THE QUESTION OF PAIN

Only one of the twenty-four patients showing bony union complains of pain. She has a valgus position of the head, a certain amount of sclerosis of the head, and is developing a degenerative arthritis. She was operated on twenty months ago, and her gait is deteriorating as her pain is increasing.

Arthritis.—Radiologically three patients appear to be developing arthritis—the one already mentioned, who is a woman, and two others, who are men. One of these men, aged 55, walks slowly without limp and says he has no pain; his operation was performed in a country hospital "on the blind," with the assistance of one antero-posterior photograph and no apparatus or special table. His nail was removed twenty-four months after operation, and six months later he climbed a hill of 500 feet without trouble or subsequent pain. His range of movement is still good. The other is aged 57. He was operated on two years ago; is getting restriction in his movements, especially abduction; has a valgus position of the head; and had the nail removed a month ago lest his arthritis might be due to its presence.

Conclusions

1. The Smith-Petersen nail introduced by the method of Hey Groves is suitable for the treatment of the great majority of cases of fracture of the neck of the femur admitted to a general hospital.
2. Of all the patients operated on, bony union may be expected in over 70 per cent. Of those in whom a nail has been successfully introduced, and who live long enough, bony union may be expected in 80 per cent.
3. Of the patients obtaining bony union almost all will have painless weight-bearing, while 50 per cent. will have almost perfect function.
4. A few will have poor function, due to arthritis, absorption of neck, coxa vara, and defective calcification of the fragments.

Summary

The paper deals with thirty-three patients suffering from fracture of the neck of the femur. In these, thirty-seven operations have been performed for introduction of the Smith-Petersen three-flanged nail by a closed method.

It discusses the suitability of patients for this form of treatment, the method of operation employed, and immediate and remote results obtained on review after three years.

It gives the mortality, immediate and remote, and the number of patients in whom bony union was obtained, with details of the failures.

Immediately after the insertion of the nail the patient obtains complete relief from pain, good control of the limb, and, beyond confinement to bed, suffers from no disability.

The final functional results were demonstrated by a film showing twenty-two of the patients.

At the annual meeting of the British Association for the Advancement of Science, to be held this year in Dundee from August 30 to September 6, under the presidency of Sir Albert Seward, F.R.S., the Section of Chemistry will be presided over by Professor E. K. Rideal, F.R.S., the Section of Anthropology by Professor W. E. Le Gros Clark, F.R.S., F.R.C.S., the Section of Physiology by Professor David Burns, and the Section of Psychology by Mr. R. J. Bartlett.

TUBERCULOSIS—DOGMAS AND DOUBTS
OF SIXTY YEARS

BY

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During the course of my training and my period of thirty-seven years as medical officer of health accepted views have varied, and some of the explanations given from time to time have not appeared to accord with experience, raising doubts in my mind as to their correctness. With a view to resolving these doubts I kept records in the hope that opportunity would arise for summarizing the results. This has been done in the following notes from various books and papers and over 200 references.

In Wynter Blyth's *Dictionary of Hygiene and Public Health* (1876), published thirteen years before I registered as a medical student, occurs the following description: "Although there are differences between phthisis, consumption, and tuberculosis, they are only such as have been pointed out of late years by a more accurate and extended pathology; hence it will be convenient for the study of consumption statistics to define, for the purposes of this article, the term 'phthisis' as a disease of the lungs attended by wasting . . . and signified by others as consumption, dry-rot, etc." It was suggested that in certain instances phthisis would appear to be contagious, especially in crowded barracks and such-like places. It was considered that hereditary influence had been much exaggerated, and it is said: "that impure air alone will produce consumption, the excessive mortality of soldiers in certain barracks . . . sufficiently proves." Damp soil, unhealthy trades, tight clothing, etc., are also given among the causes.

Already bacteriology had been born and the microbic causes of a few diseases were known. Within six years of the publication of the above note Koch reported his discovery of the tubercle bacillus. Even so, the new idea was not readily accepted in all quarters, and indeed it was described by some as "simple nonsense—utter humbug" (Philip, 1932). As late as 1893, in the textbook on which I was educated—Frederick Taylor's *Practice of Medicine*—the cautious description reads: "Recent researches on the bacillus of tuberculosis tend strongly to the view of the unity of phthisis—that is, to the belief that all forms of destruction of the lung commonly known as phthisis are due to the invasion of this bacillus, and are tubercular in nature." Later it is said: "Nothing seems to be better established than the truth of the hereditary transmission of phthisis." A common phrase in use about this time was "tubercular diathesis," to which greater importance appeared to be attached than to infection with an organism. As regards lupus, Taylor says: "Nevertheless, there is an increasing tendency to regard the tubercle bacillus as the cause of lupus."

At that time there seems to have been no suggestion of more than one kind of tubercle bacillus: in the *Manual of Bacteriology* (Muir and Ritchie, 1897) the following phrase appears: "There can be no doubt that the bacilli present in tuberculosis of the various mammals mentioned are of the same variety, though differences in virulence may be occasionally noticed. There has, however, of late years been considerable discussion as regards the identity of the bacilli in avian and mammalian tuberculosis."

Dr. B. Arthur Whitelegge (1899) says: "There is still much doubt as to the frequency of direct infection from person to person but none as to its occasional occurrence or as to the fact that almost all persons must frequently inhale and swallow living *Bacilli tuberculosis*."

Dr. Theodore Shennan (1908) observes: "In the causation of the disease one must bear in mind two factors, the soil and the germ. In the absorbing discussions which

are taking place concerning the tubercle bacillus and its modes of entrance into the body we are apt to give insufficient weight to the personal factor. It is now generally concluded that the bacillus is only capable of taking root in individuals whose nutrition and power of resistance are greatly lowered. In fact, tuberculosis may be looked on as the sequel of another debilitating condition due to accident or disease." He describes the characteristics of human, bovine, and avian bacilli, but at that time the great significance of the bovine variety does not appear to have been known generally.

These quotations give an idea of the phases through which tuberculosis had passed in general acceptance in the thirty-two years up to 1908. In that year were published two of the most valuable special works on the subject: Sir Arthur Newsholme's *Prevention of Tuberculosis* and Dr. H. Timbrell Bulstrode's Supplement to the 35th Annual Report of the Local Government Board. Both authors give a detailed historical review of researches with regard to tuberculosis, using many of the same references, but with much the same facts before them come to diverse conclusions. Sir Arthur Newsholme favoured personal infection as being the chief factor in maintaining the disease, while Dr. Bulstrode concluded that possibly bovine infection, especially from milk, was an important element.

Meanwhile, in 1901 Professor Koch gave his famous address at the meeting of the British Congress on Tuberculosis in London and startled the medical world by his expressed belief that tuberculosis in cattle did not infect man. This led to the immediate appointment of the Royal Commission on Human and Animal Tuberculosis, and to its intensive work on the subject covering ten years. As a general result our knowledge of many aspects of tuberculosis was placed on a firmer foundation than would otherwise have been the case, and since that time the researches of the original and other workers have added further to the store of sure facts with regard to tuberculosis.

I have given this cursory review of the changing outlook on tuberculosis in my lifetime to indicate the manner in which one has had to adjust one's views in the light of developments and, even more important, the fact that it is impossible to say even now that the problem of tuberculosis has been wholly solved. In the following paragraphs I deal with various branches of the subject and finally give conclusions to which they lead.

Dimensions of the Problem

Large as was the known share of tuberculosis in the death rates of various countries, the extent to which members of the community were infected was little realized until the present century. The first of my notes on this aspect gives the figures for necropsies collected by Dr. F. Langmead (1913), showing that lesions in all children ranged from 35 per cent. in London to 42.5 per cent. in Christiania: in Vienna the proportion increased from 4 per cent. in children under 3 months to 70 per cent. between 11 and 14 years. Subsequently there are numerous references to much the same effect. These conclusions were confirmed in the living subject with the development of tuberculin tests: as an example may be mentioned Heimbeck's investigation in 1931, quoted by Dr. W. H. Wynn (1932), showing infection increasing from 10 per cent. among children under 3 years to 100 per cent. among persons aged 40 to 50 years. In 1929 Dr. Wynn records an inquiry by M. A. Asserson into the after-history of 460 infants giving positive von Pirquet tests: 112 suffered from advanced tuberculosis (96 per cent. died), thirty-two developed bone, joint, or gland disease, while 316 gave no clinical evidence of disease though skiagrams suggested enlargement of tracheo-bronchial glands in sixty-one cases.

