

### The Carrier Problem in Disease.

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THE discussion which I have the honour of opening this evening is one, I frankly admit, I approach with a certain amount of diffidence. Our knowledge of the subject in relation to the human carrier is limited to a few diseases; the fact that carriers are known to exist in relation to these few indicates that other diseases in which the causal germ is not yet known are probably, if not certainly, spread in a similar manner; further, in the diseases definitely proven to yield carriers, treatment of this source of infection has so far been distinctly unsatisfactory; and with treatment more or less at a discount, control must obviously be inefficient.

I propose to discuss briefly the carrier in relation to a few well-known diseases endemic in this country, touching on the question of treatment and control as I proceed.

The carrier, or more correctly "germ carrier" may be defined as a person who harbours, and disseminates, the virulent germs of a disease, without himself presenting at the time, any clinical symptoms of the disease. Carriers may be grouped into the following classes:—

1. Those convalescent from the disease in question.
2. Those in the incubation period of the disease, the so-called "precocious" carrier.
3. Those who have not recently had the disease and who do not subsequently develop it, despite the fact that the causal germ in a virulent condition continues to exist in some part of their body.

This class may be conveniently spoken of as the "healthy carrier."

The term "contact carrier" is frequently employed in relation to members of this group in whom recent direct contact with a case of infectious disease can be proved. It is obvious that all healthy carriers must at some time or another have been in contact with the disease or with another carrier, so the distinction is only one of degree.

The question "Why should carriers arise at all?" may well be asked. We know that the convalescent from an infectious disease acquires, by the formation of certain substances in his blood, an enhanced immunity or protection against future attacks of the disease. If he becomes a carrier, it would appear that the protective substances formed during his attack are not sufficiently powerful to bring about the complete disappearance

of all the germs from his body. In the case of the healthy carrier it has been proved that a certain degree of immunity also exists. Such an immunity may be a natural one or it may be acquired, the carrier in question apparently suffering from a mild or abortive attack of the disease with complete absence of symptoms.

The healthy carrier is therefore finally in a similar position to the convalescent carrier, in that, the antibodies in his system, which serve to protect him from an acute attack of the disease, are quite inadequate to bring about total destruction of the invading organisms.

An unhealthy condition of the tissues at the site where the germs are harboured, such as enlarged tonsils or a chronic inflammatory condition of the mucus membrane of the nose, also plays a considerable part in maintaining the carrier condition.

Carriers have been definitely proven as a source of infection in the enteric group of fevers, diphtheria, cerebro-spinal fever, dysentery and cholera. As I have already mentioned, it is safe to assume that carriers exist in relation to other of the infectious diseases: acute anterior polio-myelitis and scarlet fever appear to provide instances of carrier infection. Unfortunately the causal germ in many of the infectious diseases is yet undiscovered, and without this knowledge final proof of a carrier condition cannot result.

In this country carriers of diphtheria undoubtedly occupy first place as a source of public danger. There is, however, no uniformity of action in dealing with them: in certain districts routine swabbing of all diphtheria contacts is employed, and where this is done, especially during epidemic periods, the number of immediate contact carriers discovered may be considerable. These immediate contact carriers usually respond rapidly to treatment: a protective dose of serum; a course of antiseptic applications to the throat or nose, and complete disappearance of the organism, as a rule, quickly follows. Apart from any treatment, most of these cases would probably clear up spontaneously in a short time.

In those districts where the immediate contact carrier is dealt with, it is unfortunately the case that no marked reduction in the incidence of diphtheria has followed. I think, that perhaps the greatest benefit obtained from dealing promptly with this group is, that a certain number are actually "incubation carriers," and the treatment given aborts the onset of an acute attack of diphtheria.

The line of action to be followed in dealing with the "convalescent carrier" is a source of much controversy. In some places cases are discharged from hospital when perfectly well without any bacteriological examination of the throat or nose being made. Other authorities insist on one, two, or three negative swabs prior to discharge.

The arguments advanced against swabbing are (1) expense resulting from the retention in hospital of people who are perfectly fit, (2) the fact that the total carrier population is so large that the few discharged with germs in the throat or nose are a negligible percentage, (3) the fact that periods of intermission of infectivity undoubtedly occur in carriers and negative swabs may be obtained during such a period, (4) the fact that in swabbing a throat or the nasal passages it is quite impossible to cover the whole area. Where swabbing is carried out as a routine it must be granted that the actual numbers who have to be retained for any length of time are not very great, and a certain amount of satisfaction results from the knowledge, that a slightly lengthened stay in hospital has possibly reduced the number of positive throats and noses in the community. When the convalescent has become a true "carrier," however, and such a condition cannot be considered as existing until, say, at least three months have elapsed, little, if anything, is gained by further detention, as no certain means of clearing the carrier of his condition is known.

