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THE PUBLIC HEALTH LABORATORY SERVICE*

BY

G. S. WILSON, M.D., F.R.C.P., D.P.H.

Director of the Public Health Laboratory Service (Medical Research Council)

"Immer höher muss ich steigen,
Immer weiter muss ich schau'n."—GOETHE.

In the codicil to his will, prepared in 1877, Dr. Milroy speaks of the importance of determining the part played by contagion in the development and spread of various diseases. "This can only be effected by the patient investigation of numerous *verified* and *authenticated* facts in various localities and regions, and under different circumstances and conditions, apart from all previous speculation and any mere traditional or customary beliefs." Though we have progressed a long way in our knowledge of infection since that time, these words might well be taken as its text by the Public Health Laboratory Service, whose aim it is, by a combination of careful and accurate observations in the laboratory and in the field, to interpret the various manifestations of contagious disease in the community and to discover the causative agents of those diseases that have so far remained obscure.

During the past ten years or so, mainly stimulated by the demands of war, the pathological services of this country have expanded greatly. New laboratories have been established, existing laboratories have been enlarged, and the number of persons engaged in pathological work has increased beyond expectation. Some of this development was the result of deliberate planning to counter emergencies; some of it was of an *ad hoc* and almost fortuitous nature, designed to meet the pressing demands of the moment. The bodies taking part comprised the Ministry of Health, the Medical Research Council, universities, local authorities, and private pathologists, each working towards a separate end and each acting to some extent independently of the other. What, may we ask, has the result been? Have we now got the pathological services that we need to fulfil the extensive obligations imposed by the National Health Service Act? Are our laboratories staffed by properly trained and experienced pathologists? Are the laboratories under Government control working in harmony with those owned by the universities? And is the great body of pathologists actuated by a desire not only to provide efficient help for the clinician and the medical officer of health but to carry research into the various fields where our knowledge is still deficient? These are some of the questions that need answering, and I feel the time has come to review our present position. It is difficult to appraise the situation as it now is without understanding

how it has come about, and I propose therefore to devote the major part of the time allotted to me to a historical retrospect of the gradual intrusion of the laboratory into the practice of preventive medicine.

[The lecturer then dwelt at some length on the studies of John Snow on cholera, William Budd on typhoid fever, and Villemin on tuberculosis, in order to illustrate how, by their pathological insight and epidemiological acumen, these pioneers of the pre-bacteriological era were able to prove as fully as was then possible not only that the diseases they investigated were contagious but that the contagion must consist of minute particles indefinitely reproducible in the body of the host.]

Development of Public Health Bacteriology

The rise of public health laboratory work must be traced to the stimulating influence of Sir John Simon (1890) and of his successors at the Local Government Board—George Buchanan, Thorne Thorne, and William Power. Simon held it necessary that special investigations should be promptly made in all parts of England wherever and whenever the local prevalence of disease afforded ground for apprehending the existence of epidemics or the prevalence of local, occupational, or other insanitary conditions. He also maintained that special laboratory researches should be undertaken by the department for the elucidation of obscure aetiological questions, and for bringing the data so obtained to bear on sanitary administration. Under his aegis a series of careful, minute, painstaking, and accurate field inquiries was made by officers of the Board into such diseases as enteric fever, scarlet fever, smallpox, and food-poisoning, supported by an increasing volume of laboratory work designed to control the quality of water, milk, shell-fish, foods, and air. The administrative side of the organization that was built up and galvanized by Simon has recently been described by Sir Arthur MacNalty (1947, 1948a, 1948b) in his FitzPatrick Lectures to the College. I shall therefore content myself with giving a brief résumé of the gradual development of laboratory examinations in relation to public health and sanitary science.

Water

From the middle of last century onwards the chemical analysis of water came to be practised more widely, but from the hygienic point of view the results were disappointing. Several careful investigations into water-borne outbreaks of enteric fever combined to show that water which satisfied the strictest tests for chemical purity might nevertheless be capable of giving rise to serious disease. Cory

*The first of two Milroy Lectures (abridged) delivered to the Royal College of Physicians of London on Feb. 10 and 12.