Information as to the numbers of persons with clinical evidence of tuberculosis in the country as a whole is not

available so far as I am aware; but in Gloucestershire, with a population of about 330,000, a live register is kept of persons who have been notified at any time as having had illness attributable to tuberculosis. From 1915 the numbers of cases of pulmonary tuberculosis increased from 1,242, at first rapidly and from 1922 more slowly, to 2,457 in 1935; for non-pulmonary trouble the increase has been from 307 to 1,463, and the figure is still rising. The number of pulmonary cases is now fairly constant at about 2,500, or one case for every 132 persons in the population; the maximum number of non-pulmonary cases has not yet been reached, but at present it is about one case for every 240 persons. From these numbers it would appear that though, from the evidence of post-mortem examinations and tuberculin testing, practically all persons have been infected with tuberculosis, the numbers having illness attributed to this cause are small. The development of illness is rather of the nature of an accident owing to the resistance of the individual being reduced from some cause—concurrent trouble, lack of food, debilitating climatic conditions (W. Gordon, *Rainy Winds and Phthisis*, 1910), etc., recognized generally as contributory factors. This accident risk is small, being only about 0.75 per cent. for pulmonary tuberculosis and half that figure for non-pulmonary tuberculosis.

In one-third of the pulmonary cases illness develops rapidly to a fatal conclusion and the death rate in the year of notification is about 30 per cent.; thereafter it falls rapidly to about that of the general population in the sixth year. Under the Regulations of the Ministry of Health some 1,000 cases that have progressed so well as to have had no trouble for five years have been removed from the register as no longer suffering from active tuberculosis.

Source of Infection

To account completely for the fact of practically universal infection it is necessary to find almost universal opportunities for exposure to infection. Numerous *ad hoc* investigations to this end have been made, mainly in connexion with hospitals and by a few tuberculosis officers.

Thus R. C. Wingfield (1931), the medical superintendent of Brompton Sanatorium, made an inquiry into the fate of children in homes of patients where there was a contact case of tuberculosis and in others where the patient had not tuberculosis; he reports the infection of children as follows:

Age	Contact	Non-contact
0-5	67%	17%
5-10	77%	31%
10-15	82%	52%

As a contrast to the column of the table dealing with contacts he mentions that there was a complete absence of clinical tuberculosis among 133 children born at the Papworth Village Settlement.

About the same time the tuberculosis officer for Leeds (Tattersall, 1931) made an investigation as to children aged 0-1 year in respect of the years 1925-9: he grouped the children according to whether there was a sputum-positive or a sputum-negative case in the home. According to his results the numbers of children dying of tuberculosis in sputum-positive houses was over six times that in sputum-negative houses, while the death rate from other causes than tuberculosis in the former approached double that in the latter. The tuberculosis officer in Lancashire made a somewhat similar inquiry in his county with respect to children under 5 years of age, and found the death rate nine times greater in age group 0-1 year, fourteen times in age group 1-2 years, and nineteen times in age group 2-5 years in tuberculous than in non-tuberculous households. The tuberculosis officer for Sheffield (Turner, 1931) criticized the Lancashire results, which showed, curiously enough, a death rate from all causes not very different from the normal, indicating a class differentiation between the controls and the dispensary population.

This aspect of the question has been approached also in respect of married persons, in view of the fact that if infection occurs from association with an infected person the opportunities are greatest among them. Thus, Sofie Tillisch (1921) investigated 1,152 married patients among 3,151 between 1911 and 1920. Of the 1,152, eighty-five had consorts with tuberculosis: thirteen had a history of exposure in childhood, but in the remaining seventy-two cases it is said there was a possibility of conjugal infection. She thought it was unwise to ignore the possibility.

Karl Pearson (1912) concluded that "exposure to infection in married couples was of little importance, while immunity or diathesis was a chief determinant." Dr. Rowland (1924), tuberculosis officer for Northampton, later made an examination of many reports giving figures ranging from 1.5 to 58 per cent., and said his own experience showed a rate of 2.7 per cent.; he concluded (Rowland, 1926) that "conjugal tuberculosis is rare and death rate of partners differs little from that of the general population." In 1922 Dr. Paul Roussel summed up an inquiry among families in Nancy by saying, "Conjugal infection is uncommon even in the poorer classes." Others—for example, Barnes (1924) in America and two observers in Christiania—concluded that there was some risk. In 1933 the Assemblée Française de Médecine Générale referred to variations in findings and passed unanimously a resolution which, while not dismissing conjugal tuberculosis as a figment of the imagination, emphasized the much greater danger of infection in childhood.

From such evidence it would appear that there is little to support a suggestion that adult pulmonary tuberculosis is due to familial infection. The evidence with respect to children is perhaps a little stronger; even so, half of the children at 10 to 15 years in non-contact houses were reported to be infected and above 80 per cent. in contact houses. Why so large a proportion in non-contact houses are found infected and 20 per cent. in contact houses should escape infection is not explained. Further, if comparatively close familial contact is not sufficient to cause infection, is casual association with cases likely to infect 50 per cent. of children not in infected houses? And what proportion of the 50 per cent. have been in contact with any cases of pulmonary tuberculosis? A factor which appears to have been overlooked in connexion with many of these inquiries is that a considerable proportion of the children have been infected by tuberculous milk.

My first reference to the familial aspect appears in the Lady Priestley Memorial Lecture delivered by Professor Elie Metchnikoff on November 29, 1912. He described how, at the age of 23, he married a young lady of the same age who was so ill with pulmonary tuberculosis that she had to be carried in a chair up the steps to the church. He was in close intimacy with her until her death four years later: that he did not develop the disease himself he attributed to the fact that he had ophthalmic scrofula and ganglia in the neck, presumably of tuberculous origin.

Infective Material and Mode of Entrance

After the announcement of Koch's discovery of the tubercle bacillus the manner in which it could be conveyed excited attention, and this aspect of the question receives very full consideration in Bulstrode's report and Newsholme's book. The presence of the bacilli in sputum and discharges, and the fact that much of the trouble was pulmonary, naturally led to the assumption that in some manner material containing the bacillus, given off by infected persons, was inhaled. Investigation followed; dust of rooms occupied by patients was examined, culture plates were exposed in rooms, and experiments were made. It is not necessary to recount these in detail, but it may be said briefly that animals were infected by pumping material into their cages, that culture plates were infected

by droplets from the coughing of consumptives and from the mouth of a person washed out with broth containing *B. prodigiosus*, and that tubercle bacilli in droplets were found to survive for many days in the dark, though only a day or two in sunlight. The evidence of infection by inhalation was considered generally as conclusive, but some of the experiments raised doubts. For example, the tests on animals were considered severe, and the conclusions obtained by some were not confirmed by other workers.

That inhalation was an important factor seemed to be supported by experiments in which animals inhaled coloured dusts and by the occurrence of anthracosis in man. But Newsholme very fairly refers to experiments on feeding animals with coloured dusts: "At the autopsy on these animals pigment [was found] in the lungs only, the abdominal organs and mesenteric glands being free." Earlier he refers particularly to the "complexity and shape of the respiratory passages" and the distances along them which the bacilli would have to pass before they could reach "the first lesion in pulmonary tuberculosis . . . at the angles and projections situated where the smallest bronchioles become continuous with the acini." Further, the part of the lung usually affected first is the apex—one of the most remote spots from the main respiratory passages.

Dr. R. C. Wingfield (1938) also refers to the intricacies of the respiratory tract and, answering his own question as to the method of deposit of tubercle bacilli in the lungs, says: "They may have been inhaled during contact with a case of pulmonary tuberculosis (a fact which, considering the beautiful mechanism of the respiratory tract, which on this assumption must have permitted a foreign body to penetrate to an ultimate alveolus, I find it hard to credit), or they may have been deposited by the blood stream, having seeped past the last lymphatic barrier into the thoracic duct."

Newsholme later refers to evidence of infection of the lungs through the bronchial glands, and says: "In this connexion must be noted the frequency with which, in man, pleurisy precedes other signs of pulmonary tuberculosis." He expresses the view, however, that "the predominant means of infection are the spray produced by the consumptive as he coughs and the dust of his powdered expectoration."

Sir Robert Philip (1934) has reached the opposite conclusion, and says: "I am, of course, well aware that the majority of opinion, pathological and clinical, favours—almost takes for granted—the view that human infection occurs generally by way of the respiratory passages. . . . I have been constrained by an overpowering weight of evidence in my own experience—clinical, pathological, and experimental—to relegate the lung [as the seat of primary infection] to a secondary place."

There is a factor which some observers have not taken into full consideration, and that is the general infection of our population in early life and the immunity that should be given thereby if our ordinary views with regard to most infections hold true. But the accepted explanation is a reinfection by inhalation of droplets or infected dust. In 1927 Professor S. Lyle Cummings said: "To sum up, the evidence was inconclusive, but there were two certainties—namely, that pulmonary tuberculosis was due to a reawakening of previous infection and that strong evidence existed in favour of reinfection." In 1932 Dr. W. H. Wynn summed up the position at that time in the following words: "The common conception of tuberculosis infection is that it generally occurs during the early years of childhood and that pulmonary tuberculosis in the adult shows the characteristics of localization and chronicity because it occurs in a person previously immunized by a mild infection in his early years." He adds that "it is difficult to bring certain facts—for instance, the morbidity at the ages between 20 and 30—into line with this theory," and then summarizes investigations made by

Heimbeck on the increase of infection with age. Dr. P. D'Arcy Hart (1932) quotes Dr. L. Cobbett as follows: "It is clear that an infected people is much safer than an uninfected people brought into contact with tuberculosis, but what price does it pay for this protection?"

Dr. A. Stanley Griffith (1930) observed: "It is often impossible, as is well known, to establish definitely by necropsy the paths of infection in chronic pulmonary tuberculosis in the adult. . . . In children, on the other hand, in whom tuberculosis runs an acute course, the primary seat and the mode of spread of the tuberculous disease can generally be recognized. The evidence from autopsies on children infected with bovine tubercle bacilli shows that the commonest route of invasion of the lungs by bovine bacilli is the blood stream."

Many other quotations might be given, but enough has been said to indicate the tendency to change in the general views on the problem and the existence of grave doubts as to pulmonary tuberculosis being due in all cases to respiratory infection.

Schemes for the Prevention, Detection, and Treatment of Tuberculosis

In view of the wide prevalence of tuberculosis a Departmental Committee recommended in 1913 that schemes for the above purpose should be promoted by local authorities, and these schemes have been in operation for some twenty-four years, steadily increasing in efficiency. It was hoped that cases would be detected at early stages, when treatment could be particularly useful, and that the segregation of patients while discharging bacilli would reduce the amount of disease, especially pulmonary tuberculosis.

During the time schemes have been in operation there has been a considerable fall in the death rates for all forms of tuberculosis, and in the Report of the Ministry of Health for 1937-8 it is said that the "figures may be considered to reflect the results of the combined attack on tuberculosis by the improvement of environment, including the great post-war housing achievements, by education in better habits of living, and by the direct measures of prevention and treatment outlined above." The figures mentioned show that for every 100 deaths in 1881-5 there were only forty-five in 1901-10 and eighteen in 1936 and 1937 for all forms of tuberculosis. The rates for pulmonary tuberculosis and other varieties of tuberculosis are given separately for 1901-10 and the last two years, and the falls in this period are from 100 to forty-five for the former and 100 to twenty-six for the latter. These statistics do not enable a comparison to be made between pre- and post-scheme periods, but figures supplied by the Registrar-General show that, while between 1881-5 and 1891-5 the fall in the death rate for pulmonary tuberculosis (England and Wales) was 22 per cent., that between 1921-5 and 1931-5 was not much more—namely, 24 per cent. It should be noted that the decrease for other forms of tuberculosis is very much greater than for pulmonary tuberculosis. In the notes in *Tubercle* of November, 1937, on the Annual Conference of the National Association for the Prevention of Tuberculosis, after a reference to the fall in tuberculosis mortality since the middle of last century, it is said: "In the absence of records there is no evidence that the fall has been expedited by any specific preventive measure taken to date."

The conclusions from the statistics would appear to be:

1. The fall in the tuberculosis death rate, which has progressed steadily from the time statistics have been available (except for a few years in the period of the war), has been associated with the great improvement of environment—housing, better habits of life—mentioned in the Report of the Ministry of Health.
2. There is no evidence of any appreciable change in the death rate for pulmonary tuberculosis due to schemes—greater segregation of patients, etc.
3. The fall in the death rate for non-pulmonary tuberculosis has been much greater than that for pulmonary tuberculosis,

and, as is now known, a very great part of this trouble is caused by the form of organism known as the bovine tubercle bacillus. It would not be expected, therefore, that segregation of patients would influence greatly the numbers of these cases.

This aspect of the problem has been included as supporting the conclusions which may be drawn from the previous paragraphs as to the minor influence of persons suffering from pulmonary tuberculosis in the occurrence of all forms of tuberculosis in the community.

Types of Organism

During the present century intensive investigation has been made by various observers into the type of the organism found in lesions regarded as tuberculous. The greatest stimulus in this direction was due to Koch's startling statement at the British Congress on Tuberculosis in London in 1901, when he expressed the belief that tuberculosis in cattle did not infect man. The Royal Commission appointed as a result made an exhaustive survey with Dr. A. Stanley Griffith as one of their expert advisers, and as an outcome of his continued work the picture of to-day is very different from what it was in 1901. Many as have been the changes in the tuberculosis outlook, the most striking of all have been due to the work of the Royal Commission, A. Stanley Griffith, and his colleagues.

From the report of the Royal Commission it was learned that a vast amount of non-pulmonary tuberculosis was in fact attributable to animal sources, and the lesions yielded the form of organism usually associated with cattle, but up to that time there was no suggestion of this type of bacillus being found in pulmonary tuberculosis. Indeed, at the Washington Congress in 1908 (Griffith, 1930) Professor Koch maintained that bovine bacilli "had never been definitely demonstrated in a case of phthisis pulmonalis." Several members of the Congress, however, quoted instances. Dr. Griffith says that "Koch declined to accept this evidence as proving that the bovine bacillus may be the cause of phthisis pulmonalis, and it must be admitted that the evidence was not convincing," for reasons which he gives. The first two cases known in England were discovered by Dr. L. Cobbett and Dr. A. Stanley Griffith in 1907 and 1911 respectively, the last in the year of publication of the Final Report of the Royal Commission. These cases remained unique in England until 1930, when Dr. Griffith found one more. Meanwhile organisms in cases of pulmonary tuberculosis in Scotland were being typed by Dr. W. T. Munro, medical superintendent of Glenlomond Sanatorium, and in 1924 he and his colleagues reported finding the bovine bacillus in the sputum from three (in one mixed with human) out of 100 cases; previously Dr. Griffith had found the bovine bacillus in one Edinburgh case of seventy-three Scottish cases. In an address Griffith (1932a) said that the number of pulmonary cases in which the bovine bacillus had been found was forty-five (eighteen in England and twenty-seven in Scotland); this number was increased to nearly eighty in 1933, and over 120 in 1935 (Griffith and Munro, 1935). As a rarity he mentioned the discovery, in the same case, of both human and bovine bacilli. Cases have been reported also from the Continent—for example, four by B. Lange in 1931, in one mixed with human bacilli.

In organs other than the lungs the bovine form is found much more frequently. The percentages given for England in 1932 by Dr. Griffith (1932b) are: cervical glands, 45.7; lupus, 48.6; meningeal, 30.1; bone and joint, 18.0; genito-urinary, 17.4. In general, the younger the patient the higher is the proportion of the bovine form.

In a joint paper by Dr. Griffith and Dr. Munro (1935) attention was drawn to the fact that up to that time no evidence had been found of transmission of bovine phthisis pulmonalis from one human to another; they now reported two families with two cases of phthisis pulmonalis in adults and one glandular in a child, all with bovine bacilli. After weighing the evidence they concluded: "We think that familial infection is the more probable, since attenuated bovine tubercle bacilli are rare: they have

been found in only three other instances in upwards of 120 cases of pulmonary tuberculosis caused by tubercle bacilli of the bovine type."

In only few cases, apparently, has it proved possible to isolate strains from glandular and pulmonary lesions in the same subject. Dr. W. Melrose Cumming reports in 1933 having been able to do so in four instances of a series of 221 cases, the human type being found in the strains from all lesions: he adds that it was impossible by known laboratory methods to distinguish the glandular from the pulmonary strain. In view of the known high incidence of the bovine type of bacillus in glandular lesions he suggests that the pulmonary tuberculosis in such cases may be due to double infection. It should be mentioned that it is generally agreed that clinically there is nothing to distinguish the cases from which different types of organism have been cultivated.

Another complication is introduced by a suggestion in 1910 of a filterable virus which, inoculated into guinea-pigs, produced lesions from which acid-fast bacilli could be obtained. Dr. W. H. Wynn (1928) notes that these results had recently been confirmed by French workers.

Variation in Characteristics

This great increase in our knowledge has led many to consider whether or not the difference in the characteristics of the bacillus is due to the soil on which it has grown, and whether the human and bovine types are really forms of the same organism. The possibility was evidently in the minds of the members of the Royal Commission of 1901—with much less evidence than we have at the present time—when they said: "We are not prepared to deny that the transmutation of one type into another may occur in nature," and (in the report of 1907): "It is on account of the far-reaching bearings of the conclusion that we are unwilling to make any statement at all premature." Such a change in the characteristics would explain the smaller incidence of the bovine type in glandular, etc., tuberculosis as persons grow up. In some tissues—for example, the skin and meninges—the organism tends to retain the bovine characteristics longer than in others. In 1932 Dr. Griffith (1932a) said that in favour of mutation was the fact that bovine infection disappears as the individual develops, but it was against mutation that passage experiments were uniformly negative—(1) the human type remaining unchanged in calves up to 2½ years, and (2) similarly with the bovine type in chimpanzees. Dr. W. T. Munro (1932) said: "We have come across instances of transitional virulence in the strains isolated from sputum. Tubercle bacilli are remarkably constant in their virulence, and it may take years to effect any change in their characteristics, but these transitional characteristics suggest mutation of type in the human subject." Jensen and Kioer (1938) followed up 100 patients with pulmonary tuberculosis produced by the bovine type, and reported that, while only two were found to show a double infection at the end of one year, of seventeen observed up to four years no fewer than nine were found to have a mixed or double infection.

Evidence of variations in type has been given also by the work of Dr. Elizabeth A. Jackson (1934). Dr. J. W. S. Blacklock, speaking at Oxford in 1936, said: "While mutation of type has not been proved in the case of tubercle bacilli, yet it is stated to occur with other groups of bacilli."

Summary and Conclusion

The variations in our knowledge of tuberculosis during the past half-century have been very great, and have necessitated gradual—and at times sudden—changes in our views of this disease in its different manifestations. With the discovery of the *Bacillus tuberculosis* it might have been thought that all problems were solved, though as a matter of fact the results of investigations as to its nature have complicated the issue.

The idea of predisposition has survived the earlier views on heredity in connexion with tuberculosis, and indeed it is agreed generally that at least as important as infection is the resistance of the individual to the bacillus. The researches made on behalf of the Royal Commission of 1901 led not only to information as to the extent of bovine infection in non-pulmonary tuberculosis but also to evidence that the lesions, whether caused by the human or the bovine type of bacillus, were indistinguishable.

Further, investigations on post-mortem examinations showed that the incidence of infection was much wider than had previously been realized—from 35 per cent. in London to 42.5 per cent. in Christiania, and even 70 per cent. of children between 11 and 14 years in Vienna. The development of tuberculin testing provided information as to infection among living persons, increasing in one group of observations from 10 per cent. of children under 3 years of age to 100 per cent. at 40 to 50 years among a working-class population. Also, records from notifications received in Gloucestershire show that, while in early life infection is so general as to have been described as universal, the proportion of the population developing recognizable pulmonary tuberculosis is only 7 per 1,000 of the population, and other tuberculous trouble about half this proportion.

With the knowledge that tuberculosis was an infective disease and that pulmonary tuberculosis was the commonest cause of known trouble, it was assumed that the ordinary channel of infection was the respiratory passage. This aspect of the question has been the subject of close investigation, and evidence is given above to indicate that some of those who most strongly favour respiratory infection recognize the great difficulties in accepting this view fully. There is a further difficulty in the minds of many—that, with the knowledge that infection of persons is so general, it is not in accord with ordinary experience for a person who has tuberculous trouble to be affected by a new dose of the infection. However, the idea of reinfection is favoured by many, and the peculiar qualities of pulmonary tuberculosis are attributed to allergy in an already infected person. Cumming (1932) expressed the feeling of some persons when he said: "The two theories of exogenous and endogenous superinfection are not irreconcilable. Brought up in the former, converted to the latter, the writer is satisfied that both are necessary to explain all cases."

During the past twenty-five years intensive special measures for prevention and treatment have been in operation over the whole country, largely based on the theory of infection by inhalation, especially from droplets of infected sputum or infected dust, and it was hoped that with increasing segregation of persons with open tuberculosis the incidence of the disease would be reduced. Statistics show, however, that the fall in the death rate is little, if any, greater than it was in pre-scheme days, when it was dropping rapidly with steady improvement in all that makes for healthier conditions of life generally.

In the meantime the research of bacteriologists has greatly extended our knowledge of the organism. It was shown early that what is known as the bovine tubercle bacillus was the type of organism in a very large proportion of non-pulmonary lesions, but only in the last eight years has it been recognized, increasingly, how important a factor it probably is in pulmonary tuberculosis. Further, there is evidence that the characteristics of the organism do change after long periods of residence in the human body. The possibility of such change has not been accepted generally as yet, but bacteriological developments in the last quarter of a century have necessitated great changes in our outlook, and it may be that further investigations may throw yet further light on the matter.

