THE TYPHOID AND PARATYPHOID GROUP OF FEVERS

Report communicated by the French Government

INTRODUCTION

In accordance with the indications given in document EB10/29 and Resolution EB10.R.22 of the WHO Executive Board, we shall endeavour in this report to give the viewpoint of the health administrator responsible on the national level for the application of a long-term programme for control of communicable diseases of the typhoid and paratyphoid group.

We shall attempt, in particular, to determine the respective values of the various techniques available today both for the prevention and for the treatment of these infections, bearing in mind as far as possible the necessity (inherent in any long-term undertaking in the field of health) to obtain the most effective results with the minimum expenditure. Finally, stress will be laid on the value of the voluntary participation of the population concerned.

The task of the health administrator is to:

(a) define the general attitude to be adopted towards the problem,
(b) make an analysis of the means at his disposal for recognizing the disease and combating it (as well as of the respective advantages and disadvantages of such means, regarded from the dual viewpoint of efficiency and economy),
(c) proceed, finally, to a critical synthesis which will make it possible to draw up a national plan of campaign.
I. GENERAL ASPECTS OF THE PROBLEM

Before establishing a plan of action the health administrator has the duty of asking himself whether such action is opportune and what place should be given it in the general health policy of the country (or of the state).

1.1 First of all he must determine the part played by the disease (or group of diseases) concerned, regarded as morbid entity, in the state of health of the population, i.e. the morbidity, mortality and case fatality rates. Here as in other fields, reliable statistics are the primary necessity for any health action.

1.2 Secondly, he must endeavour to evaluate the cost of the disease, this expression to be understood in the broadest sense and applying to the sum total of the human, social and economic consequences of the disease.

In the economic sense of the word, the cost has two aspects, one in a certain way "positive" (medical and pharmaceutical expenses, days of hospitalization, etc.) and the other "negative" (inability to work, non-productivity, compensation for loss of salary etc.). But in addition the disease has personal, family and social repercussions which cannot be put into figures.

1.3 Having thus gauged the consequences of the morbid entity which he proposes to combat, the health administrator is in a position to judge the part played by the disease relative to the general state of health of the territory considered and, at the same time, to assign it a position in the list of priorities upon which his general programme of activities is based.

2.1 The moment has now come for him to define the methods to be used in the proposed campaign.

The health administrator will select these on the basis of the following criteria in particular:

- the epidemiological aspect of the disease concerned, which affects the choice of methods and consequently the structure of the programme (which may differ in this connexion not only from one country to another but also from one region to another of the same country);
the effectiveness of the different techniques, considered in relation to a long-term action;

- their cost, considered not only as an absolute figure but also in relation to the data collected on the cost of the disease;

- their possible effect on other communicable diseases or on the general health conditions of the population (general use of treatment establishment for various morbid conditions, polyvalent effects of a campaign against water-borne diseases or against diseases transmitted by insects, etc.).

2.2 Selection of the methods for the health campaign depends to a large extent on the geographical, economic and social characteristics of the territory concerned. The effectiveness of a given method may vary according to latitude, climate, degree of economic and social development, the psychological attitude of the population, etc.

2.3 Consequently the greatest prudence should be exercised in deciding upon, from an inevitably limited national viewpoint, a generally applicable plan of campaign.

Although techniques may be universal, their methods of application are essentially contingent. This summarizes all the difficulty - and interest - of public health administration.

3. Science and techniques are constantly developing; the health administrator should keep abreast of the latest advances and make use of them as soon as they have gone beyond the initial stage of laboratory experiments.

He should not forget that he bears the responsibility for applying new methods to a large section of the population and thus judging their practical value. He should feel himself closely associated with scientific and technical progress and consequently should reserve a by no means negligible part of his programme of action to the application of research.
Furthermore, the epidemiological phenomena which he is called upon to observe supply the laboratory with a constantly renewed harvest of facts, constituting excellent material for experimentation.

The health administrator should not hesitate to infringe the "minimum cost" rule when there are reasons for believing that by so doing he can help scientific or technical progress. In fact, such action represents a sort of long-term investment, perfectly compatible with an economic view of preventive medicine.

(There are cases where a bold health administration, deeply interested in progress, has not hesitated to assume serious risks in this way. The campaign against typhoid carried out in Germany at the beginning of the century at the prompting of Robert Koch and, quite recently, the attempt to eradicate Anopheles maculipennis labranchiae in Sardinia constitute two striking examples of this. Neither of these campaigns gave results in proportion to the expenditure entailed, but nevertheless they are rich in instruction for modern hygiene).

II. ANALYSIS OF METHODS
APPLICABLE TO CONTROL OF TYPHOID AND PARATYPHOID FEVERS

We shall deal solely with the septicaemic diseases corresponding to the nosological entity known by the name of "typhoid fever" and due to the pathogenic action of Salmonella typhi or of Salmonella paratyphi A, B or C. Consequently we shall not refer in this paper to the other types of salmonellosis (alimentary toxic infections, infantile gastro-enteritis, etc.) while noting, however, that certain of the preventive measures applicable to the typhoid and paratyphoid fevers (inspection of milk and foodstuffs for example) represent at the same time effective protection against those other Salmonella infections.