(1881-2) relates how he tested the truth of this conclusion by adding known amounts of typhoid excreta to water and sending it for chemical analysis to Dr. A. Dupré of the Westminster Hospital. It was found that the addition of 3.5 gr. (0.23 g.) of a typhoid stool to a gallon (4.5 litres) of water caused a rise of only 0.02 part per million in the albuminoid ammonia. According to the standards then in vogue such a sample fell into Class I, comprising waters of extraordinary organic purity to which no objection could be taken. The position at the time was ably epitomized by Buchanan (1881-2) in the words: "The chemist can, in brief, tell us of impurity and hazard, but not of purity and safety."

From about 1882 onwards attempts were made by exponents of the rapidly developing science of bacteriology to improve on the methods of the chemists. Robert Koch in Germany, Percy Frankland at Dundee and later at Birmingham, and Emanuel Klein at the Brown Institute and St. Bartholomew's Hospital, among others, used the plate method for the quantitative estimation of bacteria in water. Gelatin was employed, and attention was paid to the total number of colonies developing and the proportion liquefying the medium. Little immediate progress, however, was made, but it began to be recognized that the potential harmfulness of polluted water was due to the micro-organisms it contained, and that the results of chemical analysis had their highest value in the light they threw on the quality of the water from the standpoint of bacterial contamination (Brown, 1890).

It soon became apparent that the attempt to gauge the degree of impurity of a water by the isolation from it of pathogenic organisms like the typhoid bacillus was technically too difficult and what we might call strategically unsound. Instead a search was made for the common intestinal organisms, which would act as indicators of excretal contamination. Again little progress resulted. It was left to Alexander Houston to show that it was not enough to demonstrate the presence of intestinal organisms in a water, it was necessary in addition to measure their numbers and so gain some idea of the degree of pollution of which they afforded an index.

Working with Klein (Klein and Houston, 1897-8), Houston found that crude sewage usually contained about 100,000 coliform bacilli per millilitre and about 10 to 1,000 spores of *Bacillus enteritidis sporogenes*. Together, Klein and Houston (1898-9) performed a very illuminating experiment. They obtained sewage from eight different sources, diluted it progressively with sterile water, and carried out chemical and bacteriological analyses on the mixtures. The results revealed that the bacteriological method was 10 to 100 times more delicate than the chemical, and led the authors to conclude that "chemistry, as usually applied, is powerless to detect a degree of pollution of water with sewage which, from the viewpoint of the bacteriologist, would be considered gross in amount."

This conclusion was soon substantiated in practice. For some years there had been a series of dropping cases of enteric fever at Chichester. The town was supplied from several wells. The water from all of them was apparently pure as judged by chemical methods, but when Houston (1901-2) examined them bacteriologically he found that most of them were contaminated with organisms of excretal origin.

During the succeeding years Houston expended his whole energy on developing and improving bacteriological methods for the examination of water. He studied different index organisms; he elaborated methods for their recognition and differentiation; he followed the rate at which

they died out in sewage under natural and artificial conditions; and he defined the particular type of information that each of them could give. From his appointment in 1905 to the newly created post of Director of Water Examinations to the Metropolitan Water Board till his death in 1933 he occupied a position of authority that none could challenge. It is as true now as it was fifty years ago, when he made his first great contribution, that bacteriology alone of the laboratory sciences is able to provide that assurance of safety which is demanded of the water supplies of our great cities. Subsequent work, though it has refined the means for distinguishing between different members of the coliform group, has done nothing to impair the essential soundness of Houston's conclusions, and his methods are in daily use throughout the public health laboratories of this country.

It may be noted that systematic bacteriological examination of the water supply was begun by the Metropolitan Water Board in 1885, by Professor Rubert Boyce at Liverpool in 1898, by Manchester and Birmingham Universities and by the West Riding Laboratory about 1900, and by the University of Leeds about 1904.

Shell-fish

By 1895 it had become clear that shell-fish might serve as a vehicle for infection with typhoid fever. At the request of Dr. Thorne Thorne, who was then Chief Medical Officer of the Local Government Board, Dr. Bulstrode (1894-5) surveyed the conditions under which oysters and certain other edible molluscs were cultivated and stored along the coast of England and Wales, and in a later report (Bulstrode, 1909-10) he summarized the evidence incriminating shell-fish as carriers of enteric fever.

Though Klein (1894-5) was unable at first to distinguish between polluted and non-polluted oysters, he was helped by the work of Houston, and subsequently (Klein, 1899-1900) succeeded in demonstrating excretal pollution of cockles bought from a street hawker. He showed (Klein, 1900-1) that cockles and mussels readily took up pathogenic organisms like the typhoid bacillus and the cholera vibrio from sea-water and remained infected sometimes for days. It followed from this, and from the observations of later workers, that to ensure safety shell-fish ought to be laid down in non-polluted water for a few days before being marketed, so as to undergo a process of natural self-purification. For this purpose artificial tanks containing chlorinated water have come to be used for oysters and mussels (see Dodgson, 1936), and the purity of the shell-fish is gauged by the coliform count or, still better, by the faecal coli count using the 44° C. MacConkey broth-fermentation test (Dodgson, 1938).

Sewage

Some of the early bacteriologists studied the flora predominating in different stages of decomposition and prepared the way for the so-called biological method of the purification of sewage. The story is told in Sims Woodhead's fourth Harben Lecture of 1897 and is continued in the reports of the Royal Commission on Sewage Disposal appointed in 1898.

Of late years the public health bacteriologist has been interested in the demonstration of pathogenic micro-organisms in sewage. Since the introduction in 1927 of Wilson and Blair's medium, and the subsequent development of further valuable liquid enrichment and solid selective media, it has become practicable to isolate pathogenic intestinal bacteria from highly contaminated materials like sewage. As a result typhoid and paratyphoid

bacilli have often been demonstrated in town sewage even in the absence of any known cases of enteric fever. This discovery is becoming of considerable epidemiological interest. It seems probable that the organisms are derived from subclinical cases or from carriers, and the problem now is to determine their precise origin. Already a start has been made, at Cardiff, by King (1944), who was able by examining sewage effluents from a factory to detect the presence of paratyphoid bacilli of a particular phage type, and then by examining the faeces of the individual employees to discover a symptomless carrier infected with the same type. The exploitation of this method for revealing unsuspected foci of enteric infection will be watched with considerable interest.

Milk

According to Newsholme (1936) Dr. Michael Taylor, of Penrith, first drew attention in 1858 to contaminated milk as a cause of fever, and in 1870 published the first recorded account of an outbreak of scarlet fever due to milk. In Norway, Homan and Harting, who practised in the town of Kragerö, described in 1859 an outbreak of dysentery spread by milk, and brought strong epidemiological evidence to show that the infecting agent was a living organism which had gained access to the milk by excretal contamination (Kobro, 1923).

The annual reports of the Local Government Board during the latter half of the nineteenth century contain records of numerous milk-borne outbreaks of scarlet fever, diphtheria, enteric fever, and diarrhoea, of which some of the most interesting refer to scarlet fever. In 1882 Power (1882-3) investigated the occurrence of multiple cases of this disease occurring simultaneously in several districts of central London, and ascribed the infection to milk coming from a particular farm in Surrey. He postulated that one of the cows in the herd must have been infected with the scarlet fever organism. He reached the same conclusion again three years later (Power, 1885-6a), when he traced another outbreak affecting several of the North London boroughs to milk from a farm at Hendon. Just before the outbreak three newly calved cows suffering from udder disease had been admitted to the herd from Derbyshire, and it is highly probable that one at least of these animals was suffering from streptococcal mastitis. Unfortunately another disease causing fever, constitutional disturbance, and a localized vesicular eruption spread through the herd soon after the arrival of these animals, and both Power and Klein concluded that this generalized disease—known as the Hendon cow disease—was due to the same streptococcal organism as was responsible for the scarlet fever cases in man.

Though Power and Klein have been severely criticized for confusing these two diseases, it is only fair to point out that they deserve a great deal more credit than they received. Power was almost certainly right in attributing milk-borne scarlet fever to the diseased udder of a cow, though it was not till fifty years later that he was vindicated by the observations of Bendixen and Minett (1938) on the occurrence of bovine mastitis caused by infection with the human type of haemolytic streptococcus—*Streptococcus pyogenes*. Klein (1886-7) was also right in concluding that scarlet fever was due to a streptococcus, which he called *Micrococcus scarlatinae*. He isolated this organism from the finger blood of four cases of scarlet fever during life and from the heart blood of one case after death. Klein's conclusions were confirmed shortly afterwards by Gordon (1898-9; 1900-1); but it was not till the extensive work of Dochez, Avery, Lancefield, and the Dicks in the United States and of Fred Griffith in this country during the second and third decades of the present

century that the aetiological role of streptococci in scarlet fever was finally established.

[The lecturer then described the gradual incrimination of milk as a carrier of tuberculosis, undulant fever, and epidemic respiratory and intestinal disease, and deplored the effect of Koch's pronouncement in 1901 at the London Congress on Tuberculosis that the bovine type of tubercle bacillus was relatively harmless to man. This led to discontinuance of the current practice of boiling milk, and put back the clock of pasteurization for many years. He ended with the following words.]

It is a sombre thought that our people are still suffering from the effects of an ill-considered authoritative pronouncement made nearly fifty years ago by a German bacteriologist to whom we, and the whole world, owe so much for the other services he rendered to medical science. We may perhaps recall the words of the book of Job: "Great men are not *always* wise: neither do the aged understand judgment."

On the laboratory side bacteriological methods of testing milk were not introduced till after Bang's discovery of tubercle bacilli in milk in 1884. Delépine at Manchester started examining milk for these organisms in 1892, and Sims Woodhead, Kanthack, and Klein were early in the field. Between 1896 and 1908 Delépine (1908-9) examined no fewer than 7,000 samples of milk for the Manchester Corporation; he found that of 5,320 samples of milk as delivered to the consumer 8.9% contained living tubercle bacilli.

In 1901 Park in New York drew attention to the "great bacterial contamination of the milk of cities," and Pakes (1900) reported that London milk contained over 3 million bacteria per millilitre. Savage, Delépine, and Thomas Orr, among others, laboured to devise some way of measuring the degree of bacterial pollution, but without much success. The value of the plate count was recognized as being limited, and no such clear answer was obtainable from the coliform test in milk as Houston had derived from its use in water examination. It was not till the concept of purity in milk was differentiated into its two components of cleanliness and safety that the failure of laboratory methods to protect the consumer became evident. It is now realized that by routine methods the bacteriologist cannot say, as he can with water, whether a given sample of milk is safe to drink. All he can do is to say whether the milk is of a reasonable standard of bacterial cleanliness and whether its keeping quality is likely to be satisfactory to the housewife. For this purpose much simpler methods, based on the reduction of certain aniline dyes and designed to estimate the total metabolic activity of bacteria in the milk, are sufficient.

Heat-treated milk forms an exception. The introduction of the phosphatase test by Kay and Graham in 1935 provided a means of assessing the degree of heat treatment a milk had received, improved the control of pasteurizing plants, and went a long way to ensure that only milk which has been adequately heat-treated and freed from the risk of causing human disease shall be offered to the public under the designation "pasteurized."

Food

Knowledge of the animal parasites that are conveyed by food was well advanced before bacterial food-poisoning had even been recognized. Thudichum in 1864 gave a detailed description of the helminths of animals, of the diseases they cause, and of the illnesses that may result in man if he becomes infected with them. Power (1879-80) recorded what was probably the first account of trichiniasis in England, occurring on board the reformatory school ship *Cornwall*. The diagnosis was made retrospectively by

microscopical examination of the muscles of one of the victims exhumed two months after death.

[The lecturer then recounted the steps that had led to the displacement of Brieger's ptomaine theory of food-poisoning by the belief that it was a specific infection with organisms of the *Salmonella* group; and told of the later definition by Dack and his colleagues (1930) of the staphylococcal toxin type of food-poisoning. He went on as follows.]

The great increase in food-poisoning during the second world war led to renewed interest in the aetiology of this disease; and, though much of the increase was traced to the presence of salmonellae in imported spray-dried egg, and to staphylococcal intoxication attributable to the low hygienic standards of communal feeding centres, the causation of many outbreaks remained obscure. Suspicion is now being cast on other organisms, and a great deal of research will be necessary before the full story is unfolded.

The diagnosis of food-poisoning can usually be made on clinical grounds alone, but laboratory investigation is necessary to define the particular bacterial agent concerned. Indeed, it is mainly as the result of systematic examinations of material from food-poisoning outbreaks that our present knowledge of some of the factors causing this disease has been gained. The value of field investigations has been greatly increased of recent years by the development of methods for the serological typing of salmonellae and the bacteriophage typing of staphylococci which can often throw light on the probable article of food responsible and the way in which it became contaminated.

Air

The observations of the mid-Victorian epidemiologists on the effect of overcrowding in favouring the spread of such diseases as typhus, cholera, and tuberculosis prepared the way for bacteriological investigations of the air as soon as it became evident from the work of Pasteur, Lister, Koch, Loeffler, and others that infectious diseases were almost certainly due to the action of living micro-organisms.

Systematic research on the bacterial content of the air was begun in Germany by Hesse, who published his records in 1884. Two years later Percy Frankland (1886), in this country, making use of Hesse's gelatin-coated tubes for the detection of organisms suspended in the atmosphere, and of gelatin plates for the detection of organisms attached to heavier particles undergoing sedimentation, found that bacterial contamination of the air was higher in the town than in the country, higher at street level than at the top of St. Paul's or of Norwich Cathedral, higher indoors if people were moving about than if they were still, and very high indeed in a crowded railway compartment.

Considerable work was carried out during the 'nineties, and at the beginning of the present century Gordon (1902-3) and Graham-Smith (1903) both made quantitative studies on the air of the House of Commons. Influenced by Houston's work on the value of coliform bacilli as indicative of excretal pollution of water, Gordon selected salivary streptococci as his index organisms, and by this means was able to show that during loud speaking in a closed room air-borne organisms derived from the mouth could be detected 40 ft. (12.3 m.) in front and 12 ft. (3.7 m.) behind the orator. Indeed, he found by examination of the air in the chamber that different speakers on the Treasury bench emitted their own characteristic salivary flora. The Chancellor of the Exchequer harboured a *longissimus* strain, the Prime Minister a *brevis*, and the President of the Board of Trade a haemolytic streptococcus (Gordon, personal communication).

The gradually increasing recognition of the importance of the carrier in the spread of infectious disease led to a

diminution of interest in the part played by air, and it was not till the study of Wells (1934) in the United States on the characters of air-borne droplets, and the observations in this country on cross-infection by Allison and Brown (1937) in fever hospitals, and by Leonard Colebrook and others in surgical wards, that it was revived. The old controversy between the supporters of Cornet and Flügge on the relative importance of dust and droplets was taken up again, and even the long-discredited work of Power (1880-1; 1884-5; 1885-6b) on the aerial dissemination of infection around smallpox hospitals began to be reconsidered.

To-day air-borne infection stands in the forefront of epidemiological and laboratory studies in public health work, and numerous teams are investigating the different modes of aerial spread and the measures that can be taken to control them.

Disinfection

The study of disinfection played a large part in the early laboratory work on public health. Even before the bacteriological era, Budd in 1856 had advocated the use of chemical agents for the destruction of the infecting agent in typhoid stools. Parkes in 1873 defined a disinfectant as a substance that destroys the specific poison of an infectious disease. Lister's paper in 1867 on the successful treatment of compound fractures by the use of phenol opened up a wide field of investigation, and careful observations were made by Baxter (1875), among others, to determine the range of usefulness of the common disinfectants such as chlorine, potassium permanganate, sulphur dioxide, and phenol. He came to the conclusion that dry heat was probably the most effective of all bactericidal agencies, and emphasized the difficulties of aerial disinfection.

Robert Koch in his classical paper of 1881 with Gaffky and Loeffler drew attention to the particular virtue of saturated steam under pressure, and introduced the first quantitative method for estimating the comparative value of chemical disinfectants. Intensive quantitative work was carried out during the following thirty years by Geppert in Germany, Arrhenius and Madsen in Denmark, and by Chick and Martin, and Rideal and Walker, in this country. No satisfactory method of standardizing chemical disinfectants has yet been devised, and inquiry still proceeds.

The last ten years have witnessed the introduction into medicine of the sulphonamides and of the antibiotics like penicillin and streptomycin, and the attention of bacteriologists is now focused largely on the action of these drugs in the tissues. The older use of disinfectants for the destruction of micro-organisms outside the body is, however, not altogether forgotten; and renewed interest is being taken in the disinfection of the air by ultra-violet light and by various sprays distributed in the form of aerosols or vapours.

Laboratory Investigation of the Infectious Diseases

Time does not permit me to review, even briefly, the epidemiological studies undertaken on the major infectious diseases during the past century, and I must confine myself to a short account of the laboratory investigations made in respect of their prevention and control. Even here I must restrict myself to one or two examples, beginning with diphtheria.

Diphtheria

After the successful isolation in pure culture of the diphtheria bacillus by Loeffler in 1884 there followed an interval of about ten years before the examination of throat swabs for this organism was introduced into routine practice in Great Britain. In 1894 Sims Woodhead, who was director of the laboratories on the Victoria Embankment

belonging to the Conjoint Board of the Royal Colleges, organized a service for the systematic examination of material from diphtheria patients admitted to hospitals of the Metropolitan Asylums Board. In 1895 specimens were examined from 3,648 cases, in 1896 from 4,870 cases; and in 1897 Sims Woodhead was able to take the bacteriological diagnosis of diphtheria as his subject for the first of a series of four Harben Lectures delivered to the Royal Institute of Public Health. Using primary cultivation on Loeffler's medium, followed, when necessary for confirmatory purposes, by growth in broth, he claimed to have found diphtheria bacilli in 95% of clinical cases. What was perhaps more interesting for the epidemiologist was his discovery of these organisms in a number of mild cases of sore throat, not diagnosed clinically as diphtheria, in fully recovered patients during convalescence, and even in healthy contacts. He insisted on keeping convalescents in hospital till they were bacteriologically free from infection, and on isolating child contacts if they were found to be carrying diphtheria bacilli, partly because they might spread the disease and partly because half of these children developed diphtheria themselves in the course of a few days.

Sims Woodhead's work affords an excellent example of the early application of public health bacteriological findings to administrative practice. The routine laboratory diagnosis of diphtheria was begun by Delépine at Manchester in 1894, and by Robertson at St. Helens in 1895. While investigating an outbreak of diphtheria at Cambridge, Cobbett (1901) drew attention to the danger of the nasal carrier.

The discovery by von Behring and Kitasato in 1890 of diphtheria antitoxin, and the introduction by Ehrlich of a method for its exact quantitative estimation, stimulated a demand in this country for preparation of the serum on a large scale. Armand Ruffer in 1894 was the first to make antitoxic serum in this country. The following year Sims Woodhead, with the help of Cartwright Wood, undertook its manufacture for use in the hospitals of the Metropolitan Asylums Board. In 1897 George Dean was appointed to the post of superintendent of the antitoxin department of the British Institute of Preventive Medicine (now the Lister Institute), situated at Sudbury (moved in 1902 to Elstree), and started on a series of investigations that contributed substantially to the present method of producing diphtheria toxin and of immunizing horses against it. In the large outbreak of diphtheria at Cambridge already referred to, Cobbett used antitoxic serum for passive protection of contacts, combined with the isolation of cases and carriers, and succeeded by this means in bringing the infection rapidly under control.

