CONTROL OF THE COMMON FEVERS

BY TWENTY-ONE CONTRIBUTORS

Arranged with the help of

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Dedicated to
the alliance between health office and laboratory,
with the M.O.H. and the bacteriologist as equal partners
in the campaign against infection

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In the following pages we present the players in a great world drama of Man *versus* Microbe. The caste includes some who are taking a leading part in the struggle. When they cry " delenda est Carthago " they have themselves just returned from a crack at Hannibal's elephants, for it is not only in the distant past that epidemic disease has turned the course of history. Jewry was saved on the Palestinian plain when 185,000 Assyrians waked in the morning to find themselves all dead corpses. The tsetse-fly complete with flagellates killed off the big game in Equatorial Africa and nearly vanquished the hunter. An intracellular parasite held up for a generation the water-way between Atlantic and Pacific and played havoc on the Burma Road. A then unidentified filter-passer halted and nearly stayed the first world war, and soon after the armistice another, with its patron the louse, depopulated whole provinces of Eastern Europe. Nearer home the haemolytic streptococcus has ravaged lying-in wards and children's hospitals, while the corynebacterium has made life precarious in slum and shelter. It may be that the common fevers of one generation will become the curiosities of the next, although no-one has yet been sanguine enough to picture life without our present recurrent miseries, influenza, measles and the common cold. Had medicine given them the thought that has been lavished on smallpox or typhoid, they would surely not have had it all their own way. We may yet see the time when their memory is laboriously kept alive by passage in ferrets, and the louse is known only from the show-cases at South Kensington. Meanwhile we offer this book as a working manual.—Ed. L.

AUTHORS AND SUBJECTS

The chapters by contributors who are in the London County Council service express the personal views of the authors, and no official significance must be attached to them.

GENERAL PRINCIPLES

(Dr. Robert Cruickshank)

Control of the common fevers is a matter which concerns every doctor and indeed every responsible citizen. The public health officer, the general practitioner, the parent, the fever expert, the bacteriologist, and a host of other specialists all have a part to play in the effective control of infectious diseases; for control includes not only a concerted assault on the infection, to lessen the *morbidity* or attack-rate of a particular disease, but it also implies the care and cure of the infected person, with a consequent reduction in the *mortality* or death-rate. In a broad sense, as Gordon (p. 85) has put it, prevention includes all measures which decrease damage—whether physical, economic, social, or psychological—to the human host as the result of disease; and with no marker to indicate where actual preventive medicine leaves off and good clinical medicine begins. Thus, in the chapters that follow, special stress will be laid on the methods of preventing infection where these methods have been proved to be the most practicable, and on the treatment of those diseases against which prevention has so far proved ineffective. Examples of diseases in the first category are diphtheria and smallpox, infections which (given the goodwill of all concerned) *can* be controlled by appropriate prophylactic vaccination; or the intestinal infections (typhoid, dysentery, bacterial food-poisonings) which have already been brought to heel by sanitary measures, but which could be abolished by strict attention to personal hygiene. In the second category of diseases which we have not yet learned to prevent—and they include most of the air-borne infections—the physician, be he family doctor or specialist, and the hygienist must concentrate at present on securing the best care of the patient and of the community at risk. For the affected patient, it means early diagnosis often with the help of a well-equipped laboratory, and it may mean removal to a hospital for effective treatment. The community at risk may be best served by isolation of the infectious case and by other measures to prevent spread of infection among contacts. Diseases in this category are the pneumonias, cerebrospinal fever, poliomyelitis, and most streptococcal infections. Happily, the addition of the sulphonamide drugs to our therapeutic armoury has greatly reduced the toll which some of these infections have exacted in the past; but still better results for both patient and community await the full exploitation of methods and machinery for early diagnosis, of the search for sources and channels of spread, and of facilities for effective treatment.

