being transferred to some other branch of service at increased remuneration. In reality his special skill should be recognized and retained, and higher emolument offered. It is difficult to indicate the remedy without outlining the possibilities of added material benefit to each individual worker. A satisfactory homogeneous co-ordinated service would have a clear policy, would afford facilities for research, establish team work amongst workers suited for such advanced and combined effort, would possess higher special appointments where individual merit would be both retained and rewarded, and would, in short, offer all those advantages to the community and the worker at present denied to both.

If we assume that the average period of service for the individual worker be, say, twenty-five years, the community and the worker would both gain if a fraction, say even one-twenty-fifth of that time, were devoted to specialized training at the commencement of service in all matters connected with tuberculous disease, and would gain still more if during service additional short periods of special study leave were granted. This is a principle well recognized in other forms of public medical service, and it would be particularly valuable in so specialized a branch of medical activity as that of the tuberculosis service.

A thoroughly efficient tuberculosis service working with a well-defined policy and in co-operation with the general practitioner would constitute the most efficient instrument in combating tuberculous disease. Till it is instituted progress will be delayed, and discontent both within and without the service will continue. When it is accomplished advance will be rapid. It is to the man rather than to the method that the attention of the authorities should be now directed. The method should follow the trained man, not *vice-versa*.

THE INFECTIVITY OF TUBERCULOSIS.

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ALTHOUGH the discovery that tuberculosis is due to the tubercle bacillus first made it clear that each case must arise directly or indirectly from a preceding case of tuberculosis, writings and edicts of the seventeenth and eighteenth century, both in this country and elsewhere, deal with the subject, drastically in some instances.¹ Exactly how the infection

¹ Cobbett, Louis: "The Causes of Tuberculosis." Cambridge: The University Press. 1917.

takes place and how far we can prevent it are matters much more difficult to decide. After Koch's original discovery a belief in direct case-to-case infection was widely held and measures were advocated to this end; it was, however, considered too difficult to prevent the spread of the disease from tuberculous humans, and attention was directed mainly to tuberculous cattle.

From Koch's announcement that bovine and human tuberculosis were not identical dates the reaction from this view, and the conception of tuberculosis which began to be generally adopted was that of a universal disease the seed of which cannot be prevented, and which can therefore only be dealt with by attention to the soil and the surroundings of the living subject. It seems now as if we are entering on a third period, when importance will again be attached to the influence of the seed. It can hardly be denied that if we can prevent the tuberculous seed being implanted we can prevent tuberculosis, even in susceptible subjects, and this may not be so hopeless as would at first sight appear.

Many striking instances of direct infection have appeared in the literature of the subject from time to time. Among the latest of these is an instance recently published by May.¹ Six fishermen spent a season at sea in a small boat with another who had open pulmonary tuberculosis; five of the six, as well as the original patient, died within two years of phthisis. MacNalty² also mentions an outbreak of tuberculosis in a girls' home, forty cases occurring, with eleven deaths.

The problem of infection in tuberculosis can best be studied in an area of scattered rural districts and small towns such as South Devon mainly presents; moreover, the work of the tuberculosis officer here is carried out almost entirely in the homes of patients, and not at dispensaries, which enables one to get a much closer view of the problem.

Conjugal Tuberculosis.

Considering first the important question of *conjugal tuberculosis*, some regard the risks of infection under these circumstances as serious;³ Pearson and others⁴ take the opposite view and attribute any increased

¹ May, O.: "Some Aspects of the Tuberculosis Problem in Life Assurance." *Tubercle*, January, 1920.

² MacNalty: "Supplement to Fortieth Annual Report of the Local Government Board," 1919.

³ Weber, H.: "On the Communicability of Consumption from Husband to Wife." *Transactions of the Clinical Society*, 1874, p. 144. Newsholme, A.: *Transactions of the Epidemiological Society*, xxv.

⁴ Pearson: "A First Study of the Statistics of Pulmonary Tuberculosis: Marital Infection." *Drapers' Company Research Memoirs*, 1907. See also Pope, E. G., and Pearson: "A Second Study of the Statistics of Pulmonary Tuberculosis: Marital Infection." *Drapers' Company Research Memoirs*. London: Dulau and Co., 1908.

incidence of disease under these conditions to predisposition and causes other than direct infection. It is suggested, for instance, that so-called "assortative" mating will explain the difference—that is to say, a person predisposed to tuberculosis is attracted by, and mates with, another similarly handicapped.

I find that out of 156 cases in which the mate of a tuberculous husband or wife was examined, 91 were tuberculous, 16 suspect, and 49 negative.¹ If we reduce these figures to percentages, it gives approximately 58 per cent. tuberculous, 10 per cent. suspect, and 32 per cent. negative. Considering solely wives whose husband was first notified, out of 120 cases 66 were tuberculous, 12 suspect, and 42 negative, or 55 per cent., 10 per cent., 35 per cent.; while among husbands of tuberculous wives (36 cases), 25 were tuberculous, 4 suspect, and 7 negative, or 69 per cent., 11 per cent., and 20 per cent. In 15 cases the tuberculous mate first notified has died, and in 7 both husband and wife have died of tuberculosis. Comparing now the results of examining contacts other than husband and wife, we find, out of 1,057 examined, 219 tuberculous, 284 suspect, and 554 negative, or roughly 20 per cent., 27 per cent., and 53 per cent. An attempt to control results by examining contacts of non-tuberculous patients gave, out of 81, 4 tuberculous, 7 suspect, and 70 negative, or 5 per cent., 8 per cent., and 87 per cent. I take the view that the great majority of the mates of tuberculous husbands or wives do sooner or later show signs or develop symptoms of tuberculosis; but I further believe that the great majority of those infected recover, and make a speedier recovery, than most tuberculous patients.

Considering for a moment the question of "assortative" mating among the working class population, with whom my work is mainly concerned, I cannot discover that this factor comes into the question at all. Mating seems to be not so much selective as fortuitous—between the men and women who are most thrown into contact with one another. If a man or woman of a tuberculous type marries I do not find that they usually marry another of the same type. Moreover, by this time, I know most of the markedly tuberculous families in South Devon, and can recollect extremely few cases where two such families have intermarried, as they certainly would frequently have done in out-of-the-way places where there are reasonable opportunities, if this sort of selection were an important factor.

The views held as to conjugal infection have been prejudiced to some extent by the well-known case of Metchnikoff, who married a tuberculous lady, and, though exposed for years to infection, never contracted the disease. This is after all only one case, and it is as unjust to argue from it as it would be to argue about diphtheria antitoxin from

¹ Ward, E.: *Lancet*, October 4, 1919.

the death of the daughter of an early investigator in this field after a first injection.

Infection other than Conjugal.

No one can deny that the individual resistance to tuberculosis varies within wide limits, or, indeed, that there may be families of low resistance, but the main factor in spreading the disease that suggests itself when visiting the homes of tuberculous patients is infection.

The question of direct infection in tuberculosis¹ apart from conjugal cases is more difficult, and would be almost hopeless to attack in any but rural districts. I have attempted to classify the cases investigated into the following groups: (i.) Immediate infection; (ii.) remote infection (in which the patient has been in intimate contact with an infective case, either in early life or at some time separated by an interval of years from the appearance of the first symptoms); (iii.) no traceable infection; and (iv.) doubtful. I find out of 252 cases, 102 appear to be due to immediate infection, 47 to remote, 78 no traceable infection, and 25 doubtful; or, expressed in percentages, we have the following: 40 per cent. I., 19 per cent. R., 31 per cent. O., and 10 per cent. D. A new series of 316 adults gave 43 per cent. I., 14 per cent. R., 36 per cent. O., and 7 per cent. D.

Among 96 children under sixteen I found the following: 74 per cent. I., 2 per cent. R., 23 per cent. O., and 1 per cent. D. Out of 102 non-tuberculous control cases similarly investigated, I found 5 per cent. I., 7 per cent. R., 82 per cent. O., and 6 per cent. D. It is interesting to note that 77 tuberculous soldiers gave the following proportions: 5 per cent. I., 26 per cent. R., 67 per cent. O., and 2 per cent. D. Cases of tuberculosis may be divided ætiologically into those due to (1) childhood infection, which is often untraceable, and which has been rekindled in later life by overwork, illness, poverty, or other debilitating influence; and (2) immediate infection. This may occur at any period of life with sufficient virus to break down the patient's resistance at the time. The first class is for the most part beyond the reach of preventive measures, but may be prevented in time, incidentally, by measures devised to eliminate the second class.

The following cases indicate how tuberculosis is spread. Similar instances could be given by most tuberculosis officers.

(1) An invalided soldier is found with his wife and two young children occupying two rooms. This patient is highly infective and brings up half-a-pint of sputum daily. He is sitting shivering over a fire before which the children are being washed. At his side in the fender is a dry spittoon with sloping sides; at the bottom of the spittoon is dry or drying sputum, on the sides are blobs of sputum, and

¹ Ward, E.: *Lancet*, January 3, 1920.

starred all round the receptacle is more sputum where the patient has made "bad shots" at the spittoon. I was able to get this man a separate bedroom, and a few months later to persuade him to go into a tuberculosis hospital, where he died. When the family were seen again, four months after his death, the wife had been getting thinner, and had physical signs of active disease at both apices, one child was ill with pulmonary and glandular tuberculosis, and the other a suspect. A child born since the husband's death was the only healthy member of the family. Others might interpret this as a case of hereditary predisposition and selective mating, but such an interpretation would seem far-fetched.

(2) On another occasion (March, 1919) I visited a young man of twenty-five in a seven-roomed house with nine inmates. The patient, who has advanced disease, lies in a room adjoining the kitchen, and where the family frequently have their meals. The room is a sitting-room with a bed in it, and in the centre stands a large table. Alongside the patient's bed two or three newspapers are spread as a receptacle for his sputum, the mother informing me that he will use nothing else. Scattered over the paper are lumps of nummular sputum in varying stages of desiccation. On the carpet beyond the papers are a few more nummuli, and on the table-leg there is a mass which has hit the leg high up and trickled downwards some 18 inches. Between the papers and the door, and on into the front room are traces of sputum carried on the feet of visitors.

The patient has since died of tuberculosis, also one sister and a brother; another sister has been in a sanatorium and is now ill in bed. I have not examined all the household yet, as the family consists mainly of adults, and therefore difficult to find in at the same time; but so far all I have seen are tuberculous, including a New Zealander who married a sister of the patient and went to live there. Yet these people were somewhat apathetic and careless about the whole matter.

I have sometimes found a little colony of tuberculous persons in a more or less isolated spot, such as one street of a village, and I am inclined to attribute the existence of such a colony to conditions of infection similar to those described, rather than to the influence of the local climate, or the prevalence of some special wind.

Discussion.

These considerations seem to indicate that the attempt to check tuberculosis should be made by treating it as an infectious disease, dealing first with obvious sources of infection in the home and the factory.¹ These measures would entail no great hardship to in-

¹ Mock, H. E. : "Industrial Medicine and Surgery." London : W. B. Saunders and Co., 1919.

dividuals or any dislocation of society, and we might very well find after their adoption that the infection was becoming less universal, and further means completely to prevent the disease would suggest themselves.

Brownlee's work¹ on types of tuberculosis does not affect the problem appreciably. Most probably the differences he discloses are due to the differing reactions to the disease at different ages, and not to special types of micro-organism. For some years I have noticed that a girl who suffers from active tuberculosis between eighteen and twenty-five may, if she survives, enjoy good health until between forty and fifty, the menopause period, when another breakdown not infrequently occurs. The same phenomenon may be noticed in men. Clinical observation also shows an earlier period of low resistance up to seven or eight, which is succeeded by a high resistance period up to fourteen or fifteen, which is in turn succeeded by the low resistance period already described. Similar age differences in reaction to disease may be noticed in syphilis. Time has not yet allowed me to work out the tuberculosis periods statistically.

Whether infection by the tubercle bacillus from open cases of human tuberculosis and from bovine sources covers the whole ground cannot yet be said. The question may well prove to be more complicated, and Spengler's "splitter" bodies or some other spore formation may become important, or there may be other quite unsuspected sources of the disease. But the facts already known show clearly the necessity of isolating known sources of bacillary infection, and this has not yet been attempted. When this has been done, the consideration of these further questions will be considerably simplified.

THE SUN TREATMENT OF SURGICAL TUBERCULOSIS.

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SURGICAL tuberculosis is not, as it was for a long time considered, merely a local disease, requiring local treatment, but also a general disease demanding general treatment. Of all infectious diseases tuberculosis is the one in which the resistance of the organism invaded plays the most important part in securing cure. A rational treatment should therefore aim primarily at building up the resistance of the

¹ Brownlee: Medical Research Council, S.R.S., 46.