Infirmary and the City Hospital were examined. The records of cases of actinomycosis which had been treated in the X-ray Therapy Department, Aberdeen Royal Infirmary, were also examined. The period 1936-1948 was chosen, as it was considered desirable to use a period of time in the fairly recent past in order to ensure accurate diagnosis and follow-up of cases.

The north-east area of Scotland, on account of its geographical position, contains a population which is relatively static. At the census of 1931 the total population of the whole area was about 444,000, of which 167,000 people lived in the city of Aberdeen. The chief occupations in the city are fishing, shipbuilding, and the granite and distributive trades. The provincial towns in the area are market towns dependent on the surrounding agricultural districts. The chief occupations of the rural population are dairy-farming and stock-raising.

It was decided that no case should be included as one of actinomycosis unless there was confirmatory bacteriological or pathological evidence of the infection. As a result, at least 10 cases diagnosed clinically as actinomycosis have been excluded. The minimum requirements for bacteriological confirmation were the finding of sulphur granules and the demonstration microscopically of the branched filamentous organism. The finding of

club-bearing filaments in sections of the tissues was required before pathological confirmation could be claimed.

Results

In the thirteen years over which the investigation extended 98 cases of actinomycosis occurred amongst the population of this region. Each of these satisfied the requirements of laboratory confirmation stated above, although in seven of them there were few or no details of the clinical manifestations of the disease. Table I shows the results obtained in some previous

TABLE I.—Results in Some Previous Surveys

Investigation	No. of Cases	No. of Years	Mean Annual Incidence
America:			
Sanford and Magath (Mayo Clinic) (1921)	96	13	7.4
Davis (1941)	46 (32)	10	4.6 (3.2)
Britain:			
Acland (1906)	109	23	4.7
Foulerton (1913)	78	13	6.0
Cope (1930) (11 hospitals)	167	97	1.7
N.E. Scotland (1950):			
Present survey	98	13	7.5

The case numbers in parentheses refer to those confirmed by laboratory examination.

surveys in America and Britain; the results of the present investigation have been included for comparison. The figures given by Sanford and Magath (1921), of the Mayo Clinic, are comparable in size to those from the north-east of Scotland. But, whereas the latter came from a well-defined area with a known population, those of Sanford and Magath were collected from all over the United States and Canada. Of the 46 cases reported by Davis (1941) from the University Hospital, Nashville, Tennessee, it would appear that 14 were unconfirmed by laboratory examination.

The 167 cases collected by Cope (1930), and discussed at a meeting of the Royal Society of Medicine, came from eleven hospitals in England over periods totalling 97 years, giving an annual mean incidence of 1.7. This low annual mean incidence is accounted for by the fact that the 167 cases were all hospital cases, no out-patients being included in this total. At the same time Cope gave the number of cases which had occurred in two large Scottish hospitals—the Glasgow Royal Infirmary and the Edinburgh Royal Infirmary—five cases in ten years and eight cases in nine years respectively. In the light of these figures from Scotland the 98 cases obtained from the area here under consideration is a surprisingly large number.

The distribution of cases of actinomycosis over the years of the survey is fairly uniform except for 16 and 12 cases in the two "peak" years 1941 and 1943 (Table II). The increase in these years may be explained, at least partially, by the inclusion in each of five cases of

TABLE II.—Number of Cases in Each Year

Year	No. of Cases		Year	No. of Cases	
	Male	Female		Male	Female
1936	5	1	1943	9	3
1937	3	3	1944	4	1
1938	4	1	1945	4	1
1939	5	—	1946	3	4
1940	6	2	1947	4	5
1941	12	4	1948	7	2
1942	2	3			
			Total	68	30

actinomycosis which had occurred in members of the armed Forces stationed in the area.

Sex and Age Incidence

It is characteristic of this disease that males are much more often affected than females, the ratio of male to female cases being roughly two to one. This is borne out in the present series, 69% of the cases being in males (Table III).

TABLE III.—Percentage of Males Affected

Investigation	No. of Cases	% of Males
Acland	101	65
Foulerton	78	65.4
Sanford and Magath (Mayo Clinic)	96	84
Sanford and Magath (U.S.A.)	119	66
N.E. Scotland	98	69

The age of the youngest patient was 2 years and that of the oldest 80 years. The distribution in the various age groups is shown in the Chart. The maximum number occurred in the 21–30 age group or, to extend the period further, in the 11–30 age group, which included 53 out of the 97 cases. Cope (1930) asked if the rise in incidence over the age of 5 years was parallel to the increasing incidence of dental caries. It is difficult to obtain figures of the incidence of dental caries,

Chart showing distribution of 97 cases according to age groups. The percentage of the population in each age group (based on civilian population) is marked —P—.

but it is commonly held that the maximum occurs between 15 and 30 years. Over the age of 30 the "denture era" is reached.

In the 1–10 group the number of cases is small in comparison with the size of the population in this age group. In the 11–20 and 21–30 groups more cases have occurred than would have been expected from the proportion of the population in these groups. After the age of 30 the fall in the number of cases is parallel to the fall in

the number of the population. However, these 97 cases include 11 which had occurred in members of the armed Forces, while the percentage population figures are for the civilian population only. These 11 cases were distributed in the various age groups as follows: under 20, 1 case; 21 to 30, 6 cases; 31 to 40, 3 cases; 41 to 50, 1 case. If the seven cases in members of the armed Forces in the group up to 30 are deducted it will be seen that more cases still occur in this age period than would be expected from the size of the population.

Anatomical Distribution

The anatomical distribution of the disease is known in 95 cases (Table IV). In 72 (75%) the lesions were

TABLE IV.—Anatomical Distribution in 95 Cases

	Cases
Cervico-facial actinomycosis	72
Abdominal	14
Thoracic	1
Actinomycosis of breast	1
" " C.N.S.	1
" " thorax and skin	1
" " " " neck	2
" " " " abdomen	1
" " neck and skin	1
" " face and C.N.S.	1

confined to the cervico-facial region, in 14 to the abdomen, and one was intrathoracic. The breast alone was affected in one instance and the central nervous system in another. In the remaining six cases more than one region was involved. It is well recognized that actinomycosis occurs in the cervico-facial region more often than in any other part of the body. In the 1,330 collected cases of Cope (1938) 56% of them involved the cervico-facial region, while of New and Figi's (1923) 167 cases 68% affected the same region. The high percentage of cervico-facial cases in the present series—75%—may be explained by the fact that 31 of them came from the dental department of the Aberdeen Royal Infirmary. It may well be that more of the cervico-facial cases were associated with dental caries but that only in the dental department was a careful and minute inspection of the teeth made and bacteriological examination regularly carried out and the finding recorded in the case-sheet.

Occupational Incidence

In the past there has been much difference of opinion on whether those engaged in agriculture were specially liable to this disease. Sanford and Magath found that farming was the occupation of 57 out of 90 of their cases, while Davis concluded that farmers were no more susceptible to this disease than others, since only 15 out of his 46 cases were farmers. Table V gives the

TABLE V.—Occupations of 91 Cases

	Cases		Cases
Farming	20	Marine engineer	1
Forces	11	Painter	1
Housewives	15	Munition worker	1
School-children	15	School teacher	1
Labourers	5	Brickworker	1
Chauffeurs	2	Tramdriver	1
Factory workers	2	Fish worker	1
Motor mechanic	1	Postman	1
Railway porter	1	Retired	2
" fireman	1	Agricultural student	1
Van boy	1	Domestic servant	1
Blacksmith	1	Milk delivery girl	1
Draper	1	Pre-school child	1
Salesman	1		

occupations at the onset of the disease of 91 of our cases; it will be seen that 20 occurred in farmers—all males. As they came from a restricted area with a stable population it was possible to obtain the figures of the number of males engaged in farming and the number

of males engaged in non-agricultural occupations; it appeared worth while to submit the figures to statistical analysis, for which I am indebted to Mr. Queniouille, statistician, Marischal College, Aberdeen. The results show that the attack rate among farmers was 1 in 250 and in the remainder of the male population 1 in 2,900, the difference between these rates indicating that males engaged in farming are more liable to develop this disease than those in non-agricultural occupations.

Eleven cases of actinomycosis occurred in members of the armed Forces in this area. Ten of these occurred in men who were strangers to this part of Scotland. It may be that there is a greater liability to develop this infection here, or it may be that the conditions under which the troops were living played a part in the production of the disease.

