The entire body (back and front) has been exposed to radiations from a mercury vapour lamp (or preferably to the rays of three of these lamps used simultaneously) twice weekly for a period of six to seven weeks, the maximum exposure being ten minutes to both back and front of the body, at a distance of about 16 inches from the burner. This is followed by a rest for one month, and then the patient undergoes a second (and, if necessary, a third) course. I have aimed at producing a second or even a third degree erythema at each exposure; in other words, the radiations have been intensive rather than mild.

The majority of these cases were sent for treatment by their own doctors after other methods had yielded indifferent or negligible results, and in only 5 of them (12.5 per cent.) was there no appreciable improvement. In the remaining 35 cases (87½ per cent.) marked improvement resulted, as evidenced by increased co-ordination and steadiness of muscular control (both in grosser movements, such as walking, and in the finer movements of dressing, feeding, etc.), cessation or diminution of excessive salivation, disappearance of pain and insomnia, increased sense of mental vigour and physical well-being, and relaxation of the mask-like facial expression. In 2 cases out of the 5 apparent failures extended trials were given; the other 3 failed, for one reason or another, to continue treatment after the first three weeks.

The patients whose cases are recorded below are typical of the series treated.

Case 1.—An artisan, aged 22, had contracted the disease eighteen months before coming for treatment. This was a well marked case of post-encephalitic Parkinsonism, with marked hypertonus, tremors, sialorrhoea, and pain in his throat. After a first course of radiations he showed great improvement, feeling much better in his general condition, and using his hands easily. Thus he was able to feed and dress himself, but his throat was still troublesome. After a second course of radiations the general improvement could only be described as excellent; he was walking and talking well, his legs were much stronger, and his upper limbs were practically free from tremors.

Case 2.—A married woman, aged 47, had suffered from the disease for nearly two years. She was unable to feed or dress herself, and suffered from nerve pain and marked depression. Now, after ten exposures (five weeks), she is much brighter and stronger, is feeding herself, talking, eating, and walking well.

Case 3.—An artisan, aged 25. Parkinsonian syndrome well marked. Improved considerably from the very outset. Walked better after five exposures, and felt considerably stronger. After a second course he is now eating, sleeping, and talking well; feels his legs and body generally to be much stronger; has regained almost complete confidence in himself; has completely lost the characteristic facial expression, and is now back at his job, and working well.

Case 4.—A married woman, aged 32, had contracted the disease two and a half years before coming to the clinic. Her tremors, inco-ordination, dragging of the legs, excessive salivation, and helplessness were salient features in a characteristic condition. After fourteen exposures she was able to dress, feed, and help herself. She felt a peculiar degree of mental stimulation, and a definite sense of increased steadiness and strength for twenty-four hours after each radiation. She is now greatly improved.

Case 5.—A man, aged 44. Onset of disease four years ago. During the last two years he was getting definitely worse. Twelve radiations have so far been administered, and the patient is to-day brighter, happier, and stronger, his expression has softened, and his tremors have become subdued. He expresses himself as feeling "much stronger, and better altogether."

Case 6.—A man, aged 31, had typical Parkinsonian symptoms with distressing salivation, and paresis of right arm. Has improved from the first exposure, salivation is diminished, and he is now using the right arm and fingers with comparative ease.

Case 7.—A woman, aged 18, was treated for an acute attack of encephalitis lethargica in the General Hospital four years ago. She has so far only had eight exposures, but already shows increased strength, vast improvement in talking, and good general improvement.

Case 8.—A clerk, aged 28. This patient had treatment spread over several months. He can now dress, undress, and feed himself, his general improvement being remarkable. He is brighter, stronger, and more steady in every way.

Case 9.—A woman, aged 19. Two years' history of illness. Was much improved, stronger, and free from excessive salivation after a course of seventeen radiations. On cessation of the first course of treatment she became worse (possibly because she had had too many consecutive exposures), but after a lapse of one month she had a further twelve exposures, and showed marked improvement.

Case 10.—An artisan, aged 30, had contracted the disease three years before coming to see me. Tremors, salivation, and paresis have improved greatly after eight exposures in his second course.

DISSEMINATED SCLEROSIS: THE RAT AS A POSSIBLE CARRIER OF INFECTION.*

BY

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THE purpose of this article is, first, to set forth some new statistics on the occupational incidence, geographical distribution, and death rate of disseminated sclerosis, and secondly, to discuss these, with the occupational history of a series of clinical cases, in their bearing on the theory that the virus of the disease may be spread by the rat.

OCCUPATIONAL INCIDENCE.