A. Epidemiological information and enquiries

1.1 Notification of typhoid and paratyphoid fever cases should be legally compulsory.

This obligation should apply to any person observing the presence of the disease, primarily of course to the physician who has diagnosed it but also to all those who,
on various grounds, have a family or professional responsibility with respect to the patient. 1

1.2 Knowledge of the number of deaths following on typhoid and paratyphoid fevers is also indispensable and implies the existence of a suitable organization for statistical recording of causes of death.

1.3 The legal notification of cases, and registration of deaths supply the basic data necessary for calculating the morbidity, mortality and case fatality rates. However, they also represent the starting point for the aetiological and epidemiological enquiry which will itself result in the application of preventive measures. Consequently nothing should be neglected in order to make these data as reliable as possible.

1.4 The laboratory constitutes an excellent source of additional information on the epidemiological position; the results of microbiological analysis often make it possible to fill certain gaps in the legal notification, and sometimes reveal at an earlier stage the presence of an epidemic focus (since a large number of analyses for a given sector are centralized in one and the same laboratory).

1.5 Generally speaking it always pays the health administrator to employ persuasion rather than compulsion and to prefer open and trusting co-operation to the application of legal sanctions. However, he will obtain such co-operation only insofar as those concerned are familiar with the preventive aspect of medicine; this indicates the importance of the attitude adopted towards this viewpoint in the training of the medical student and other categories of health staff as well as towards education of the public.

2.1 Aetiological investigation has as its aim, the determination of the microbe concerned and is dependent upon laboratory work.

1 French law extends this obligation "to the principal occupant, head of family or establishment of the premises where the patient is living and, in general, to all persons residing with him or looking after him" (Act of 15 February 1902, amended on 30 October 1935).
The advances made during the last fifteen years in the microbiological diagnosis of the typhoid and paratyphoid fever group have enlarged its field of application from mere confirmation of the clinical diagnosis to the general epidemiological study of the disease. It is well known what results can be obtained in this connexion from methods for isolation of the causal agent (particularly from water), from the determination of bacteriophage types (Vi-phage typing) and from the search for Vi-agglutinens in the identification of carriers.

2.2 The existence of a well-organized national chain of health laboratories is an essential element in the control of the typhoid and paratyphoid fever group. The laboratories in this chain vary in their importance and in the part they play;

(a) on the local level, multivalent laboratories carry out routine analyses; isolation of the causal agent by means of haemoculture or coproculture, serological diagnosis (O,H) analysis of water used for beverage purposes, etc.;

(b) on the regional level, more advanced and better equipped laboratories carry out, as required, confirmatory analyses judged necessary: e.g. biochemical and serological study of Salmonella strains (in addition they perform the routine analyses in their area);

(c) on the national level there are highly specialized laboratories, termed reference laboratories ("Centre National des Salmonella", "Centre National de lysotypie") which, while carrying out any confirmatory analyses requested, direct their main activities towards research.

It need hardly be said that the above is only a schematic outline and that the differences between the three types of laboratory may be less clear-cut in practice. (The participation of regional laboratories in research work is, in particular, very desirable).

2.3 This national chain is extended on the international level through the international reference laboratories (World Centres, WHO Regional Centres) such as the International Salmonella Centre at the Copenhagen Statensserum Institut or the Colindale Central Enteric Reference Laboratory and Bureau.

1 The Public-Health Laboratory Service of the Medical Research Council in Great Britain affords a particularly remarkable example of this.
2.4 Microbiological analyses, above all those which (like lysotyping) are of direct epidemiological interest, should be carried out free of charge and the greatest material facilities for carrying out such work should be made available to doctors and patients. The same, of course, will apply to the possible detection of carriers and the search for Salmonella in the external environment.

3.1 Epidemiological investigation, which tries to determine the connexion between the cases (i.e. the mode or modes of transmission of the disease) is the logical culmination of the preceding steps. The health administrator must realise that such an investigation is particularly difficult and that the proportion of cases whose origin can be determined with certainty hardly exceeds 50 per cent bearing in mind the sporadic forms of the disease.

3.2 Lysotyping is a great aid to epidemiological investigation, as many frequently reported observations have shown. Although it may not always make it possible to assign a definite origin to a case, lysotyping frequently supplies proof that a certain origin is not the correct one— an observation of great epidemiological value despite its apparently negative nature.

3.3 If it is to be complete, the epidemiological enquiry should deal with the multiple relations of the patient to his environment: drinking water, milk, various foodstuffs, health conditions of the dwelling, personal, family and occupational health factors, etc. The physician, sanitary engineer, health inspector and public health nurse all co-operate in this investigation, to which they should bring all the vigour and care of a veritable police enquiry directed against the microbe responsible and its human and physical vectors.

3.4 The results of the epidemiological enquiry must be entered on a detailed card, the standard model of which is established by the national health administration for the whole country.

The cards for each case are collected together by the health authorities responsible on the local level and then centralized on the national level. They serve as a basis for thorough statistical examination which shows up, in addition to the
quantitative factors already gleaned through case notification and registration of causes of death, the qualitative aspects of the disease, e.g. morbidity and case fatality rate by age-group and by sex, effects of curative measures (chloramphenicol), types and relative proportions of the microbial agents responsible for the disease, the source of infection, etc.

4. We have made no reference to the cost of measures in connexion with epidemiological information and enquiry. These measures, as well as the administrative and technical organization which they imply, are in fact essentially polyvalent and it would be rather difficult to determine the share of the expenditure involved attributable to the typhoid and paratyphoid fever group. At most, the cost of the microbiological analyses and enquiries might be ascertained, but such expenses for the most part cannot be reduced, since a thorough knowledge of the disease and its epidemiological features is absolutely indispensable for the application of effective curative and preventive measures.

The only possible economy would apply to the so-called reference laboratories, which call for highly specialized equipment and personnel and which consequently cannot be too many in number. Territories without such laboratories would be well advised, rather than to establish them at great expense, to send Salmonella strains to the already existing centres outside their frontiers. This is a fresh proof of the value of international co-operation in this field (see above 2,3). ¹

B. Curative measures

The problem of treatment will be dealt with in this report only to the extent that it forms an integral part of a general programme for control of the disease. We shall therefore pass over purely therapeutic aspects concerning the patient as an individual.

1.1 As a general rule, all patients suffering from typhoid or paratyphoid fever should be hospitalized as far as possible.

¹ The Salmonella Centre and the Lysotyping Centre of the Pasteur Institute in Paris, for example, receive numerous strains coming from European countries as well as territories in Africa and the Far East.
The value of hospitalization, from both the curative and preventive viewpoints, can hardly be doubted, but it clearly depends to a large extent on the general health condition of the population considered (it is the more necessary, the poorer these health conditions).

1.2 From the curative viewpoint, hospitalization gives an excellent guarantee of satisfactory clinical and microbiological diagnosis, it ensures better surveillance of the patient (particularly important with this group of diseases) and finally it provides the most favourable conditions for suitable treatment and competent nursing care.

1.3 From the preventive viewpoint it makes possible satisfactory isolation of the patient, eliminates risks of infection by direct contact (frequently difficult to avoid in the family environment) and lends itself to disinfective measures during the course of the disease.

1.4 Compulsory hospitalization may be in itself a useful measure but its application or even its inclusion in health legislation is not always compatible with the psychology of the population concerned. In this case, hospitalization may be recommended both to physicians and to patients and those responsible for them.

1.5 Clearly, the above considerations are valid only if the conditions of hospitalization itself are satisfactory. This leads us to stress the importance of hospital facilities as an element in the control of communicable diseases in general.

1.6 In the absence of hospitalization the best method is without doubt the use of a home-care service, attached to a hospital centre.

1.7 In the absence of such a service, as is usually the case, the responsible public health physician on the local level should establish close liaison with the physician in attendance, the nurse and the family. The public health nurse is best suited to ensure such liaison, particularly as concerns the preventive aspect of the measures to be taken with respect to the patient.
In this connexion, the training in preventive medicine of medical and nursing personnel practising outside the hospital and education of the public would appear to be of primary importance.

2.1 The use of chloramphenicol (chlormycetin, tifomycin) marked a decisive step in the treatment of the typhoid and paratyphoid fevers.

Rapid disappearance of fever, a spectacular improvement in the state of the patient, a shortened convalescence, a large decrease in the frequency of complications and also (although to a lesser degree) of relapse, a considerable lowering of the case fatality rate – these are the remarkable advantages of this method of treatment.

Recent statistics\(^1\) give the following figures:

<table>
<thead>
<tr>
<th></th>
<th>Deaths</th>
<th>Complications</th>
<th>Relapses</th>
</tr>
</thead>
<tbody>
<tr>
<td>In 416 cases not treated with chloramphenicol</td>
<td>14%</td>
<td>30.5%</td>
<td>19%</td>
</tr>
<tr>
<td>In 110 cases treated with chloramphenicol</td>
<td>2.7%</td>
<td>9.7%</td>
<td>14.5%</td>
</tr>
</tbody>
</table>

A survey by the National Institute of Hygiene, at present being carried out, covering about 500 cases of infection due to \(S.\) \(typhi\) and 400 cases of infection due to \(S.\) \(paratyphi\) \(B\) shows the change in case fatality rate for the two different causal agents:

<table>
<thead>
<tr>
<th></th>
<th>(S.) (typhi)</th>
<th>(S.) (paratyphi) (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases not treated with chloramphenicol</td>
<td>12.5</td>
<td>1.6</td>
</tr>
<tr>
<td>Cases treated with chloramphenicol</td>
<td>1.4</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The fall in the case fatality rate appears to be much greater for the \(S.\) \(typhi\) infections, which were formerly very serious.

Although accidents sometimes occur on treatment with chloromycetin, they rarely take a serious form and cannot be considered an obstacle to its systematic use.

\(^1\) E. Aubertin et al, Journal de Médecine de Bordeaux, 129, 1952
Its effectiveness and innocuity depend moreover to a large extent on the method of prescribing the antibiotic, e.g., quantity, total amount taken, daily dose, splitting up of the doses, duration of treatment, etc.

2.2 By shortening the course of the disease the antibiotic greatly simplifies the problem of diet which used to be raised by typhoid fever. Nowadays the nitrogenous denutrition and the resulting wasting can be combated by replacing, on the restoration of a pyrexic conditions, the exclusive milk diet by a diet becoming rapidly richer in animal proteins. Convalescence is thus shortened and normal activities can be resumed more quickly.

2.3 Chloramphenicol treatment coincides in a number of cases with the disappearance of Salmonella from the stools; but such disappearance is temporary, and coprocultures effected after cessation of the treatment are again frequently positive.

Though treatment reduces the number of the germs eliminated during the disease (which from the preventive point of view is not a negligible factor), it does not therefore constitute under present conditions a method of sterilizing carriers (see below).

2.4 The treatment of the typhoid and paratyphoid group of fevers by chloramphenicol is very expensive.

What we said of its advantages shows that the advisability of the treatment cannot be discussed on mere grounds of economy. These advantages, moreover, lead to a reduction in the cost of the disease.

The duration of hospitalization is, as a matter of fact, reduced. Investigations are at present being carried out on this subject in France by the "Institut National d'Hygiène".

A first enquiry\(^1\) shows that in 70 cases treated by chloromycetin the average period of hospitalization was 25 days, whereas it was 42 days for the same number of patients who had not been given the antibiotic.

\(^{1}\) C. Bétourné, Bulletin de l'Institut National d'Hygiène, Vol. 8, No. 1, 1953.
A second enquiry at present in progress, the detailed results of which will be published later, dealt with 972 cases. It showed a reduction in the period of hospitalization from 35 to 27 days. The reduction is much more marked in the case of S. typhi infections (41 to 28 days) than in the case of S. paratyphi B infections (27 to 25 days). 1

These figures, which are somewhat variable, are mainly valuable as a guide, but at the very least they show that an appreciable gain can be obtained in regard to the number of hospitalization days.

We shall not stress the gain in human life connected with the reduction in the case-fatality rate (see above B-2.1).

The shorter period of convalescence and the more rapid resumption of activity also influence what we have called the "negative" aspects of the cost of the disease (incapacity for work, unproductiveness, payment of health insurance benefits where they occur).

2.5 Whatever the balance sheet of the curative measures may finally show, it is none the less true that, contrary to an opinion which has been too widely held by the public since the first employment of chloromycetin, the typhoid and paratyphoid group of fevers are not absolutely benign affections and that, although reduced by modern curative methods, the total cost remains high.

If it is also borne in mind that any patient may be a source of direct or indirect contamination before, during and after his illness, the idea of prevention clearly retains its full importance.

An epidemic focus covering 50 cases of S. paratyphi. B was observed some time ago in the French town of A......; these cases were due to the consumption of fresh cheese contaminated by a dairy worker who had had typhoid fever and who continued to be a chronic carrier. Coproculture, elementary personal hygienic precautions, or still better a change in the occupation of the carrier, would have saved the community considerable expenditure necessitated by the hospitalization and treatment of fifty sick persons!

1 It is interesting to compare these last figures with those relating to the comparative case fatality rate in two types of infection (see above B-2.1).
The health administrator should devote his greatest efforts and the major portion of his available resources to prevention.

C. Preventive measures

As far back as 1873, W. Budd stated that all attacks of typhoid fever necessarily resulted from a pre-existing manifestation of the disease.

"It is", the French epidemiologists Dopter and de Lavergne wrote in 1926, "the focus of infection which is found at the origin of every epidemic; the latter may be derived from it directly, or depend indirectly on a specific contamination of the environment which the focus has polluted; but it is to the human carrier, whether sick or not, that we must always go back to ascertain the origin of the epidemic and consequently to employ rational measures of prophylaxis."

This fundamental idea still dominates today the whole question of the prevention of the typhoid and paratyphoid group of fevers.

1.1 The most rational, and theoretically the most satisfactory, method is therefore to discover the original "focus of infection" and to render it innocuous, or in other words to detect and neutralize the carriers. Provided all the carriers in a given area were known and effectively controlled, it would appear obvious that the typhoid and paratyphoid group of fevers would as a necessary consequence be definitely eliminated.

Is this method, however, applicable in practice?

1.2.1 The health administrator has at his disposal today well-tried techniques for the detection of carriers, the most recent of which and one of the most effective epidemiologically is lysotyping. Detection is therefore qualitatively realisable (provided account is taken of the intermittent elimination of the germ and provided recourse is had to repeated control analyses).

1.2.2 Quantitatively can a sufficient proportion, if not the total number of the carriers be detected?

The various types of carrier may in this respect be divided into two groups.
First group: Convalescent patients who have been brought to notice as a result of their recent attack and who are comparatively easy to detect.