Further progress in the struggle against diphtheria was made when James Ritchie at Oxford described in 1901 a method of modifying toxins by weak acids and alkalis in such a way as to deprive them of their toxicity without destroying their antigenic power. Many years elapsed, however, before this line of investigation was developed, and it was not till the early 'twenties that Glenny and his colleagues in this country and Ramon in France introduced the formal method of detoxication that forms the basis of preparation of our modern diphtheria prophylactics.

The last great weapon in the public health armamentarium against diphtheria is the test introduced by Schick and his colleagues in Vienna in 1913 for ascertaining the susceptibility or immunity of subjects to infection. Though this test has been exploited beyond its capabilities, it provides, when carried out on groups of inoculated children, a simple and reasonably accurate index of the antigenic

potency of diphtheria prophylactic agents and, when carried out on individual adults, a guide to those who need protection and those who do not.

Typhoid Fever

The discovery of the typhoid bacillus by Eberth in 1880, and its isolation in pure culture by Gaffky in 1884, opened the way for the bacteriological diagnosis of enteric fever. The difficulties, however, of culturing this organism from the faeces at a time before enrichment and selective media had been devised were very great, and the application to human serum by Widal and by Grünbaum in 1896 of the agglutination reaction recently discovered by Gruber and Durham afforded a simpler method for distinguishing enteric fever from the numerous other pyrexial diseases with which it could be so readily confused. In this country Dr. D. S. Davies, medical officer of health for Bristol, is credited by Newsholme (1935) as being the first to apply the Widal-Grünbaum test to the investigation of an outbreak of enteric fever and to show its importance in discovering overlooked cases of the disease. Delépine introduced the test into routine practice at Manchester almost immediately after its description, and by 1902 he was able to report that he had used it in 8,000 cases of suspected typhoid fever. Employing a modification of his own, he was satisfied that the error of the test when carried out on sera taken after the first week of illness was not more than 2%.

The interpretation of the results of this test became complicated by the introduction during the South African War of anti-typhoid inoculation, and by the discovery around 1900 of the paratyphoid group of bacilli, in 1903 by Smith and Reagh of flagellar and somatic antigens, in 1920 by Arkwright of the smooth-rough variation, and in 1934 by Felix and Pitt of the Vi antigen. Though the Widal-Grünbaum test is still used in practice, it has been mainly superseded for the diagnosis of enteric fever in inoculated persons by the more reliable cultural methods now available, and its main value probably lies in the detection of the chronic carrier state by means of the modified Vi-agglutination technique.

[The lecturer then summarized the early history of the bacteriological examinations carried out for public health purposes on anthrax, cholera, plague, typhus fever, smallpox, rabies, cerebrospinal fever, and Siberian cattle plague. In respect of the last disease, better known as rinderpest, he drew attention to the discovery by Burdon-Sanderson (1866; see also Lady Burdon-Sanderson, 1911) that the infectious agent in the blood of diseased animals was incapable of passing through an animal membrane, thus providing the first clear-cut laboratory evidence of the existence of filtrable viruses.]

[The second lecture, with a list of references, will appear in our next issue.]

Nearly 1,000 volumes of medical books and periodicals have been distributed through Unesco during the past two months to libraries in eight war-devastated countries. The literature was given by the Army Medical Library of Washington and the Vanderbilt University School of Medicine Library, Nashville, Tennessee. The Army Medical Library in Washington, D.C., acting upon the recommendations of Unesco, distributed to five libraries in Hungary, Poland, and Yugoslavia a total of 635 volumes of scientific periodicals and books in the field of medicine. Following an agreement between Unesco and the American Medical Library Association by which duplicate books and periodicals of American medical libraries will be made available to medical libraries in other countries, a list of duplicates has been received from the Vanderbilt University School of Medicine Library in Nashville. So far 155 volumes have been allocated to ten libraries in Austria, Belgium, China, France, Greece, Hungary, and Poland. A list of the remaining titles for which no specific allocations have been received is being circulated to more than 50 libraries in war-devastated areas.