Through the kindness of the Registrar-General I was able in 1926 to investigate the occupations of 688 persons who had died of disseminated sclerosis in 1925. The occupations were classified as far as possible, and then the actual number of deaths in a given occupation was compared with the expected deaths. By "expected deaths" I mean the number of deaths which would have occurred from disseminated sclerosis in those following a given occupation if the deaths had been evenly distributed among the population. For instance, if one-twentieth of the population are clerks, one-twentieth of the 345 male deaths from disseminated sclerosis should be among clerks. The matter is not so simple as it looks, but the advice of the expert staff of the Registrar-General on dealing with the figures has, I think, eliminated such error as is avoidable. The figures are as follows:

	Expected Deaths.	Actual Deaths.
Miners	19.17	20
Clerks	11.95	11
Farmers	7.46	16
Farm labourers	12.98	15
Railway workers	8.63	11
Carpenters	5.53	9
Painters and decorators	4.36	7
Gardeners	5.33	8
Plumbers	1.24	3
Moulders	1.94	3
Grinders	0.43	2
Window cleaners	0.39	2

The summary of the full statistics is as follows:

Farmers and farm labourers ...	33;	Relatives ...	23
Gardeners	8	"	8
Labourers	37	"	16
Workers in chemicals and dyes... ..	6	"	2
Domestic and nursing	27		
Cotton workers	25;	Relatives ...	12
Wool workers	13	"	4
Boot and shoe makers	7	"	10
Carters, etc.	12	"	8
Timber workers	17	"	12
Painters	8	"	7
Building trade	8	"	5
Printers	9	"	3
Clerks and teachers	30		
Army pensioners	11		
Engineering and plumbing	19;	Relatives ...	13
Railway workers	11	"	9
Ships and fishing	8	"	11
Iron and steel	22	"	14
Mining industry	26	"	14
Foodstuffs	22	"	25

The remainder may be classified as "Miscellaneous."

GEOGRAPHICAL.

The death rates were calculated for 1925 in the different counties of England and Wales. A greater range of years would have been much more valuable, but the labour involved was greater than I could then undertake. The death rate for the country as a whole was 17.5. This does not mean that the 1925 rate was lower than the death rate at all ages of 18.2 for the period 1921-25, but merely that the 1921-25 figures include diagnoses on certificates which were only presumed to be those of disseminated sclerosis—for example, "spinal sclerosis." Such doubtful diagnoses were eliminated from the 1925 figures considered separately; consequently the number of deaths is apparently smaller.

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The highest death rate for 1925 was in the Soke of Peterborough—103.3; then follow Merioneth 91, and Monmouth 83. Middlesex, Dorset, and Buckinghamshire were lowest, all having death rates of less than 9 per million.

There is reproduced by permission the map published in 1921 by the American Association for Research in Nervous and Mental Diseases, which shows the case incidence (not death rate) in America. It will be seen that the heaviest incidence is round the Great Lakes, beside the slow-flowing navigable portion of the Mississippi, and in one or two other areas.

DEATH RATES FOR DIFFERENT AGES.

Again by courtesy of the Registrar-General I was given the figures showing the death rates at different ages for the years 1921-25. Graphs of these show an interesting difference between the curve for males and that for females. It is of special interest

to note that the death rate is much more like that of all illnesses taken together than would be expected from a disease thought to attack young persons, and believed to have an average duration of about eight years. Probably the explanation is that the illness lasts much longer than was formerly supposed. In the series of 72 cases recorded below, two patients had suffered from disseminated sclerosis for over twenty years.

THE RAT AS POSSIBLE CARRIER.

This possibility is put forward very tentatively. The following facts gave rise to it. The late Dr. J. W. Dawson,¹ to whose work so many owe inspiration, reported the case

Spirochaetosis icterohaemorrhagica is caused by a rat- and water-borne leptospira, which has probably two phases (as has also the spirochaete of syphilis⁴ and that of relapsing fever), the infective phase developing in stagnant water. The spirochaete of disseminated sclerosis—which is mentioned in the descriptions of some sixteen sets of avowedly

successful experiments to find or to transmit this organism—is described as “resembling closely the leptospira of Weil’s disease.”⁵ Here are two pieces of circumstantial evidence.