Second group: Unrecognized cases (clinically asymptomatic forms), chronic carriers whose initial infection, often going back a very considerable time, has been lost sight of, healthy carriers finally, whom there is no reason to suspect until they are found to be the origin of fresh cases of infections. In a great many cases there is no possibility of investigating these three types of carrier.

On the whole, therefore, the quantitative data are always incomplete. Any preventive action based on the detection of carriers can only give partial results.

1.2.3 Even thus restricted in its scope, detection may usefully be employed in regard to:

- convalescent patients,
- persons who were exposed to infection either in the family circle (environment of the sick person) or in a community (school, barracks, workshop, etc.),
- persons who, by reason of their business activities, would (if carriers) expose the population to a special risk of infection (preparation and handling of food and drink for human consumption).

1.3.1 The detection of carriers, which we have dealt with under the heading of "Preventive measures" for the sake of clearness, is in itself only one element of the epidemiological investigation. Its entire value is, in fact, due to its prophylactic consequences.

The object aimed at is not merely the recognition, but the neutralization of carriers as possible agents of infection.

1.3.2 Sterilization of the carriers would be the ideal solution. Unfortunately it must be acknowledged that at present we do not possess any generally effective method.
None of the very numerous methods proposed for the definite elimination of the Salmonellae from their sites in the organism could be finally adopted.

With chloramphenicol, which at the outset had given rise to certain hopes on this point, it is also impossible to obtain a lasting sterilization of the stools.

The health administrator must follow with the closest attention the investigations which are being prosecuted in this direction and which give reasonable grounds for hoping that they will prove successful in a not too remote future.¹

1.3.3 In the absence of an effective method of sterilization recourse must be had to measures of personal hygiene, the object of which is the destruction of the germ on issuing from the organism (disinfection of the excreta in particular).

There can be no certainty that these rules will be strictly observed for weeks or for months. As a matter of fact the widest appeal will be made to the education of the carrier, but only relative effectiveness can be expected in any case from this form of prophylaxis.

1.3.4 In view of this imperfection, it is prudent to secure a further guarantee in the case of all carriers whose occupational activities represent a special danger of new contaminations. Such a guarantee can only be obtained by prohibiting the carrier from pursuing his calling. This prohibition may be of short or long duration according as the carrier does or does not continue to excrete pathogenic germs; a necessary corollary is the assigning of a grant as compensation or the placing of the carrier in another occupation (can chronic carriers not be regarded as veritable "social invalids"?).

¹ P. Durand and G. Renoux report the lasting disappearance of Salmonella from the stools of 36 typhoid patients (out of a total of 37) treated with a chloramphenicol-cortisone combination (Société Tunisienne des Sciences Médicales, 24 October 1952).

The above is an interesting example of the type of research work which should be prosecuted.
1.4 The locally responsible health administrator should establish and keep up to date a file of carriers. The personal card of each carrier should indicate the results of the initial analysis and of the periodical control analyses and the prophylactic measures prescribed, together with (as far as possible) the manner in which they are carried out and, should occasion arise, particulars relating to employment, the movements of the person concerned, etc.

1.5 The control of carriers (detection and neutralization) calls for a combination of authoritative measures and persuasive action in the field of public health administration.

Appropriate health legislation is indispensable in a sphere where the rights of the individual are liable to be infringed for the good of the community. Health education is no less essential.

1.6 The effectiveness of the control depends in the main on the psychology of the population concerned. A disciplined population endowed with a sufficiently developed social sense clearly constitutes a specially favourable field for the application of control.

The health administrator must attach great weight to this factor when determining the comparative importance assignable to the control of carriers in his overall programme for combating the disease.

1.7 If it is borne in mind that every unrecognized carrier represents the possibility of a larger or smaller number of future infections, and therefore of patients to be treated who can themselves become carriers or create carriers around them, the method is economically worthy of adoption as giving good results.

Its importance will, however, undoubtedly be greatly increased when an effective method of sterilizing carriers becomes available.

1 According to J. Dumas, 4% of the convalescents may retain Salmonellae in their stools for more than six months and 2 to 4% of the persons exposed to contagion may become healthy carriers.
2.1 When the carrier stage is over, the Salmonellae spread throughout the external environment. Faecal contamination is henceforward the source of extremely varied pollutions; drinking water, milk and dairy produce, raw vegetables, oysters and other shellfish, etc. may be contaminated and transmit the germ of infection in their turn.

The wide diffusion of the germ, the multiplicity and intricacy of the means of transmission which characterize the endemicity of the typhoid and paratyphoid group of fevers present the health administrator with a real puzzle, the solution of which it becomes extremely difficult and even impossible to discover.

From time to time a clear epidemic manifestation, grafted as it were on the permanent endemic, brings out some particular factor of infection and makes it possible to take useful action; such action, however, continues to be of limited scope and does not go to the deep roots of the endemic.

The sole effective form of prophylaxis in a long-term programme consists in carrying out systematic measures of environmental sanitation.¹

2.2 The comparative evolution of the endemic of typhoid and paratyphoid fevers in France in urban and rural environments provides striking evidence of the effectiveness of environmental sanitation measures.

When such sanitation is undeveloped the extent of the endemic is directly proportional to the density of the population; urban centres are most heavily stricken, the places with the largest population suffering most, while rural areas on the other hand remain comparatively unaffected. Such was the case in France in the first quarter of the present century.²

¹ This expression is to be understood in its widest sense as defined by the WHO Expert Committee on Environmental Sanitation at its first session (WHO - Technical Report Series, No. 10, 1.1.)

² It is highly significant in this respect to find in the Treatise on Epidemiology by Dopter and de Lavergne published in 1926 the following statement: "Urban areas are certainly a favourable environment for typhoid fever". This statement no longer corresponds absolutely to the facts, at least in France.
The towns have since then had the benefit of much more important measures of environmental sanitation than the rural areas, in the first place because such sanitation appeared to be more necessary there, but also because the cost is lower for a dense than for a scattered population.¹

A progressive shifting of the morbidity of typhoid and paratyphoid diseases has been noted from the urban to the rural areas, where it is at present relatively higher.

An enquiry conducted by the "Institut National d'Hygiène" dealing with about 7,000 cases of typhoid and paratyphoid fever observed in 1942 and 1943,² showed that the morbidity was at that time about one third in towns of over 50,000 inhabitants of what it was in less densely peopled areas.

(The health administrator is thus today faced in France essentially with a problem of rural environmental sanitation.)

2.3 Once this idea of the effectiveness of environmental sanitation has been established, it is still desirable to examine its various aspects and to analyze as precisely as possible the respective shares of the different methods of environmental sanitation. These shares vary essentially in accordance with local conditions; since the figures we have selected as a basis of determination relate to conditions existing in France, they are obviously of value only as an example.

2.4.1 The question of drinking water should, in the first place, be taken into consideration. The enquiry already referred to, undertaken by the "Institut National d'Hygiène", showed that in France 52% of cases of infection were water-borne.

¹ The cost of supplying drinking water, for example, varies inversely with the numbers of the population up to a maximum figure beyond which the unduly increased quantitative requirements raise the cost of furnishing the supply (case of the city of Paris).

² Series of works by the "Institut National d'Hygiène", Vol. 3 part 2, 1948.
Of this number 48.5% are attributable to well water, and only 1.4% to urban piped water. The distinction drawn above (2.2) between rural and urban areas therefore rests mainly on the different quality of the drinking water.

2.4.2 An improvement in an urban area in the supply of drinking water leads to a decline in the number of water-borne contaminations.

The town of Marseilles (Bouches-du-Rhône) is situated on the Mediterranean coast of France, an area where typhoid and paratyphoid morbidity has always been comparatively higher. Out of 4,114 cases notified from 1940 to 1950, 49% were water-borne in origin.

A study of the evolution of the number of cases and of the percentage represented by them of the total typhoid and paratyphoid morbidity during that period shows, however, that the measures of environmental sanitation that were adopted have had a direct influence on the epidemiology of the disease; the few figures given below furnish evidence of this fact.1

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of water-borne cases</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>1941</td>
<td>377</td>
<td>73.9</td>
</tr>
<tr>
<td>1943</td>
<td>397</td>
<td>65.9</td>
</tr>
<tr>
<td>1945</td>
<td>103</td>
<td>33.5</td>
</tr>
<tr>
<td>1947</td>
<td>78</td>
<td>22.8</td>
</tr>
<tr>
<td>1949</td>
<td>55</td>
<td>26.9</td>
</tr>
</tbody>
</table>

2.4.3 The health administrator must assign a leading place in his efforts to the supply of chemically and bacteriologically pure drinking water.

Preference should be given, in principle, to naturally pure water, but recourse must also be had to the purification of water originally polluted. The choice depends on the one hand on the quantitative requirements of the population to be supplied and on the other on the cost of furnishing the supply (initial installation and maintenance

1 Figures taken from an enquiry by R. and G. Bestieu (Archives de Médecine sociale, 1950, 4, 194)
costs). Large areas, such as London and Paris, have been unable to satisfy their total requirements by means of well water and have had to use river water (Thames, Marne) after filtering.

The same reasoning is applicable to small groups of rural dwellings or to isolated houses, for which deep borings to provide originally pure water may be too costly.

2.4.4 When a given territory includes both urban and rural areas, priority should be assigned in the programme to supplying the urban areas with drinking water; as a general rule the importance of this supply from the twofold health and economic point of view varies inversely with the numbers of the population (see above 2.2 and note 2). This theoretical view, however, must be modified in accordance with the epidemiological situation.

2.5 Sewage plays a part which is obviously of capital importance, since it is a vehicle for the germs eliminated by bearers and thus causes contamination of water-bearing strata.

Although its action in transmitting the disease takes place before that of drinking water, we assign it the second place in this report, for it is much more difficult to evaluate the exact importance of its role and we are without statistical data on the question. It constitutes in effect only an intermediate link in transmission, which most often passes unnoticed.

