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SOME PROBLEMS IN THE CONTROL OF INFECTIOUS DISEASES*

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The mortality from infectious diseases has declined steadily and steeply in the past half-century; yet to-day approximately one death in five is attributable, directly or remotely, to infection. The problem of the control of infectious diseases is a complex one, for "it includes all measures which decrease damage, whether physical, economic, social, or psychological, to the human host as a result of disease, and with no marker to indicate where actual preventive medicine leaves off and good clinical medicine begins." To assess the value of past measures and as a guide to further progress the bulk of infectious diseases in this country may be considered in four main groups: (1) *Acute respiratory infections*—the pneumonias, influenza, and the common cold; (2) *Tuberculosis*; (3) *Intestinal infections*; and (4) *Childhood fevers*—pertussis, measles, diphtheria, and scarlet fever, in that order of importance. But if all other streptococcal infections are added to scarlet fever that group becomes one of the principal causes of invalidity.

This list excludes at least two important groups—infections of the central nervous system, and venereal disease. Cerebro-spinal meningitis and poliomyelitis have each so complex an epidemiological picture that I have no space to discuss them here, while the control of venereal disease is such a controversial problem just now that I propose to leave it alone.

Acute Respiratory Infections

The Pneumonias.—There has been an irregular but appreciable decline in deaths from pneumonia since the beginning of the century, more so in the adult age groups than in the young and not at all among the aged; yet some 40,000 deaths are still attributable yearly to pneumonia and bronchitis. The introduction of sulphapyridine in 1938 brought high hopes that pneumonia would cease to be one of the captains of the men of death; but, in fact, deaths from this infection during 1939-41 were for England and Wales still 88% of the average figure for the previous four pre-sulphonamide years—1934-7 (Martin, 1942).

It may be assumed that most primary pneumonia in this country is due to infection with the pneumococcus, and pneumococcal pneumonia occurs in two clinical forms—lobar pneumonia, which is an infectious disease of older children and adults, and bronchopneumonia, which is largely an auto-genous infection of the very young and the very old. Hospital figures show a reduction in the case fatality of sulphonamide-treated lobar pneumonia to about one-third of pre-sulphonamide days; whereas in all Scotland, where deaths from lobar and other forms of pneumonia are differentiated, mortality from lobar pneumonia in the years 1939-41 was still three-fifths that of the 1934-7 period. These figures suggest that cases are being treated more effectively in hospital than in the home. If that be true—and too often the practitioner gives too small a dose for too short a period—then more hospital pneumonia units might well be established in industrial towns where the infection is prevalent. The factors which affect prognosis in lobar pneumonia, such as age of patient, infecting pneumococcus type, extent of lung involved, and bacteraemia, are

more readily determined in hospital, where appropriate dosage can be more easily arranged.

Such scanty data as exist on the sulphonamide therapy of bronchopneumonia indicate that a considerable reduction in mortality has been effected among hospital cases of primary bronchopneumonia in children; yet the figures from Scotland show that in the sulphonamide years there has been only a 15% reduction in mortality from "other forms of pneumonia," compared with a 40% reduction in lobar pneumonia. The explanation of this remarkable disparity is perhaps to be found in the differences between the two infections. Lobar pneumonia is an exogenous infection of lung tissue by a highly invasive pneumococcus in a healthy child or adult who either lacks some specific antibody or whose resistance is temporarily impaired, as by fatigue or an antecedent cold. The sulphonamides seem to be most effective against actively invasive pathogens, and this factor, together with the ready response of healthy tissues to infection, helps the individual to overcome the invading pneumococcus. Bronchopneumonia is usually an autogenous infection in a poorly resistant individual by pneumococci of low virulence. The infection affects primarily the mucous membrane of the bronchial tree, where the organism is badly placed to stimulate production of antibody and is less accessible to the drug. Moreover, the tissues of the very young and the very old are perhaps less able to kill a pathogen which the sulphonamide can only prepare for destruction. Thus the factor of non-specific resistance probably plays an important part in the successful administration of a chemotherapeutic substance.

The bronchopneumonia of the aged may often be an unavoidable terminal infection, but there is something far wrong with a nation's health which allows bronchopneumonia to kill every year 7,000 to 8,000 children under the age of 5 (see Table). Mortality from pneumonia at this age is four to

Table showing Deaths in Children, 0-5 years; England and Wales, 1938

	0-6 mths.	6-12 mths.	1	2	3	4-5	0-5
Pneumonia ..	2,943	1,961	1,581	514	286	167	7,452
Enteritis ..	2,129	891	275	59	36	24	3,414
Tuberculosis ..	118	258	414	264	196	127	1,377
Measles* ..	65	327	538	235	136	88	1,389
Pertussis ..	281	268	323	95	76	29	1,072
Diphtheria ..	25	48	107	215	296	320	1,011
Scarlet fever ..	2	8	26	46	25	49	156

* 1938 was a measles year.

seven times greater in industrial and working-class districts than in residential areas. Thus poverty is a principal predisposing cause; but which factor in poverty—poor nutrition, poor hygiene, poor environment, or way of life—is most important we do not know. Certainly rehousing does not *per se* improve matters much, and anyone who has read *Our Towns* (1943) will realize how difficult it will be to eradicate slum habits, with their evil influence on the health of young children. The higher infant mortality rates of the Northern industrial areas are largely due to an excess of deaths from respiratory infections, and here the harsher climate is an important contributory factor; yet Huddersfield has shown that these adverse conditions can be overcome. Provision for earlier and more frequent hospital treatment of young children

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with measles and pertussis in the industrial North would probably help to lessen this appalling mortality from broncho-pneumonia.

Influenza.—Many of us are wondering if there is any likelihood of a pandemic of influenza in this Second World War similar to that which happened in 1918. The 1918 pandemic—the first of its kind to coincide with a major war—probably owed its origin to other factors than war-weariness, malnutrition, and the herding together of men; but its spread and its ravages were doubtless facilitated by these abnormal conditions. Any spark, in the shape of men drafted from an epidemic focus to war-stricken Europe, may set the flame alight again. In considering whether anything can be done to forestall or limit a possible pandemic, the following facts are relevant. Influenza is due to a number of viruses, of which two varieties have already been isolated and labelled influenza virus A and B. After a clinical attack, specific antibody, which can be readily detected by a simple test, develops to these viruses; many individuals during an epidemic develop antibody without being clinically affected. Thus by taking blood from representative samples of the population we can tell whether the community possesses a low or a high degree of resistance to the influenza virus. Ordinarily the virus attacks only those individuals with little or no immunity, and it is perhaps disturbing that there has been scarcely any epidemic influenza due to virus A or B in this country since 1937. Vaccines have been prepared from influenza virus A, and in controlled institutional trials they have, when used prophylactically, reduced the incidence of infection by about one-half. But in the presence of a highly virulent strain of pandemic propensities a moderate degree of immunity would probably be insufficient to protect against infection. Burnet and Clark (1942) in their excellent monograph advocate for such a contingency immunization by spraying the upper air-passages with a living but attenuated virus which could be quickly prepared in large amounts in chick-embryo. There is much to do along these lines, and every opportunity and encouragement must be given to laboratory workers to develop some such mode of defence. Until specific prophylaxis becomes practicable, strict quarantine is the only reliable means of protection, and in the event of pandemic influenza on the Continent an attempt to quarantine this island might be worth while; for, if even only partially successful, it might slow down the spread and thereby attenuate the virulence of the virus.

In the presence of a pandemic the wearing of efficient masks by those in close contact with infected cases will afford protection, while bactericidal mists or vapours (sodium hypochlorite, resorcinol, propylene glycol) could be used as aerial disinfectants in public meeting-places. Throat sprays and gargles are useless. With mucous membranes made highly susceptible, secondary infection is the great danger in influenza, so that clinical cases should be isolated early, preferably in their own homes. Herding together of patients, as was done in 1918, courts disaster from secondary bronchopneumonia due to cross-infection with the streptococcus, staphylococcus, etc. If institutional treatment is unavoidable, wards must be kept well ventilated, beds widely spaced, and floors and bed-linen treated with oil (Van den Ende and Thomas, 1941). Best results in 1918 were claimed by those who nursed patients in the open with only a canvas canopy over their heads. There was little secondary pneumonia in the summer epidemic wave of 1918.

The Common Cold.—American analyses have shown that each of us has an average of three colds a year. Much invalidity from otitis media (10% in children under 5), sinusitis (6.6% of older patients), bronchitis (one-third of the cases), and pneumonia is directly attributable to the common cold. If colds have a varied aetiology, there is strong supportive evidence for an elusive filterable virus as a causative agent (see Browning, 1942): experimentally only chimpanzees have been successfully infected, and only one team of workers has claimed to have grown this virus outside the body, so that specific prophylaxis is as yet impracticable. Bacterial vaccines will not reduce the incidence but may lessen the risk of secondary infection. There is some evidence that physical well-being and a comfortable environment increase resistance to the cold. Avoidance of contact with infected persons is virtually impossible, but much can be done by education and propaganda

to make the unguarded sneeze as much of an antisocial habit as spitting now is. In factories and places of entertainment aerial disinfectants may prove to be most useful in preventing dissemination of the virus. And the public could reduce the risk to themselves and to their neighbours by staying indoors for one or two days when they fall victim to this common plague. It constitutes a great economic problem, which might commend itself to the new Nuffield Foundation.

Tuberculosis

The interruptions in the steady decline in mortality from tuberculosis during the First World War and again in the present one have brought home to us the need for greater and unremitting attack on this infection, which because of its chronicity presents problems of control very different from those of the acute respiratory diseases. The Government's wartime promise of more financial assistance to the families of affected persons is an enlightened step in the right direction. Over 90% of the deaths from tuberculosis result from contact with a case of "open" pulmonary infection, and four important points to remember if the downward trend is to be hastened are:

(i) Although most of the population are infected few become infective. Unlike most other pathogens, the tubercle bacillus has the peculiar property of burying itself in the body tissues, and only that minority of infected patients whose lesions break down spread the disease to others. Yet it has been estimated that about 250,000 cases of open tuberculosis exist in the community (Wingfield, 1942-3), and a large proportion of these are undiagnosed. Even among diagnosed cases there is an unduly long lag period between the onset of clinical symptoms and sanatorium treatment. In a recent series the average delay was 9 months, distributed as follows: 3½ months between onset of symptoms and reporting to the doctor; 3¼ months before the doctor referred the patient to a tuberculosis dispensary; and 2¼ months before the patient was admitted to a sanatorium. In only 22% of the cases was sputum sent by the practitioner to a laboratory for examination (Mann, 1943). Obviously the methods for earlier diagnosis and treatment of open tuberculosis need to be speeded up.

(ii) Tuberculosis is five times as common among intimate contacts of sputum-positive cases as among the general population, and tuberculous fathers are more common sources of infection for their children than tuberculous mothers. Thus the tuberculosis officer must concentrate on the family rather than on the individual, and the detection of early infection among contacts becomes a most important function of any tuberculosis service.

(iii) The most susceptible ages are infancy and adolescence. Among infants the infection is apt to become generalized and prove fatal; a large proportion of the adolescent cases will, if not diagnosed and treated early, join the ranks of the infective army. Much stricter regard to personal hygiene would reduce the risk of infection to young children, as shown by the fact that no child in the Papworth Colony has developed tuberculosis. Meanwhile more active efforts must be made to protect the susceptible children of tuberculous parents, and artificial immunization with vaccines of B.C.G. or Wells's vole bacillus may supply the need. Data from American and Scandinavian sources show that B.C.G. vaccine is a safe and relatively effective means of protecting children, nurses, and students in intimate contact with tuberculosis. For example, Baudouin in an investigation of more than 2,000 children of sputum-positive parents over a period of 11 years found a tuberculous morbidity of 31 per 1,000 among the vaccinated and 120 per 1,000 among the controls; the corresponding mortalities were 19 per 1,000, against 54 per 1,000 (see Hopkins, 1941). The problem of artificial immunization needs fresh consideration in this country, where in the past 10 years our attitude has been too conservative and apathetic. Mass radiography must be used to detect and control early infection in the adolescent. This is a long-term policy, and to be properly done the examinations should begin among children leaving school and be repeated at regular intervals.

(iv) Tuberculosis is closely associated with poverty, and malnutrition is probably one of the most important factors predisposing to clinical infection. It is therefore essential that milk, one of the best of foods for children, should be cheap, popular, and plentiful as well as safe to drink. The cheap-milk schemes for mothers and children and milk for school children must be continued and extended after the war. Milk-bars help to popularize milk as a beverage, and we may hope with Mellanby (1939) that "to give tea to children instead of milk may come to be regarded as bad form, just as it is now considered bad form for people to have unwashed ears."

The downward trend of tuberculosis probably owes more to the decline in poverty and to improved hygienic conditions in the com-

munity than to the institution of tuberculosis services; for the mortality rates in other respiratory infections have gone down *pari passu* with that of tuberculosis, and tuberculosis has declined at the same rate in countries with and without public health tuberculosis schemes. It is therefore proper to inquire whether the best use is now being made of the tuberculosis service and to stress again that the tuberculosis officer must be social worker as much as expert diagnostician.

Intestinal Infections

Paratyphoid and Bacterial Food-poisoning.—Typhoid fever is not only becoming rare in this country (mortality has fallen in 60 years from 371 to 6 per million) but should now be easier to control, for the Vi-antibody test and new phage typing facilitate detection of sources, usually chronic carriers, of infection (Felix, 1943; Bradley, 1943). On the other hand, paratyphoid has been unduly prevalent in recent years and bacterial food-poisoning has probably also increased. These two infections are perhaps more closely related epidemiologically than paratyphoid is to typhoid (Savage, 1942). Typhoid fever in epidemic form is often water-borne. Paratyphoid is rarely water-borne, and has a summer rather than an autumn prevalence, usually following contamination of milk, cream, or prepared food by a clinically mild case or carrier. Persistent carriers of the *Salmonella* food-poisoning organisms are rare, but healthy and convalescent carriers are much commoner than was previously thought, and it may be that the human host spreads infection as much as the more commonly suspected rodent. The control of these infections is largely dependent on a high standard of personal hygiene among food handlers, together with improved methods for the protection of milk and prepared foods against infection from human or animal sources. The 1938 Food and Drugs Act decrees that persons employed in a room used for the sale of food are required to observe due cleanliness as regards themselves, the room, and all articles in it; while suitable washing-basins with a sufficient supply of soap, clean towels, and clean water must be provided for their use. It will require much patient education by the medical officer of health and his sanitary inspector to get these regulations observed in the spirit as well as the letter. It might help if all persons handling food for sale were warned by prominent notices of the essential necessity for hand-washing after use of the w.c. and for reporting to their employer any attack of diarrhoea, however mild. The protection by impermeable wrappings of prepared foods against soiling by hands, flies, and vermin also needs to be greatly extended.

Bacillary Dysentery.—There has in the past 10 years been an increase in the reported incidence of bacillary dysentery, mainly perhaps because of the wider recognition of its presence in this country. Even so, many mild and atypical infections are neither recognized nor reported. Case-fatality is ordinarily low, and the worst feature of dysentery in temperate climates is its great infectivity. The introduction of new culture media (Hynes, 1942) has greatly improved laboratory diagnosis and has shown how common are convalescent and symptomless contact carriers, who are a particular danger in wartime: the great increase of dysentery among our troops in France from 1916 onwards was probably related to the transfer of men from the Middle East. In civil life the day nursery, the residential school, the infirmary for the aged, and the mental hospital are the most common foci of infection, but the disease is now endemic in many communities. Fortunately, the new intestinal antiseptics sulphaguanidine and sulphasuxidine can be expected to effect both clinical and bacteriological cure, and the practitioner must realize that bacteriological cure is as important for the welfare of the community as clinical cure is for the individual. The disease is largely spread from case to case by infection of food, and good personal hygiene is again the most important means of preventing it.

Gastro-enteritis.—Infantile diarrhoea to-day levies only one-tenth of the toll exacted 50 years ago; but even now, although the dreaded summer epidemics have gone, it ranks second to pneumonia as a cause of infant mortality, with over 3,000 deaths per annum. Epidemiologically it may be summed up as an infection of artificially fed infants living in urban poor-class districts. The bulk of the deaths occur in the first year of life, and there is little doubt that the disease would practically disappear if all mothers breast-fed their babies for

six to nine months. The fact that only 30 to 50% of mothers feed their infants for even three months is due to a variety of causes. A longer period of rest after confinement, more home help, proper feeding of the mother, the care of the nipples before confinement, more frequent and complete emptying of the breasts during feeding to stimulate lactation and prevent infection through milk-stasis, and, in particular, education of both doctors and the lay public about the advantages of breast-feeding, would all help to secure proper lactation and thus save a large proportion of the 3,000 to 4,000 infants who die every year because they are not breast-fed. That is the long-term policy. Meanwhile the problems of the aetiology and treatment of gastro-enteritis require wider recognition and concerted attention from research teams of paediatrician, bacteriologist, and biochemist working in close co-operation. One point may be stressed: if infants with or liable to gastro-enteritis must be admitted to hospital they should be nursed by isolation technique in single rooms.

Childhood Fevers

Deaths from the four most important childhood fevers—pertussis, measles, diphtheria, and scarlet fever—have declined enormously in the past century. In particular, scarlet fever has ceased to be a killing disease, and now causes less than 5% of the deaths from these four fevers, compared with 40% some 80 years ago. The general decline in mortality has not been accompanied by a fall in incidence, and has occurred at different periods and at different rates for these four infections (see Gale, 1942-3). Deaths from scarlet fever fell precipitously between 1860 and 1900; there was an abrupt fall in the death rate from measles after 1915; diphtheria and pertussis have shown a more steady decline since 1900.

Pertussis.—I put pertussis at the top of the list for three reasons: (1) It is second only to diphtheria as a cause of death among children, and attacks about 70% of the child population, compared with 5% for diphtheria. (2) The protracted nature of the infection and its age of attack are such as to cause much debility predisposing to secondary infection. (3) It is a disease which by prophylactic inoculation can be either prevented or so modified as to cease to be a cause of death or a source of anxiety to parents. I prefer the name "pertussis" to "whooping-cough"; for the whoop comes late in the infection, and doctors and parents must be encouraged to suspect the disease long before it develops. Frequent spasms of coughing, congestive in type, occurring at any time of the day or night and unaccompanied by any physical signs in the chest, should suggest pertussis, and call for further examination. A white-cell count and a blood film at this stage will reveal a leucocytosis with a relative lymphocytosis of 60 to 80%. Confirmation can be obtained by use of the cough-plate, which, however, is troublesome and time-consuming for the practitioner. A more practicable substitute is required, and a post-nasal swab inoculated on to a plate of Bordet medium along with an appropriate dilution of penicillin to inhibit other bacteria may supply the need (unpublished observation). With such a method doctor or nurse can take the swab in the home, clinic, or nursery, and send it for examination in much the same way as is done for diphtheria. Early diagnosis means early segregation, which not only benefits the affected child but reduces the risk of infection to others. Pertussis is a difficult and trying illness for the mother to nurse at home, and a larger proportion of cases than at present should be removed to hospital. But in hospital toddlers should not be confined to bed, for plenty of fresh air and exercise to ventilate the lungs are essential for the treatment of pertussis. Collapse and atelectasis are as common complications as bronchopneumonia, and so long as the children are properly clothed and fed they should be outside most of the day and should sleep on open balconies at night. It is important, too, to impress on doctors and parents that a whooping child has usually passed the infective stage. Hospital beds to the required number cannot be provided if the child is isolated until the whoop disappears.

Prevention is better than cure, and prophylactic vaccination against pertussis is now a practicable and reasonably effective procedure (see Cruickshank, 1942a). Most of the field trials in specific prophylaxis have been carried out in America, where

large weekly injections for three, four, or five weeks, totalling 80,000 million to 100,000 million organisms, have been given. This involves administrative difficulties, and lately a well-controlled experiment by Bell (1941) has shown that two 10,000-million doses of an alum-precipitated vaccine at a month's interval will secure as good results as the more frequent weekly injections. Important points in the prophylaxis of pertussis are the use of a smooth-phase organism, large and slowly absorbed doses, and an interval of four weeks or more between the injections. It might seem an obvious forward step to use pertussis vaccine and diphtheria toxoid together for combined immunization against these two infections; but we must remember that the age of attack for pertussis is much earlier than that for diphtheria, and in fact about half the deaths from pertussis occur in the first year of life (see Table), so that immunization should, if possible, begin at the age of 3 months. Mothers welcome the idea of protecting their children against this disease, which they know from personal experience to be a protracted, worrying, and debilitating infection.

Measles.—The mortality from measles, even allowing for the diminishing population of children under 15, is to-day about one-quarter of what it was as recently as 20 years ago. About two-thirds of the deaths occur between the ages of 6 months and 2 years, mostly from secondary bronchopneumonia, so that the main problem in measles is to postpone the age of attack or modify the infection in young susceptible children. Complete protection is possible by the use of pooled convalescent serum given in 5-c.cm. doses within five days of exposure, but, except in hospital, the date of exposure is seldom known and convalescent serum is difficult to obtain, so that this method is not generally applicable. Besides, it confers only temporary protection for two to three weeks. A modified attack by giving a smaller dose of serum is preferable, but the same difficulties confront us. Thus to protect the young child from measles the choice lies between active immunization and avoidance of exposure. Stokes and Rake (1940) have grown measles virus on chick-embryo, and apparently protected monkeys and human volunteers by intranasal or subcutaneous injection of a virus vaccine; Mayer (1941) could not confirm the protection experiments. Research workers in this country will no doubt concentrate some of their post-war energy on this vital problem.

Avoidance of exposure is for the urban child virtually impossible, but some recent work suggests that it may be possible to postpone the age of attack. Measles, as Chapin pointed out many years ago, is an infection spread mostly from school. In Philadelphia irradiation of the ceilings of junior classrooms with ultra-violet light apparently prevented the epidemic spread of measles among the irradiated classes (Wells, Wells, and Wilder, 1942). If in this way measles among school children could be shifted from the younger to the older age groups, the chances are that the younger members of the family would be over the age of 3 years before being intimately exposed to infection brought back from school by their older brothers or sisters.

The increasing tendency to admit children with measles to hospital can only be commended if home conditions are such that the child cannot be properly nursed at home, the case is removed early, and preference is given to children under the age of 3 years. The respiratory mucous membrane in measles is particularly susceptible to attack by the haemolytic streptococcus and the pneumococcus, and wards are apt to be overcrowded during an epidemic, so that cross-infection, with resulting otitis media and other complications, is more likely to occur in hospital than at home. If measles is to be nursed in hospital, precautionary measures such as adequate ventilation and bed-spacing and oiling of floors and bed-linen must be taken in order to minimize the risk of secondary infection.

Diphtheria.—The value of active immunization against diphtheria is now generally accepted, and the active campaign initiated in 1940 had already by the middle of 1942 resulted in 73% of school children and 58% of pre-school children in Scotland being inoculated; and as deaths from diphtheria in Scotland in the first three-quarters of 1942 were less than half those in the corresponding period of 1940 it seems that the campaign is already producing results. The need now is

to concentrate on the pre-school child and to make inoculation at the age of 1 year a routine social habit for all children. I should like to draw attention to two points:

(1) Infection by the more actively invasive strains (gravis and intermedius) may occur in the inoculated. Clinically such infections are usually mild, and could be called diphtheritic tonsillitis, for local inflammation without toxæmia is the characteristic feature. But it is well that both doctor and parent should know that prophylactic inoculation does not necessarily mean complete protection. (2) Diphtheria is a difficult disease to diagnose clinically. If there is any doubt, antitoxin should be given as early as possible, and the practitioner should know that with modern refined antitoxin there is little risk of serum reactions. Arrangements should also be made for doubtful cases to be admitted for observation to hospital. On no account must antitoxin be withheld until the bacteriological report on a swab is received.

Scarlet Fever.—A problem requiring careful thought is whether the notification and hospitalization of scarlet fever is at present justifiable when in many instances the only difference between streptococcal tonsillitis and scarlet fever is that the patient with tonsillitis is immune to the erythrogenic streptococcal toxin and the other is not. Scarlet fever is to-day a mild disease, and where conditions are suitable cases could more often be nursed at home, particularly as in hospital the bulk of the complications are due to cross-infection. Forbes (1936) of Brighton showed that at least as many secondary or return cases followed the case isolated in hospital as did the case nursed at home. Another controversial problem which has considerable economic importance is the value of home disinfection after scarlet fever. The furnishings of a room where a case of streptococcal infection has been nursed are likely to harbour haemolytic streptococci, and when the patient leaves it the room should theoretically be disinfected; but Forbes's figures suggest that the patient is the most important focus, and many of the family contacts will already be infected before he is removed to hospital.

If scarlet fever is now a relatively mild infection the haemolytic streptococcus is still the most common pathogen concerned in cross-infection in hospital wards. Most of the complications of scarlet fever and measles, institutional outbreaks of puerperal sepsis, and secondary infection of wounds, and much of the sepsis in E.N.T. wards, are traceable to cross-infection with this organism. The solution of this problem requires a reorientation in our ideas about sources and channels of spread, and much co-operative effort between medical and nursing staff (see Cruickshank, 1942b).

Improvement in Methods of Control

This bird's-eye view of some of the problems in the control of infectious disease suggests that there is much work to be done, and that more efficient machinery is needed for the purpose. A periodic review of the methods for tackling these problems is essential if progress is to be made. Their solution may be considered under the headings of administration, education, structural improvements, and general preventive measures.

Administration.—The health services must be directed by executive and advisory committees, which will deal intelligently and progressively with the problems of public health without having to worry about local rates and taxes. Each community will be larger than that served by many existing local authorities, and preventive medicine will be intimately linked up with other branches of medicine. In each area there must be a field epidemiologist working in close collaboration with an up-to-date laboratory and with his energies directed to tracing causes of morbidity and mortality in various infections, advising about means for their prevention and control, and educating both practitioners and the public to co-operate with him to this end. How much can be done along these lines was exemplified in Rochdale, where the medical officer of health, with full co-operation from practitioners, instituted a campaign which resulted in a marked reduction in maternal mortality rates. A more precise example has lately been afforded by the work of Bradley (1943) in tracing to a common source apparently unrelated sporadic cases of typhoid fever. Unfortunately, very few of our medical officers have been trained for this kind of work.

As a bacteriologist I am naturally concerned that an adequate laboratory service should be available in all areas and readily accessible to all practitioners. The parent laboratory should preferably be associated with an infectious diseases hospital of at least 150 to 200 beds and resident medical staff. In sparsely populated areas the I.D. block should be within the curtilage of a general

hospital with a joint laboratory, for public health bacteriology need not be divorced from clinical pathology. The essential point is that there should be a real liaison between practitioner and bacteriologist instead of the impersonal postal service which is still too prevalent.

Education.—A most important factor in the control of infectious disease is education of the public in higher standards of personal and public hygiene. This education begins with the pre-school child, and for the purpose there must be a greatly increased number of nursery schools for children between the ages of 3 and 5. At this age the child can be taught good habits and, more important, may be prevented from acquiring the bad habits which are inevitable so long as slum-life is tolerated. At elementary schools more facilities must be given for the growing child to maintain the good habits which it has learned at nursery school. There is not much point in teaching a child cleanly habits, such as washing the hands after using the w.c. or before taking food, while sanitary arrangements at most schools are so unsatisfactory. For more senior pupils physiology must be taught, either by qualified teachers or by the school medical officer, whose duty it is to look after the health and physical development of the child. Incidentally, medical care of the child is a dynamic, not a static affair, and the same medical and nursing staff should be in close touch with the growing child from birth till he leaves school. Further, the sympathy and active co-operation of the teaching profession are essential for the proper discharge of school medical work. Classes in mothercraft should be run at evening schools for adolescent girls and at welfare centres for those who are already parents. A more extended service of health visitors, who must be specially selected and fully trained nurses, would also help in teaching parents the simple rules of hygiene, while the cinema is an excellent medium for health propaganda. Education of the medical profession will include more preventive medicine in the curriculum and frequent refresher courses for those who are already in practice.

Most of us are ignorant of the best methods for disseminating this new health education, and I should like to commend a more general utilization of the Central Council for Health Education, an independent body supported partly by a grant from the Ministry of Health and partly by financial help from local authorities which make use of its facilities. This body has been studying the principles of health education, and has a team of experts who are ready and willing to give help and advice on the many problems of health education and how they can be "put over" to the lay public.

Structural Alterations.—The first essentials are well-designed labour-saving houses in pleasant surroundings for the poorer classes. But with these must go a determined effort to eradicate the slum way of life, which has again been so terribly indicted in *Our Towns*. "Good food is easier to come by than a good home." To lighten the load of the mother with young children day nurseries may have to be continued after the war, although from the point of view of infection they are not unmixing blessings. If they are to prosper, methods for controlling the spread of infection in day nurseries, and, less urgently, in nursery schools, must be devised. Schools need better ventilation, lighting, and spacing, and adequate sanitary arrangements, including wash-hand basins. Hospitals for infectious disease should contain as a minimum 150 to 200 beds, of which upwards of half must be single-bedded chambers for isolation; wards must be small, containing 4 to 12 beds, and be well supplied with wash-hand basins, sterilizers, and the like.

General Preventive Measures.—The most important of these is better nutrition. To that end every mother of a family must have enough money to buy the necessary food, and must be taught what foods to buy and how best to cook them. In this connexion the Ministry of Food is doing a grand job of work, which must be continued after the war. Improved nutrition does not necessarily protect against infection, but when infection occurs its severity is often modified and the risk of complications lessened if the child's general nutrition is good. For example, deaths from measles between the ages of 1 and 2 years are 18 times as frequent among the poorest classes than among the well-to-do, yet measles attacks the poor and the rich alike, and this great discrepancy in mortality must be attributed to the conditions that go with poverty, of which malnutrition is one of the most important.