It is exceedingly difficult to form any idea of the actual number of diphtheria carriers that exist undetected. It is certainly considerable and a marked rise takes place during an epidemic period of the disease. Some little time ago in the United States an entire school of about 800 pupils (I am quoting from memory as I cannot at the moment lay hands on the article reporting the work), was swabbed on three occasions. The result of the three swabbings was, that about 160 of the pupils were found to be harbouring diphtheria germs in the throat: this, namely, twenty per cent., would appear to be an unusually high figure. A further example: at the Fever Hospital in Edinburgh, it is the custom to swab the throats of all patients admitted with Scarlet Fever; over a period of years from ten to fifteen per cent. of these patients were found to harbour the Diphtheria bacillus in the throat. It must be granted that the evidence was only microscopic; virulence tests were not carried out. Assume, however, that perhaps half of the total harboured the bacillus in a virulent condition, and one arrives at the result, that approximately five to seven per cent. of a chance group of people, and therefore possibly the same percentage of the entire population, were at least temporary, if not chronic carriers, of diphtheria.

If carrier infection during an outbreak is suspected, the nasal passages merit as much attention as the throat. I am convinced that the healthy nasal carrier is the greater source of danger: he disseminates virulent germs each time he sneezes; a mild nasal catarrh increases this danger, and he is much more likely, in a school or factory, to infect articles such as towels, that are used in common. Last year I had two very striking

instances of the damage a nasal carrier can produce. In one family, in addition to the nasal carrier, three cases of true diphtheria and two contact carriers resulted ; in another, two cases, of true diphtheria and three contact carriers occurred.

In either family the history given was similar : the proved nasal carrier had " had a slight cold in his head for some time past."

As to the question of treatment of the convalescent and healthy carrier in diphtheria, antiseptics innumerable have been employed without any success ; removal of tonsils, adenoids or nasal polypi, if such exist, must be done ; this, in a proportion of cases proves successful, but frequently fails ; living cultures of different germs have been sprayed on the throat, but have been found disappointing. The most promising treatment now available is the employment of a diphtheria vaccine, on the principle that the immunity of the person is thereby increased, and the possibility of complete elimination of the bacilli enhanced. The amount of reported work in this direction is not extensive, but the results so far to hand, where detoxicated vaccine has been employed, are sufficiently striking to justify further investigation. Detoxicated vaccine has the advantage that practically no reaction follows its use and enormous doses can therefore be employed. It is, however, an expensive preparation, and until very definite proof of its efficiency is forthcoming, it is not likely to be used generally in the meantime.

In New York the position in relation to treatment of diphtheria carriers is considered so unsatisfactory, that an attempt is being made to deal with the problem of diphtheria incidence by rendering the susceptible population immune.

The Schick test is employed first as a means of ascertaining the susceptibility or immunity of a person to diphtheria.

A positive reaction indicates susceptibility, and whenever obtained immunisation is carried out, by the use of a special preparation known as toxin-antitoxin mixture, which, when injected, stimulates the formation of protective substances in the body.

Davies, of Bristol, has reported favourably on this method when employed by him on a small scale during the recent epidemic in that city.

Treatment by rendering the population immune is yet in its infancy, but it appears to have a much more hopeful immediate future than attempting to reduce diphtheria incidence by the treatment of chronic carriers.

The carrier in Cerebro-spinal Fever harbours the organism in the mucus membrane of the naso-pharynx. The extent to which the general population may prove to be carriers cannot be easily determined, but it is definitely established that during epidemic periods the number of carriers becomes

relatively high : estimates give the figure as from two to five per cent. of the population in the epidemic area. As a rule most cases succeed in freeing themselves in a few weeks, and under appropriate antiseptic treatment the majority of the more resistant cases clear up in two to three months. The chronic carrier, however, still appears, and no satisfactory line of treatment has been evolved.

In dealing with the carrier of cerebro-spinal fever very great care is called for in obtaining swabs for examination.

Contamination is difficult to avoid ; the organism is an exceedingly delicate one, and, unless inoculation of culture media is carried out on the spot, death of the meningococcus may easily occur. Negative results are therefore not always of great value, and the satisfaction of having cleared a carrier of meningococci is often very doubtful.

The carrier in the Enteric Fevers provides a different type of problem ; the majority are certainly " convalescent carriers," but recent work indicates that the incubation carrier and contact carrier may play a part in the spread of these diseases.

The organisms are harboured in different situations :—

- (1) The bile tract and particularly the gall bladder.
- (2) The urinary tract and, where the carrier is a urinary one, lesions in the shape of small abscesses in the kidneys, or ulcers on the bladder wall are stated to be found.
- (3) Deposits under the periosteum (the fibrous membrane covering bone). These deposits may remain inactive for years, but abscesses may finally form, and breaking down, provide a focus of infection.

These enteric carriers, particularly where the site is the gall-bladder, and the vast majority are of this type, may continue to be sources of infection for years, virulent bacilli, in enormous numbers, being passed with the stools or urine. Dean, in 1908, recorded a case in a patient, who, twenty-nine years after her attack of typhoid fever was found to be still passing virulent germs in her stools.

Enteric carriers, more than others, present the phenomenon of being only intermittently infectious. One is therefore in the position of being quite unable ever to declare with any degree of confidence, that an enteric carrier is cured.

Treatment is at a discount : some drugs, notably urotropin, are stated to be of assistance in the urinary carrier, but this is exceedingly doubtful ; cure of the abscesses in the periosteal type removes the focus of infection ; where the organisms are harboured in the gall-bladder the position is one of exceeding difficulty. