

The Value of Tuberculin Tests*

THE name 'tuberculin' has been applied to any extract, suspension, or other preparation of *B. tuberculosis* or of media on which it has grown. The Therapeutic Substances Regulations 1931 (Statutory Rules and Orders, No. 633) define the term in a more limited sense as preparations of fluid media on which the organism has been grown in artificial culture, which have been freed by filtration from the bacilli. When the filtrate has been concentrated it is known as 'old tuberculin'; its potency is measured by comparison with that of the standard preparation.

Although tuberculin is now scheduled under the Therapeutic Substances Regulations, the hopes originally raised that it would prove of value as a curative and diagnostic agent in tuberculous disease in man have not been completely satisfied. The diagnostic aspect of the problem has recently been investigated by P. D'Arcy Hart, who concludes that tuberculin tests are of definite value in certain circumstances, provided that the correct technique is observed. The Report is based on the examination of 1030 clinically tuberculous patients of all ages and types of infection, and 751 clinically non-tuberculous patients of all ages.

The intracutaneous or Mantoux test is recommended, since it is more sensitive than the cutaneous or von Pirquet test. The initial dose is 0.1 c.c. of a 1 in 10,000 dilution (in 0.5 per cent phenol-saline) injected into the skin of the forearm or upper arm. The result should be read at 48 hr. and 96 hr. A positive reaction consists of an area of erythema or erythematous infiltration the greatest diameter of which equals or exceeds 5 mm., or which is definitely greater than the reaction given by a control injection of the medium from which the tuberculin was prepared. If the test is negative, a retest should be carried out with a 1 in 1000 dilution; if this gives a negative response, a 1 in 100 dilution should be tried. A 1 in 10 dilution may be finally employed in confirmation. A positive reaction indicates hypersensitivity of the tissues to a product, probably protein in nature, of the tubercle bacillus, and is probably only seen after tuberculous infection accompanied by the formation of histological tubercles has taken place. There is a significant interval between primary infection and the appearance of tuberculin skin reactivity. A positive response indicates merely that infection has occurred at some time in the individual's life, and not, on present evidence, that it is still active.

The positive reaction has its chief clinical value in infancy, when tuberculous infection is more likely than at other ages to be associated with, or to progress into, active tuberculous disease. The prognosis is worse the younger the patient and the more unfavourable the home conditions. An infant of less than two years, but without symptoms, should be kept under observation for several years. If obscure and persistent symptoms are present, the possibility of tuberculous infection as cause should be seriously considered. Between two and five years a positive reaction with persistent symptoms should suggest that the latter are tuberculous in origin: at more than five years of age this is much less likely to be the case. Quantitative tests, however, are of very doubtful value for estimating the prognosis in clinical tuberculosis.

A negative tuberculin reaction almost excludes the presence of tuberculous infection: with the 1 in 1000 dilution the average error in the author's series of

cases was less than four per cent. With the 1 in 10 dilution, a negative reaction excludes clinical tuberculosis with an average error of a little more than two per cent (4 per cent in children up to five years of age, and 3.5 per cent in advanced cases of tuberculosis with marked toxæmia). The error is considerably greater with the 1 in 10,000 dilution, being 12 per cent. The usefulness of the test for the negative diagnosis of clinical tuberculosis depends also upon the chance of the patient giving a negative reaction should his condition, suspected of being tuberculous, be in reality due to some other cause. This chance is determined by the percentage of negative reactors among clinically non-tuberculous individuals of the same age and social status, and living in a similar environment. In Great Britain, the test can only be profitably applied for negative diagnosis, in patients of the hospital class in large cities, in childhood: in country and private practice it may also be of value in adults. The incidence of positive reactions in adults of the poorer classes in towns is too high to make a negative response of value.

Children from tuberculous households give a much larger percentage of positive reactions than those whose homes are free from this disease, and the percentage is greater when the tuberculosis is active or open than when it is closed or healed. Again, the incidence of positive reactions among children is greater when they live in contact with a tuberculous relative than when a tuberculous relative visits them only occasionally. The presence in the household of a sufferer from non-pulmonary tuberculosis does not increase the incidence of positive tuberculin reactions among the children. Infants separated from their tuberculous parents before infection has occurred and placed in healthy families appear to be no more liable to acquire infection in early life than the infants of non-tuberculous parents. All these facts suggest that the children of tuberculous families are more likely to acquire the disease than those from the non-tuberculous simply because they are more exposed to infection; in other words, no evidence of a hereditary predisposition to infection has been found by the author. Such a view is, however, not inconsistent with a conception of heredity as a determinant of the subsequent course of infection once this has taken place.

The practical conclusion from these results is that children should be kept out of contact with cases of pulmonary tuberculosis during the early years of their life, or that the chances of infection should be minimised by the careful hygienic control of the patient, such as that developed at the Papworth Settlement by Varrier-Jones. When it is considered advisable to separate the children, tuberculin tests will have an important rôle in determining which are the most suitable for this procedure.