It is none the less certain that the purification of sewage must necessarily be included in any programme of environmental sanitation for the elimination of the typhoid and paratyphoid group of fevers.

Here again urban and rural areas present separate problems which at the present time — especially as regards the rural areas — appear to be technically less well settled than those of the supply of drinking water. It is essential to define the most effective and most economical means for widely scattered dwellings in rural areas.¹

¹The Public Health Experimental Centre established at Soissons by the French Government, with the assistance of the Rockefeller Foundation and WHO in particular, devotes a large part of its research work to this question.
The spreading of sewage, especially in market garden areas, should be strictly prohibited. In this case also legal coercion will be accompanied by appropriate health education.

2.6.1 The above-mentioned enquiry by the "Institut National d'Hygiène" reported 26% of infections as being due to food. This percentage is divided up as follows between the various kinds of food:

- Vegetables and raw fruit: 5.3%
- Milk, dairy produce: 9.2%
- Shellfish: 11.5%

2.6.2 The importance of shellfish in transmitting the typhoid and paratyphoid group of fevers is striking. This is a rather special characteristic of the disease in France, and even in a well-defined area of that country (Atlantic coast area, and above all the Mediterranean area; for the town of Marseilles alone the statistics quoted above show that 25% of cases of infection are due to shellfish).

The health control of the production and sale of oysters and other shellfish, and the prevention and punishment of the sale of non-controlled products are the only remedies which will meet this situation.

2.6.3 We shall not stress the very diverse problems raised by the health control of the other foods: milk, dairy produce (butter, fresh cheese, cream), vegetables and fruits which are eaten raw, etc. Very many facts go to show their epidemiological role, but they are above all incidental observations made in connexion with epidemics of limited scope. We are without precise data regarding the relative influence of this factor on the general situation of the endemic (except perhaps as regards shellfish), and it must be confessed that here the enquirer finds himself most frequently in a "labyrinth of possibilities" from which he has great difficulty in finding the way out.

2.6.4 The part played by insect vectors, particularly the housefly, must not be left out of account, but it also is very difficult to estimate with accuracy.
The insect, a passive vector of the Salmonellae, exerts an influence, after all, only if it can come into contact on the one hand with pathogenic germs (defective system for evacuating waste material) and on the other hand with food stuffs which it contaminates (defective food protection system); that is to say the part it plays would be very small indeed if it was not afforded these two opportunities.

The destruction of flies appears to be of importance, especially in shops where food liable to transmit the infection is kept and offered for sale, and in homes before such food is consumed.

2.7 At the close of this short review of the measures of environmental sanitation we shall again stress (from the economic point of view) the fact that such sanitation represents a polyvalent prophylaxis, the effects of which go far beyond the prevention of typhoid and paratyphoid infections.

3.1 Protection of healthy persons by immunization constitutes the third element of the triad of preventive measures, and here we have the problem of immunization against typhoid and paratyphoid fevers.

3.2.1 The efficacy of antityphoid-paratyphoid immunization is certain. The best proof of this is to be found in the evolution of the morbidity rate in the Armed Forces, where immunization is systematically carried out. In 1915, the number of cases in the French army fell from 14,069 in January to 8,624 in February and then, by successive stages, to 525 (i.e. 1/30th of the previous rate).

3.2.2 This efficacy is highly specific. The number of cases in the French army rose in 1915 from 3,288 in June to 6,629 in September on account of the spread of S. paratyphi A. and B. infections on which the vaccine used (anti-S. typhi) had no effect; when the antityphoid-paratyphoid vaccine was used there was an immediate drop in morbidity.

It is probable that a certain proportion of the cases observed today in vaccinated persons are due to the fact that the vaccine used was not suited to the infecting strain (in the case of S. paratyphi C. infection, for example).
3.2.3 The value of immunization is proportionate to the quantity of antigen injected; it is essential that exact doses be used in the injections.

3.2.4 The simple antityphoid-paratyphoid vaccine seems to be preferred in the case of epidemics when the risk of infection is considerably increased, to the so-called combined vaccines (antityphoid-paratyphoid-tetanus-diphtheria, for example) the utilization of which is, on the other hand, entirely justifiable for polyvalent immunization when there is no immediate danger of infection (Armed Forces).

3.2.5 The accidents of immunization against typhoid and paratyphoid fevers should be well-known. In most cases they are due to a technical error or to the existence of an unknown morbid condition in the subject immunized.

The health administrator should bear in mind this possibility and avoid it insofar as possible by medical selection of subjects to be immunized.

Such accidents are regrettable in themselves, but in addition they create a psychological atmosphere which is not favourable to immunization.

3.3 It does not seem at the present time that immunization, in spite of its efficacy and relatively small cost, can be recommended as a single and overall method for the elimination of typhoid and paratyphoid fevers.

The WHO Expert Committee on Active Immunization against Common Communicable Diseases of Childhood\(^1\) has expressed the following opinion: "In countries where typhoid is highly endemic, such immunization may be included in the general health programme, but other methods of control are fundamental."