Influence of Trauma

It has been recognized that trauma often precedes the onset of this infection. In the present series of 72 cervico-facial cases it was found that in three there was a history of injury to the mouth or face and that in 12 there had been extraction of one or more teeth a short time before the onset of the disease. In five cases the patient had suffered from tonsillitis a few days to a few weeks before actinomycosis developed, and in 23 other cases the disease was associated with gross dental caries. In 11 of the 14 abdominal cases there had been an antecedent appendicectomy. One of the remaining three patients in this group gave the history of a fall on his right flank. The skin was unbroken, but over a period of ten days a swelling developed in the right lumbar region, from the contents of which, after incision, a pure culture of *A. israeli* was obtained.

Mortality

The number of deaths from actinomycosis in this area from 1936 to 1948 recorded by the Registrar-General for Scotland was 12, while eight deaths occurred in this series of 98 cases. It was found that seven deaths were common to both lists. The five extra cases which appeared in the list of the Registrar-General could not be included here, for the following reasons: (a) one had its origin outside the area; (b) three occurred at home and the patients do not appear ever to have been in hospital, so no evidence was available to show that the diagnosis had been confirmed by laboratory examination; (c) one case, although certified as actinomycosis, was found at post-mortem examination to be a carcinoma of the caecum.

The one further death which occurred among the 98 cases reported here and which escaped registration as actinomycosis by the Registrar-General had been diagnosed clinically as meningitis and the cause of death certified as such. However, on post-mortem examination the condition was found to be an actinomycotic meningitis. No death occurred in any case in which the infection was limited to the cervico-facial region. Five deaths occurred amongst the abdominal cases and one death in each of the following: skin and thorax, cervico-facial and skin outside this area, and cervico-facial with central nervous system involvement.

Discussion

Although actinomycetes are commonly found in the soil, these are, unlike *A. israeli*, all aerobes. Bostrom

in 1890 claimed that he had isolated an aerobic actinomycete from cases of the disease in cattle; later workers showed that he almost certainly was dealing with a non-pathogenic organism. Infections due to aerobic actinomycetes are known, but in most cases of actinomycosis the micro-aerophilic or anaerobic *A. israeli* can be isolated. This latter organism has never been found free in nature. In addition to its isolation from lesions of the disease it has been obtained by numerous workers from the mouths, carious teeth, gums, and crypts of the tonsils of healthy individuals (Lord, 1933; Emmons, 1936; Slack, 1942). The oral cavity is considered to be the normal habitat of this organism. When certain abnormal conditions arise in the mouth *A. israeli* is thought to alter its habit from a saprophytic to a parasitic state and invade the tissues, giving rise to actinomycosis. It would appear that trauma—for example, the extraction of a tooth—is one factor in precipitating this infection. That there must be others is apparent.

The fact that pieces of grain or grass were often found in actinomycotic lesions was thought to support the theory of Bostroem that the causal organism was aerobic and came from the soil. It is now believed that such foreign bodies act only in their traumatic capacity and allow the *A. israeli*, already in the mouth, to gain access to the tissues.

According to the series of cases presented here there is no doubt that agricultural workers are more often affected than others by actinomycosis. Previous surveys amply support this finding. There is no obvious explanation for this, but an occupational hazard is indicated. The city dweller is not immune from the disease, and it may well be that during a visit to the country or while working in his garden he is exposed to some factor which predisposes to this infection.

Summary

In a restricted area in the north-east of Scotland there occurred 98 cases of actinomycosis in the 13 years from 1936 to 1948. All these cases were confirmed by laboratory examination.

The results suggest that the incidence of actinomycosis is relatively high in this area.

The 98 cases are analysed with particular reference to the age groups affected, sex difference, anatomical distribution, and occupation. The findings are in agreement with previous investigations. The fact that agricultural workers appear to be specially liable to this disease is stressed.

Eight deaths occurred in this series, but there was no death where the infection was limited to the cervico-facial region.