The clinical similarity between disseminated sclerosis and known chronic spirochaetal infection has often been commented upon, and recently by Adams.⁶ Adding to the spirochaete theory, it might be suggested that variations in the life cycle of the spirochaete are responsible for the small total incidence in the population (only one phase being infective) and for the failure of

many investigators to find the organism (one stage being non-spirochaetal); that this organism is carried by rats, is excreted by them into water, and where the water is stagnant develops its infective phase; that the organism gains entrance to the patients by penetrating the mucous membranes of those who fall unexpectedly into infected water, or more commonly through the skin of the hands, arms, or feet of those who develop the disease as the result of occupational exposure; and that this entrance through the skin is facilitated by continuous dampness of the skin, and probably also by abrasions and dermatitis, occupational or other.

Going back to the former statistics, the incidence is

Map of United States showing by States the varying density rate of multiple sclerosis. “Dodge,” “Grant,” and “Custer” in the Great Lakes region are the names of camps at which the drafted men from those localities were mobilized. From “Defects Found in Drafted Men” (*Arch. Neurol. and Psychiat.*). Reproduced by permission from *Multiple Sclerosis* (Association for Research in Nervous and Mental Diseases, Paul B. Hoeber, New York, 1921). The original map shows a table, which has been omitted here for the sake of clearness in reproduction.

Age.	Male Population.			Female Population.		
	No.	Deaths.	Rate per Million.	No.	Deaths.	Rate per Million.
0-5	17,242,243	4	0.2	17,064,580	6	0.4
5-15	16,640,112	54	3.2	17,542,412	61	3.5
15-25	13,230,483	119	9.0	15,932,900	187	11.7
25-35	12,457,618	254	20.4	14,389,047	321	22.3
35-45	10,966,048	363	33.1	11,903,901	425	35.8
45-55	7,298,780	499	68.4	8,065,877	411	51.0
55-65	3,823,120	306	80.0	4,735,642	261	55.1
65-75	1,166,193	98	84.0	1,794,660	107	59.0
75-85	129,994	5	38.5	264,025	11	41.7
Total ...	91,840,048	1,702	18.5	100,349,806	1,792	17.9

Disseminated sclerosis: death rates per million at different ages (1921-25). In the chart, continuous line = males; dotted line = females.

of a patient who developed disseminated sclerosis after falling into the deep end of fresh-water baths. Charcot² also mentions a case arising after the patient had fallen into water and allowed his clothes to dry on him. Manson-Bahr³ wrote of a man who suffered from spirochaetosis icterohaemorrhagica after falling into the Thames. These things, coming to my notice one after the other, suggested a possible etiological resemblance between the two diseases.

heavy among farmers and farm labourers, and, as Adams⁴ has pointed out, among those who work in byres and with cows. These statistical investigations of 1926 and the clinical experience of Adams coincide. With regard to the former I have remarked that “the damp of cowsheds and byres and barns, from the presence of rats and the neighbourhood of the farm water supply, is perhaps more likely to be infected than the damp of the open fields.” Gardeners

have obvious sources of infection if the theory holds good; so also have plumbers, with their hands in water; moulders working with wet sand, often rat-infested; grinders who hold their tools under a drip of water from a can; window cleaners obviously; and painters from the washing of walls and roughening of hands from sandpapering, which is the occupation of the young decorator or the man working with a small firm. Clerks have only very slightly less than the "expected" number of deaths—perhaps because the semi-invalid takes to clerking, as he becomes unfit for harder work. Cotton and wool workers seem to have a heavy incidence (often they work with materials kept damp from a tank), but could not be further dealt with owing to difficulties of census classification. I am unable to explain the agreed heavy incidence on wood workers, on the basis of the present theory.

Geographically, I should like to suggest that the race inhabiting the Great Lakes area of America which is of importance in the etiology of disseminated sclerosis is not the human Scandinavian, as was suggested by the Americans, but the rodents *Rattus rattus* and *Rattus norvegicus*. If the spirochaete infests water, it is interesting to see that the Great Salt Lake is too strong for it. In England the fen district of Peterborough is infected, if any value can be attached to the figures of one year.

CLINICAL.

A series of 72 cases of disseminated sclerosis has been investigated with regard to the exposure of the patients to damp and wet in rat-infested areas. The classification made was as follows. "Positive," where there was definite history of working with hands or feet in water where the premises were known to be the resort of rats, or of sleeping in wet, rat-infested places; such were some bottle washers, and all the ex-service patients. "Probable," where there was continual damping of hands or feet, as in washerwomen and window cleaners, without evidence as to contamination of water by rats; or where the patient lived in damp, rat-infested quarters without special exposure to the wet. "Negative," where there were rats but no damp; damp, without special exposure thereto, and without rats; when the hands were in strong chemicals or disinfectants; and where neither rats, damp surroundings, nor wet occupation could be traced.