We may therefore affirm, without being too paradoxical, that immunization as a technique for the prevention of typhoid and paratyphoid infections exists only insofar as other methods fail - in particular, environmental sanitation.

\(^1\) World Hlth Org. techn.Rep.Ser., No.6
3.4 The immunization of the whole population of a country or state against typhoid and paratyphoid fevers would call for extremely complex administrative organization. In order to be effective, the immunization would have to cover a sufficient percentage of the persons subject to it, and to ensure this, difficult and expensive control methods would have to be employed. There is some doubt as to whether, from this point of view, immunization can be considered as an economic proposition.

3.5 The psychological attitude of the population concerned is of the greatest importance. Modern therapy has made this group of infections relatively benign so that the public - and often physicians - feel that there is no justification for the inconvenience (which is real) caused by immunization. However mistaken this attitude may be, there is no doubt that it does not create a propitious atmosphere for the general adoption of this preventive measure.

3.6 It is for this reason that the French Health Administration tends to take the following line:

- systematic immunization of persons occupationally exposed to infection (medical and nursing personnel in hospitals, in particular);
- immunization (optional or compulsory as the case may be) of the whole population within any area defined as an epidemic focus, or within any limited area where the morbidity rate considerably and constantly exceeds the average morbidity rate for the whole of the territory.

III. SYNTHESIS OF THE VARIOUS METHODS AND INTEGRATION INTO AN OVERALL PROGRAMME

1. There can be no question, in a general study, of recommending any particular choice of information, treatment and prophylaxis methods. As we have already said, any such choice must depend essentially on the prevailing local conditions and must, therefore, be the responsibility of the competent national authorities.

We will confine ourselves to considering the line of conduct to be taken in a few general cases.
2. The epidemic focus is generally, in the case of typhoid and paratyphoid fevers, no more than the periodic manifestation of what is actually an endemic situation; nevertheless, energetic measures must still be taken to combat it in view of the immediate consequences (morbidity, lethality) and also on account of the long-term repercussions it may have (creation of new sources of infection which would contribute to the maintenance and extension of endemicity).

The epidemic focus combines all the most favourable conditions for effective prophylaxis. The origin of the infection, being the same in a great number of cases, is easier to discover, and the limitation of the disease to a clearly defined area lends itself to concentrated preventive action.

Two methods can be combined:

- the search for and neutralization of the cause of infection, i.e. purification of water in the case of water-borne epidemics, detection of germ carriers in the case of epidemics due to food, etc.;

- immunization of the population of the affected or threatened area against typhoid and paratyphoid fevers.

To these short-term measures must be added longer term measures to prevent any possible spread of the disease from the focus, i.e. control of possible germ carriers among convalescents and patients' contacts.

3. The control of the endemicity of the disease – where the aim is the progressive elimination of the disease over the whole of a territory – is a much more delicate operation.

Let us take the case of a developed country where there are large urban population groups, where the population is educated, disciplined and conscious of its social responsibilities.

The health administrator can choose fairly complex methods, the application of which will be facilitated by precise health legislation and by effective health education. He will be able to develop to the full modern information techniques,
with the collaboration of highly specialized laboratories; he will concentrate on the control of carriers and on sanitation measures, i.e. disposal of waste matter, supply of clean drinking water in rural areas and improvement in the hygiene control of foodstuffs for urban centres.

On the other hand, let us consider an under-developed country of an essentially rural character, with a large and scattered population with little consciousness of public health problems.

The health administrator will in this case adopt the simplest and most economical methods possible, methods which are not highly specialized. He will give the preference to techniques which, for the same outlay, will have the greatest effect on general hygiene conditions. This means that in such cases the health administrator will be chiefly concerned with questions of drinking water and disposal of waste matter.

To the above-mentioned general examples many others could be added to demonstrate the diversity of the possible combinations of the already numerous and varied methods. Nevertheless, there seems no doubt that it may be affirmed - and this is one of the most important conclusions of this study - that sanitation is the common denominator in any campaign for the control of typhoid and paratyphoid infections in the various parts of the world, and that it is therefore, on sanitation that the health administrator should chiefly concentrate his attention.

CONCLUSIONS

For certain diseases the health administrator has at his disposal simple, effective and highly specific weapons which produce an immediate and spectacular effect.

Jennerian vaccination in the control of smallpox, delousing in exanthematic typhus, residual disinsectization for the elimination of malaria, are striking examples.

This, however, does not apply to typhoid and paratyphoid fevers where the plan of action, based on a judicious combination of various methods without any highly specific characteristics, can only achieve long-term results. It must nevertheless
be remembered that the other diseases with some relation to contaminated environment (in particular water-borne infections) are also progressively eliminated at the same time as the typhoid and paratyphoid infections.

In short, the overall improvement of general hygiene conditions is the best method of eliminating typhoid and paratyphoid fevers. For the health administrator these diseases constitute a justification for the adoption of measures which will lead to the individual and social well-being of the population entrusted to his charge.