Improved methods of dealing with water-supplies and sewage have greatly reduced the incidence of intestinal infections. There has been no corresponding diminution in the incidence of respiratory infections, which present a much more difficult problem, although with our newer knowledge a greater measure of control should be possible. Some—e.g., diphtheria, small-pox, and pertussis—can be specifically prevented by prophylactic inoculation, and it may be that influenza and measles will be added to the group. Meanwhile we must consider whether exposure to air-borne infection can be reduced by preventing the spread of infected dust and by the use of aerial disinfectants. Infected dust in hospitals can be controlled by oiling of bed-linen and floors, a procedure which is particularly desirable in wards where there is a considerable risk of bacterial cross-infection (scarlet fever, diphtheria, and secondary infection in measles and influenza). Aerial disinfectants are probably more

applicable to the control of respiratory virus infections, and the extended use of ultra-violet light, or of bactericidal mists and vapours, in hospitals, schools, cinemas, and other places of assembly might reduce the incidence of such common air-borne infections as the cold, influenza, measles, and chicken-pox.

Conclusion

Chadwick was a great sanitary reformer who impressed on our people the close association between poverty, dirt, and infection. In our day, as in his, poverty, dirt, and may I add ignorance, are still the most important contributors to the ravages of infectious disease. He looked forward to the time when sanitary reforms would eliminate the need for doctors. That day is probably still far distant, but meanwhile we can all, by taking thought, help towards making ours a health-preserving as well as a healing profession.

REFERENCES

- Bell, J. A. (1941). *Publ. Hlth. Rep.*, Wash., **56**, 1535.
 Bradley, W. H. (1943). *British Medical Journal*, **1**, 438.
 Browning, C. H. (1942). *Control of Common Fevers*, p. 168, London.
 Burnet, F. M., and Clark, Ellen (1942). *Influenza*; Monograph No. 4, Eliza and Walter Hall Institute, London and Melbourne.
 Cruickshank, R. (1942a). *In Control of Common Fevers*, p. 139, London.
 — (1942b). *Publ. Hlth.*, **56**, 17.
 Felix, A. (1943). *British Medical Journal*, **1**, 435.
 Forbes, D. (1936). *Lancet*, **5**, 1438.
 Gale, A. H. (1942-3). *Proc. roy. Soc. Med.*, **36**, 97.
 Hopkins, J. W. (1941). *Amer. Rev. Tuberc.*, **43**, 581.
 Hynes, M. (1942). *J. Path. Bact.*, **44**, 193.
 Mann, B. (1943). *British Medical Journal*, **1**, 283.
 Martin, W. J. (1942). *Ibid.*, **2**, 540.
 Mayer, J. B. (1941). *Arch. Hyg. Bakt.*, **126**, 285.
 Mellanby, Sir E. (1939). *Recent Advances in Medical Science*, London.
Our Towns: A Close-up (1943). London.
 Savage, W. G. (1942). *J. Hyg., Camb.*, **42**, 393.
 Stokes, J., and Rake, G. (1940). *Science*, **92**, Suppl. No. 2386, p. 10.
 Van den Ende, M., and Thomas, J. C. (1941). *Lancet*, **2**, 755.
 Wells, W. F., Wells, M. W., and Wilder, T. S. (1942). *Amer. J. Hyg.*, **35**, 97.
 Wingfield, R. C. (1942-3). *Proc. roy. Soc. Med.*, **36**, 39.

EARLY TREATMENT OF WAR WOUNDS OF THE UPPER PART OF THE FACE*

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The functions of seeing, breathing, eating, and the expression of emotion may all be seriously compromised as the result of wounds of the face and require surgical restoration. As, however, this paper is confined to the treatment of severe wounds of the upper part of the face, the function of eating need not be discussed further.

First aid in the field or forward dressing stations may first be described. When a high-velocity missile hits a soldier in the face he often feels only a local burning sensation, but he may be knocked to the ground. He then finds blood pouring from his wounds, and this bleeding is often so profuse that it may interfere with his vision or breathing. When he is picked up, a large dressing is inserted into and over the wound, and the affected part of the face firmly bandaged. This will usually suffice to stop the bleeding, but it is also of importance to shield his blood-stained and horrifying face from the gaze of other soldiers and patients. Though wounds of the face bleed furiously immediately after they have been inflicted, bleeding as a rule stops spontaneously in quite a short time, especially if a large shell-dressing is firmly applied and morphine is administered early. If blood runs back into the mouth or nose and causes difficulty in breathing, the patient is placed on his side or prone on the stretcher.

At the C.C.S., primary operative treatment and transfusion may be necessary. Facial wounds require more thorough cleansing than others because they are never excised and because it is important to avoid subsequent tattooing and "powder marks." They are washed or even scrubbed with soap and water, and irrigated first with peroxide and then with saline or acriflavine. Pieces of dirty clothing, visible metallic foreign bodies, and completely detached fragments of bone are removed. If a fragment of bone is attached to any

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