War-time Problems

Wars are notoriously associated with epidemics, for they bring together many of the ingredients necessary for epidemic infection—poor sanitation, overcrowding, and abnormal social conditions among the troops, poverty and famine among the general population. Thus, not only diseases of filth and famine, like typhus and trench fever, typhoid, dysentery, and tuberculosis, but also infections which are ordinarily regarded as the trivial illnesses of childhood—measles, mumps, and rubella—become major war-time problems (Councell 1941). But if wars bring epidemics, they are also often the harbingers of social reform, and in the field of public health there are signs that this war, by forcing all concerned to appreciate the urgent need for utilising all available methods for the control of infectious disease, may be no exception. Two movements, directly attributable to the war, have in particular focused attention on the problems of controlling infection: (1) the evacuation of children from large towns to rural and small urban communities and (2) the congregation of a fair proportion of our population in public shelters.

EVACUATION

The dispersal of town children to country districts seemed likely to carry with it the risk of spreading infection, both respiratory and intestinal, among communities with a high proportion of susceptible (or unsalted) individuals and often with rather primitive sanitary arrangements. It seemed to simulate the conditions made familiar to us by the experiments of Greenwood, Topley, and their colleagues in which the addition of a number of infected mice to a larger colony of uninfected mice was unfailingly followed by epidemic infection among the susceptible animals. But, to everybody's surprise, the statisticians (Stocks 1940, Glover 1940) have shown that the morbidity and mortality from most of the common infectious diseases were in the first year of the war lower than the average. For example, notifications of scarlet fever and diphtheria (charts 1 and 2) for the winter 1939–40 were, compared with the previous winter, reduced by about half in the "evacuation" towns, and by a fifth to a quarter in the "reception" areas. Be it noted, however, that in the case of diphtheria there was no corresponding decrease in the death-rate so that, as Stocks remarks, "one out of every 4000 children under 15 continues to die annually in the towns of a disease which could be prevented." By the following winter (1940–41), notifications of diphtheria had reached the level of the

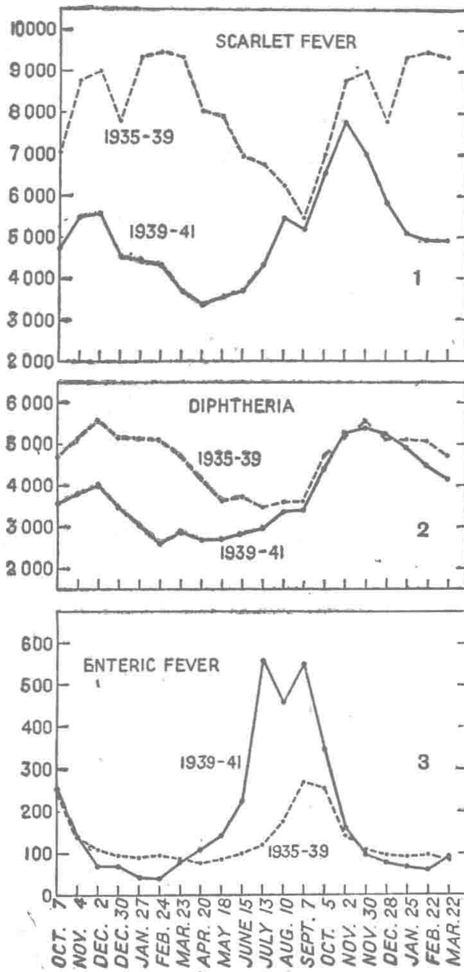

FIG. 1.—The notifications of scarlet fever, diphtheria, and enteric fever in 4-weekly periods, between the outbreak of war in September 1939 and March 22, 1941, compared with the median values during the same periods in the 5 years 1935–39.

previous five years. In the case of measles, the usual biennial epidemic due in the winter 1939–40 was completely inhibited in large evacuation cities—e.g. London, Manchester, and Liverpool—although the epidemic wave in the country generally was much less affected. The subsequent course of measles in the large cities is shown in the graph on p. 155. The incidence of whooping-cough showed little change from normal in the reception areas but was greatly reduced in the evacuation towns. The mortality in England and Wales from "infantile diarrhœa" was less by a quarter, and from enteric fever by a third in the last three months of 1939 compared with the corresponding period in 1938. The explanation of these very favourable records when disastrous results were often anticipated is probably not a simple one. Undoubtedly favourable influences were the glorious autumn weather, dispersal of children in billets instead of congregation in camps, the two-shift schooling with evacuees and natives in separate shifts, and the early return home of a large proportion of the evacuated children. These factors acted together to prevent overcrowding, excessive strain on existing sanitation, and too rapid and intimate mixing of salted and unsalted populations. In the evacuation towns dispersal to the country contributed to the remarkably low incidence of infectious disease, but absence from school was probably even more important, for Glover has called attention to the fact that diphtheria is an infection spread from schools, and Chapin came to the same conclusion about measles. These experiences, digested and assimilated by the public health authorities, may prove invaluable by stimulating new thoughts and new methods for the control of the common fevers.

The success, from the health viewpoint, which attended large-scale evacuation must not blind us to problems that arise almost as a consequence of that success. The conditions are closely analogous to those (now familiarly known as "Topley's mice") which the experimental epidemiologist has found to result in disaster, and continued vigilance is necessary. Indeed, localised outbreaks of diphtheria and scarlet fever have already occurred in some of the mixed communities, and outbreaks of paratyphoid have been unduly common (chart 3). Expert medical knowledge plus coördinated epidemiological team-work are essential for the handling of such outbreaks. For example, if an outbreak of diphtheria occurs in a school, questions arise as to whether all school or home contacts should be swabbed, and if so, are laboratory facilities readily available? Should the school-children be Schick-tested, and, if so, should positive reactors be actively or passively immunised, or both? Parental consent for immunisation is generally regarded as necessary and there may be dangerous or even fatal delay. Which under these conditions is the best immunising agent, and is it wise to immunise school-children without at the same time immunising younger and older members of the household? These are questions which the public health administrator has to solve, often in consultation with various colleagues, and the best answers may be quite different in different conditions. They will be different again in outbreaks of scarlet fever or typhoid or dysentery.

Another important point to remember is that dispersal of town children to rural districts may lead to a loss of the immunity acquired in cities from intimate contact with infection. Thus, just as the city dweller often develops a cold when he returns to town after a summer holiday, so children returning home in the post-war era may constitute a population highly susceptible to the infections of childhood. What measures can be taken *now* to prevent such an occurrence and how are simultaneous large-scale epidemics of different infections to be handled if and when they occur?

SHELTER LIFE

The other war-time phenomenon which has caused a quickening of interest in the control of infection is the communal life in public shelters. The actual size of population which uses public shelters probably has not been—or cannot be—accurately estimated, but in the London tube stations alone the number of shelterers fell from a peak figure of 175,000 in September 1940 to a fairly steady average of 60,000 during the early months of 1941. With that as an index applicable to other vulnerable towns, and with the memory of the appalling conditions that existed in many underground shelters, the concern of the medical profession about the health of the shelterers and the risk of epidemics arising among them was understandable. In the autumn of 1940 gross overcrowding and lack of sanitation seemed to invite typhoid and dysentery ; as winter approached, cold, damp, unventilated and still overcrowded shelters provided an ideal setting for respiratory infections. Yet nothing dreadful happened. The sickness rate among shelterers remained low, and the threatened epidemics failed to materialise. Even the predicted epidemic of influenza hung fire and only cerebrospinal fever, carried over from the previous year, was unusually prevalent. Again, the explanation of this unexpected state of affairs is hard to find. A population already well salted and living, many of them, in conditions little worse, if any perhaps, than they were accustomed to in their own slum dwellings, the small proportion of children, the gradual improvement of conditions in the shelters, particularly the instalment of bunks which took the shelterers off the damp ground and ensured spacing, sleep, and a fixed clientele, all helped to ward off infection. But, as Horder (1941) has remarked, " The causes of a rise and fall in the virulence of a bacterium or a virus so far escape us. You cannot start an epidemic by bad conditions ; but if an epidemic does start, then bad conditions affect both the number of cases of the disease that occur and the severity of them." Yet good may come out of evil, for the shelter populations offer an almost unrivalled opportunity for health propaganda. The shelter doctor and welfare nurse find these people ready to listen and willing to be convinced about diphtheria immunisation, personal cleanliness, and the simple rules for preventing the spread of infection.

Air-borne Infections

One immediate reaction of public health authorities to the many and various risks involved in the shelter life was an intensive search for ways and means of preventing the spread of infection, particularly " respiratory infections," including in that term diseases whose materies morbi infects by inhalation. For example, the danger of contracting diphtheria in the shelter was emphasised, and formed a cogent weapon in the campaign that was being launched for immunisation against it on a nation-wide scale. Unfortunately, other respiratory diseases can not be so easily dealt with, and other methods of attack have to be formulated. Where the induction of resistance or immunity in the host by vaccination is impracticable, an attack upon the reservoirs of the parasite, or its channels of spread becomes necessary. Attempts to control respiratory infections—e.g. scarlet fever and measles—by notification and isolation of clinical cases has not resulted in any reduction in the incidence of these diseases. How can it, when the period of greatest infectivity is probably in the prodromal stage, and when all contact and convalescent carriers and those with atypical infections are also infectious and at material times almost impossible to detect and isolate ? Thus, the reservoir remains and can only be attacked by a more thorough search for and control over the " carrier," and indirectly by improving the health and environment of the susceptible population.

What of the channels of spread ? Apart from occasional outbreaks of infection (sore throat, scarlet fever, and diphtheria) from ingestion of infected milk (itself almost always infected by the air route), air is the natural vehicle for the spread of respiratory diseases. Air-borne infection may occur in at least three different ways : there is, first, droplet infection which means direct spread of infection by moist expelled droplets to persons within a radius of 3–4 feet from the infector, although during coughing or sneezing moist droplets may be carried considerably further, say a distance of 6–8 feet. These droplets vary considerably in size, and the larger and heavier of them quickly fall to the ground or on clothing or room furnishings, and become dry. When the dried particles are disturbed by dusting and sweeping or other air movement, they rise into the air as dust ; if they contain hardy organisms like the streptococcus or diphtheria or tubercle bacillus or the viruses of smallpox or psittacosis, they may carry infection to susceptible persons inhaling the dust, and this is the second mode of air-borne infection. Some of the droplets are, on the other hand, so small, or quickly become so by evaporation, that they remain suspended in the air like smoke, and are carried hither and thither by air currents. If these " droplet nuclei " contain infective bacteria or viruses, they too may carry infection considerable distances, and this, the third aerial agent, would seem to be a common mode of spread of certain virus diseases—e.g. smallpox, chicken-pox, and measles. These different methods of aerial spread of infection dovetail into each other; their relative importance will obviously depend a great deal on the infecting dose of the particular pathogen and on its viability and pathogenicity outside the body of its host. Thus, cerebrospinal fever and pertussis are probably droplet-spread infections; scarlet fever, diphtheria, and smallpox can, in addition, be conveyed by infected dust; and probably all of them, but especially certain virus infections, by droplet nuclei.

While all three methods of dissemination may be classed as air-borne infection, it is important to keep clearly in mind the differences between them, for methods of prevention will be individual to each of them.

DROPLET

In the case of droplet or "projectile" infection, the muzzle velocity of particles expelled by sneezing may be as great as 150 feet per second, so that no physical or aerial disinfectant like ultraviolet light or germicidal aerosol can possibly prevent this mode of spreading infection. Therefore, preventive methods will include avoidance of intimate contact with a person known to be infective (e.g. someone with a cold), adequate ventilation of houses and assembly halls, the use of the handkerchief every time one coughs or sneezes—a good social habit now becoming quite rare—and even the donning of masks by infector and infectee wherever there is a highly susceptible population as in children's hospitals, or where crowds gather, in buses, shelters, or picture houses, in the presence of a highly dangerous and infectious respiratory disease like smallpox or pandemic influenza.

INFECTED DUST

That certain pathogenic bacteria can remain viable outside the body for considerable periods if protected from direct sunlight has long been known, but clinicians have been reluctant to believe that these dried bacteria can have the same vitality or virulence as similar organisms expelled directly from the respiratory tract. However, pathogenic bacteria in dust *can* initiate infection, and the available methods for dealing with the problem of infected dust should immediately be adopted, particularly in fever and children's hospitals. Here the objectives must be to minimise the amount of dust, to prevent its accumulation in inhabited buildings, and to control its dissemination in the atmosphere. In hospitals and homes where there are infective patients, the fluff and dust from blankets and bed linen are particularly likely to carry pathogenic bacteria, and methods are now being evolved for dealing with this source of infection (van den Ende et al. 1941, Thomas and van den Ende 1941). Handkerchiefs readily become infected and in turn infect pockets and hands, so that for the patient with respiratory infection paper handkerchiefs which can be readily destroyed are advisable. Hospitals and houses should be designed with rounded inside corners and the minimum of exposed horizontal surfaces to prevent the accumulation of dust; vacuum cleaning should be used not only for floors but for walls and other surfaces and furnishings. Hospital floors may be treated with spindle oil; dusting should be done with damp cloths, while good ventilation and regular and thorough cleansing will go a long way towards preventing the accumulation and dissemination of infected dust.

DROPLET NUCLEI

The method of aerial spread by infective droplet nuclei has been given much publicity by Wells and his colleagues (1936) in America, and has lately received support from work on experimental infection in ferrets in this country (Andrewes and Glover 1941, Glover 1941). It is as yet difficult to estimate what part droplet nuclei play in the spread of respiratory infections in the human, but the high infectivity of a single case of chicken-pox or measles left for a short period in a ward full of susceptible children suggests that this mode of spread is important for certain virus diseases. Black-out restrictions in war-time probably accentuate the danger from this particular channel, for good ventilation is its greatest enemy. If the infective particles remain suspended and viable for long enough and in sufficient concentration to infect, some form of aerial disinfection will be required to block this channel of spread.

The two main methods now available are ultraviolet light and bactericidal mists or "aerosols." Ultraviolet light is highly effective against moist organisms in droplet nuclei and much less so against dry organisms in dust; in the form of a "bactericidal ceiling"—i.e. light directed upwards—or as perpendicular "curtains" between beds it is now being used in children's wards in America to prevent cross-infection, with apparently promising results. Despite the cost of installation and other technical difficulties, it has advantages over the bactericidal mists, and may yet become a useful weapon in the fight against aerial cross-infection in hospital wards and in schools.

The bactericidal mists, originally introduced by Trillat, have been the subject of much research in this country; Twort et al. (1940) have, in particular, defined the conditions under which an antiseptic becomes an effective and safe aerosol. In contrast to germicidal vapours—e.g. formaldehyde—which to be effective must be in a concentration that is injurious to and unbearable by living tissues, with aerosols the incredibly small ratio of 1 volume of the liquid germicide to 10–500 million volumes of air is sufficient to sterilise a bacteria-laden atmosphere in an experimental chamber. Under practical conditions, however, where many of the bacteria in air are in larger aggregates and protected by dust, the bactericidal mist has not yet proved itself, although it apparently reduced the numbers of hæmolytic streptococci in the air of a ward polluted with that organism following an outbreak of tonsillitis (Cruickshank and Muir 1940). The possibilities of using aerial disinfectants in the control of infection in schools have yet to be explored. Further details about the use of this and other methods of controlling air-borne infection are to be found in the chapter on Streptococcal Infections (p. 80), and in a review by Andrewes (1940).

Artificial Immunisation

No discussion on the control of respiratory infections can be complete without consideration of the role of artificial immunisation. Although prophylactic inoculation has been shown to be effective experimentally or in selected groups of individuals in a wide variety of respiratory infections, its application in the field is limited to a few diseases, among