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REFERENCES

- Acland (1906). Quoted by Foulerton (1913).
 Bostroem, E. (1890). *Beitr. path. Anat.*, **9**, 1.
 Cope, V. Z. (1930). *Proc. roy. Soc. Med.*, **23**, 866.
 — (1938). *Actinomycosis*. Oxford Univ. Press, London.
 Davis, M. I. J. (1941). *Amer. J. Surg.*, **52**, 447.
 Emmons, C. W. (1936). *Bull. Hyg.*, **11**, 919.
 Foulerton, A. G. R. (1913). *Lancet*, **1**, 381.
 Israel, J. (1886). In *Recent Essays on Bacteria*, p. 463. New Sydenham Society, London.
 Lord, F. T. (1933). *Med. Clin. N. Amer.*, **16**, 829.
 New, G. B., and Figi, F. A. (1923). *Surg. Gynec. Obstet.*, **37**, 617.
 Ponfick, E. (1882). *Die Actinomykose des Menschen*. Berlin.
 Sanford, A. H., and Magath, T. B. (1921). *Coll. Pap. Mayo Clin.*, **13**, 1057.
 Slack, J. (1942). *J. Bact.*, **43**, 193.
 Wolff, M., and Israel, J. (1891). *Virchows Arch.*, **126**, 11.
 Wright, J. H. (1905). *J. med. Res.*, **13**, 349.

POTASSIUM BROMATE POISONING

BY

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AND

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Potassium bromate poisoning has been recorded only twice in the literature. Carratala and Urcaray (1941) reported one case of grave intoxication, and Dunskey (1947) published a necropsy report on a 17-months-old boy who died after swallowing an unknown quantity of potassium bromate from a neutralizer contained in a "home-perm" outfit. The following case report is presented because similar cases could be expected in view of a claim by manufacturers of home-perm outfits that more than fifty million outfits are sold annually in the United States of America alone. MacKenna (1950a, 1950b) gave a timely outline of treatment.

Case Report

A boy aged 3 found a milk-bottle containing a clear fluid and drank a quarter of its contents. The bottle contained $\frac{1}{2}$ oz. (14.2 g.) of potassium bromate dissolved in one pint (570 ml.) of water, being the neutralizing solution of a home-perm outfit. The child was well until one hour later, when he complained of nausea and vomited. During the next hour he vomited several times and began to look pale. He was given $\frac{1}{2}$ oz. of castor oil, which he vomited immediately, but within half an hour he passed two fluid stools and had much abdominal discomfort. Retching started, and he had a small haematemesis estimated at about half a cupful. It was four hours after swallowing the potassium bromate before medical aid was sought, and he was admitted to hospital two hours later.

On admission the child, a well-developed boy, was unconscious, pale, and flaccid. He could not be roused, but occasionally moved a limb. The pupils reacted to light. Tendon reflexes were absent and the plantar responses were equivocal. The abdomen was soft on palpation. The pulse rate was 100 a minute, regular, but of poor volume; the blood pressure was 85/45 mm. Hg; the heart was not enlarged. Eyeball tension was diminished; the tongue was dry but the skin moist. The axillary temperature was 97° F. (36.1° C.). Respirations were shallow at 30 a minute, and there was acetone in the breath. The fundi were normal.

Gastric lavage was carried out immediately with warm normal saline, and 10 oz. (284 ml.) was left in the stomach. Dextrose 5% in normal saline was given by intravenous drip and warmth applied. After the pulse rate had increased during the next two hours to 160 the intravenous drip was discontinued when 30 oz. (850 ml.) had been given. The axillary temperature and eyeball tension were now normal. Respirations, however, were shallow and rapid, so 1 ml. of nikethamide was given intramuscularly. Soon afterwards the blood pressure rose to 110/65 and the tendon reflexes were elicited. Consciousness was regained three hours after admission.

During the next three days intermittent vomiting continued, but considerable quantities of glucose drinks and warm citrated milk were retained. The child was irritable and pale, and lay with eyes open but remained motionless most of the time. Tachycardia at the rate of 120 a minute remained until the twelfth day after admission. Anuria was present for the first 24 hours, and only a few millilitres were passed on the second day. On the third day 6 oz. (170 ml.) was passed, and subsequently quantities were normal. Albuminuria, at first 6 g. per litre, diminished, but did not disappear until the seventh day. No casts or other