The incidence of positive tuberculin reactions in a healthy community is an index of the risk of exposure which is determined by the frequency of open tuberculosis, the measures taken to combat it, the general hygienic standard of the population, and the infectivity of the milk supply. Unless tuberculosis can be stamped out and the population kept free from it, the development of a positive reaction in an otherwise healthy person is a favourable sign, since it indicates a degree of protection against the development of clinical tuberculosis. Natural tuberculous infection has a greater fatality in infancy than at other ages, so that it is advisable to postpone the first infection, if possible, to middle or later childhood, for example, by removal from contagion at home and by pasteurisation

* Medical Research Council. Special Report Series, No. 164: The Value of Tuberculin Tests in Man; with Special Reference to the Intracutaneous Test. By P. D'Arcy Hart. (London: H.M. Stationery Office, 1932.) 2s. net.

of the milk supply. It is, however, advantageous for the first infection to take place before adult life is reached, because of the partial immunity which may result. The evidence obtained from tuberculin tests in London school children suggests in fact that tuberculisation occurs chiefly in later childhood and adolescence, that is, when the principal activities of the individual are away from home.

It is hoped that further work will result in an

answer to the question as to whether tuberculin sensitisation is decreasing in the population, following the improvement in general hygiene and control of tuberculosis. It is also to be hoped that an altogether satisfactory method of prophylactic immunisation will have been developed before the incidence of infection has fallen so much that the general population finds itself in the precarious unprotected state of a non-tuberculised race.

Winds and Weather on the Coasts of India

MR. S. BASU, of the Marine Section of the India Meteorological Department, Poona, has prepared a useful handbook on the winds and weather off the Indian coasts.* It is based, presumably, largely upon the logs of steamers of the merchant service voyaging in Indian waters, as well as on the work of meteorologists—notably Sir John Eliot—who have made a special study of the cyclones of this region, and is intended to be of service to Indian seamen. Assuming that the standard of accuracy to be expected of a professional meteorologist with extensive sources of trustworthy information has been maintained, this book should fulfil admirably the purpose for which it was written.

The most dangerous weather phenomenon with which the Indian seaman has to concern himself is of course the tropical cyclone. Tropical cyclones do not exhibit quite the infinite diversity of character shown by the cyclonic depressions of the North Atlantic, for they are definite vortices conforming to a fairly definite type. It is possible, therefore, to frame certain general principles that should be followed by a seaman who wishes to avoid exposing the vessel in his charge to the full fury of the inner circle of winds that so often attain to the full force of a hurricane. A special chapter is devoted to this

* India Meteorological Department. Winds, Weather and Currents on the Coasts of India and the Laws of Storms. Pp. iii+51 and 18 plates. (Calcutta : Gov. of India Central Pub. Branch, 1931.) 2.6 Rs.; 4s. 6d.

problem, and contains hints as to how the exchange of weather information by radio between ships, together with the utilisation of the official weather reports issued by radio, can help in the navigational problem that arises when a ship approaches sufficiently near to a cyclone.

Another source of danger is the 'Nor'wester', a thunder-squall of early summer that is believed to have given rise to winds of more than a hundred miles an hour. It is primarily a land phenomenon, but is felt sufficiently far out to sea—70-80 miles out, according to the account of it given in the second chapter of the work—to be a menace in the Bay of Bengal.

In addition to information about the more violent weather phenomena, there is much useful matter relating to ordinary local winds and currents and their seasonal variations, and to tides. The last chapter describes the system of visual storm warnings in force throughout Indian waters.

The handbook is well arranged; the standard of printing is adequate, while the maps are clear in spite of their small size. It is not easy for a reviewer in Great Britain to accept the Director-General of Observatories' request for practical suggestions for increasing the usefulness of future editions—unless of course it is proposed to increase its length, in which case much additional information about local peculiarities in the weather could doubtless be included.

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Electric Discharge in Gas at Low Pressure

DR. I. LANGMUIR presented an interesting review of the electrical properties of the discharge in gas at low pressure, at the recent International Electrical Congress held at Paris. The advances made in this field in the last nine years, which have completely revolutionised our outlook, have come largely from his laboratory and from that of Prof. K. T. Compton.

In his recent paper, Dr. Langmuir confined himself to a statement of the more important mathematical relations which have been developed to give a starting point, somewhat simplified still in comparison with reality, for the investigation of discharges. In these there are two fundamental conceptions, that of a 'sheath' and that of a 'plasma'. Sheaths are found in general on the surfaces of electrodes or on the walls of the tubes, and are essentially regions in which there is a strong separation of charges of one sign. In practice these are usually positive, but by control of the potential of the solid boundary, they may be made of the opposite sign. The potential within them is governed by the well-known Poisson equation for the divergence of the electric intensity, and the currents across them determined chiefly by the rate at which particles from the main discharge diffuse to their boundaries.

The plasma is, on the contrary, a region in which the concentrations of electrons and positive ions are

almost equal and opposite, and usually both large, of the order of 10^8 to 10^{13} per c.c. It has thus a high conductivity, in distinction to the sheaths, and almost invariably in the discharges studied by Dr. Langmuir, has exhibited the peculiarity that the distribution of velocities amongst the electrons in it has been Maxwellian, with a temperature between 5000° and $100,000^\circ$. The determination of these temperatures, and the simultaneous analysis of other features of the plasma, is perhaps the most valuable contribution to a more general theory of discharges from this work, and can be accomplished by taking the current-voltage characteristic curves for an exploring electrode. At the present time, the chief advances are being made as a result of the departures which have been observed from Dr. Langmuir's original theory of exploring electrodes, and it is clear that the conception of an electron temperature will have to be modified in certain cases.

It is interesting to notice that there are two distinct reasons why parts of a discharge tube may be non-luminous, or almost so. One is, that a sheath is present; and the other, that although in a plasma, which is usually brightly luminous, the discharge is being carried by diffusion, often in a reversed electric field, so that the electrons are not acquiring sufficient energy to excite or ionise the molecules of gas.