The history of damp and rats was considered over the four years preceding the onset of recognized symptoms—for the onset may be so insidious—and the same criterion was applied to the control series. Of these 72 patients 38 gave a definitely positive history, 14 probable, and 20 negative. Compared with these a series of 72 patients of similar age grouping, in hospital for diseases other than disseminated sclerosis, showed 21 positive, 7 probable, and 44 negative.

Of the 41 male patients, 27 had been exposed to all suggested etiological factors, 12 of them during their war service and 15 in other circumstances. The histories of some of those war-service patients are interesting. One man had been employed in water-pumping operations during the greater part of his service. He was constantly standing in water. Of the rest of the male patients 7 were classified under probable and 7 as negative. The 41 male "controls" showed 17 positive, 5 probable, and 19 negative.

There were 31 female patients, of whom 11 gave a definitely positive history, 7 probable, and 13 negative. The figures for the control series were 4 positive, 2 probable, and 25 negative. It is to be noted, however, that those recorded as "negative" in both series were engaged for the most part in domestic work, and were only negative in the sense that special exposure to the suggested factors was not proven. It is, I think, to be expected that the female patient would have less definite knowledge of the rat factor. She works with water which may easily be infected with spirochaetes unknown to her (see report of Sir Alexander Houston on London waters¹). The man, on the other hand, works in a byre, or washes bottles or prints in a tank, and knows of the rats that run in the factory at night.

The histories of one or two of these patients may be quoted.

Mary worked in a vegetable kitchen, and constantly had wet feet from water on the defective flooring, where rats were seen at night.

Ann was a tin tester, and spent her days plunging tins into a tank to see if they leaked, with her arms in the tank. There were rats in the factory.

George and Phoebe had both been bottle washers in the cellars of a wine factory (where there were rats) when they developed their first symptoms, though he was a hatter's assistant and she a cork brander when they came under observation.

Arthur, a most intelligent patient, had worked on the wet sand moulding beds of a Government works, and told how the sand would even go down his neck if he stooped near some too vigorous digger, and how dead rats were sometimes found in the sand.

John had only one grumble about his share in a campaign on a dry frontier—that he fought in a river bed, and, coming now and then on water, would walk through and allow his socks and boots to dry on his feet, with the result that he had painful abrasions on his feet.

Nellie had worked in a cable works, her hands and arms in a tank of water, and her skin rough with "rubber rash." There were rats in the works.

Robert had had his first symptoms at 15; not long before he had spent a great deal of time learning to swim in fresh-water baths in a London suburb, the water to the baths coming from a reservoir which the boys used to visit regularly on Sundays, for the purpose of rat hunting.

Interesting as these are, however, I am fully aware that most of us have been in circumstances where we might be supposed to be exposed to infection—if infection it is—at some time or another, without developing disseminated sclerosis. Proof or disproof of the view put forward can come only from the bacteriologist. The rat and water theory of the etiology of disseminated sclerosis may end as a discarded theory, but it seems to me that there is enough suggestive circumstance in the bacteriology, geographical distribution, occupational incidence, and clinical findings to justify further work along these lines.

SUMMARY.

The occupations of 688 persons dying of disseminated sclerosis in 1925 have been investigated and the occupational death rate calculated where possible; the death rates for different counties of England and Wales have been worked out for that year; and the death rate for the years 1921-25 (corrected for age) is given. Clinically, 72 patients have been interviewed with regard to their exposure to rat-infested water.

CONCLUSIONS.

1. The findings of other workers as to heavy incidence in agricultural workers, wood workers, etc., have been confirmed. Incidence appears to be heavy also among painters, plumbers, moulders, and wool and cotton workers.
2. The high death rate in the fen district is analogous to the heavy incidence around the Great Lakes of America.
3. Clinical histories show some evidence in favour of the possibility that the infection of disseminated sclerosis is spread by rats and water.
4. No positive proof of the rat and water theory is yet available.

Finally I should like to say that I am grateful to the following, who have allowed me to see patients under their care: Dr. Browning Alexander, Dr. E. A. Bennet, Dr. Danvers Atkinson, Dr. H. N. Harcastle, Dr. N. Hobhouse, Dr. E. D. Macnamara, Dr. J. G. Porter Phillips, Dr. C. P. Symonds, Dr. R. C. Turnbull, Dr. F. M. R. Walshe, Dr. Wiggins, Dr. Worster-Drought, and Dr. Yealland. I am also glad to express my indebtedness to the Registrar-General for allowing me to have access to the records, and to the authorities of Bethlem Royal Hospital, Guy's Hospital, and the West End Hospital for Nervous Diseases, for giving me facilities for work in their wards or out-patient departments.

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