Meanwhile, there would appear to be strong evidence in support of the view that the main source of infection of man is milk contaminated with the bovine tubercle bacillus, by way of the alimentary tract; that infection by the respiratory tract is far less common than is accepted

generally; and that our chief line of defence is the maintenance of resistance by every means conducing to a vigorous state of health.

[NOTE.—I did not see Dr. D. M. Dunlop's address on "Modern Views in the Prevention of Tuberculosis," in the *Journal* of December 24, 1938 (p. 1298), until the day after the proof of this article reached me. It supplements the train of thought I have endeavoured to convey, and may well be read in conjunction with it.]

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The Director-General of Health, New Zealand, in a report covering the year ended March 31, 1938, states that the period under review was memorable for an outbreak of poliomyelitis, ranking, from the point of view of magnitude and severity, with the major epidemics of 1916 and 1925. An account of the incidence of this disease during the last fifty years in New Zealand is given in a special appendix. With regard to the vital statistics as a whole the death rate rose to 9.08 per thousand from 8.75 in the preceding year. In view of the increasing number of people of advanced years now resident in New Zealand this rise was not unexpected, and a further rise is thought probable in the near future. A substantial reduction is recorded in the number of deaths from puerperal causes, excluding septic abortions. The proportion of confinements in maternity hospitals now exceeds 86 per cent., and although accommodation is adequate at present it is felt that saturation point will soon be reached. European births have been increasing by approximately one thousand per annum and every year a larger proportion desire a hospital confinement. The Maori women are also appreciating the advantages of this procedure.

EPIDEMIC NAUSEA AND VOMITING

BY

J. D. GRAY, M.D.

Miller and Raven (1936) recorded the outbreak of an acute infectious disease termed "epidemic nausea and vomiting" in a boarding-school for girls in Thanet. Their description followed that of a similar epidemic which took place in 1935 in Denmark, where the disease was first described as a clinical entity.

Towards the end of 1938 an outbreak occurred in South Hampshire. It is proposed to describe this epidemic, to show that the Thanet outbreak was not an isolated incident, and to suggest the probability of the widespread incidence of the disease. With the entity of the disease established and its symptoms remembered, medical officers of health may be saved the trouble of investigating food supplies, drains, kitchens, and stools in future institutional outbreaks. Lastly, it may be possible to rescue another disease from the conglomerate called "gastric influenza."

In general the picture is as follows: The illness is short, lasting about two days. The patient complains of dizziness, nausea, and vomiting. Less frequently, dizziness and nausea alone may occur. It is usually afebrile. In the South Hampshire epidemic frontal headache and occasionally bradycardia were also noted. In common with the Danish outbreak, diarrhoea was encountered in our epidemic, and a higher incidence of mild pyrexia was seen as compared with that in Thanet. As the epidemic occurred in an institution and the surrounding country at the same time, it will for convenience be given under separate headings.

The Epidemic in School A

This school is situated on Hayling Island and has eighty-two girls, boarders and day pupils. The staff, including servants, amounts to a further twenty. The health of the school before the epidemic had been good: the common cold was not unduly prevalent. The first case appeared on September 27, 1938, and the last on October 25. The spread of the disease is tabulated as follows:

Date	Dizziness, Nausea, and Vomiting		Dizziness and Nausea only	
	Children	Adults	Children	Adults
September 27 ..	1	—	—	—
" 28 ..	1	—	—	—
October 8 ..	1	—	—	—
" 12 ..	18*	—	—	—
" 13 ..	1†	—	—	—
" 15 ..	11	3‡	—	—
" 16 ..	1	—	—	—
" 17 ..	—	—	2	—
" 18 ..	3	—	—	—
" 19 ..	1	—	—	—
" 20 ..	3	—	—	1
" 21 ..	—	—	1	—
" 25 ..	1	—	—	—
Totals ..	42	3	3	1=49

* Included in this total are two day girls. Forty-eight hours after their attack the parents of each girl developed the disease.

† This child vomited during a Brownie class. Forty-eight hours later eleven other girls, two mistresses, and a maid in the room all developed the disease.

‡ One of these three cases developed diarrhoea.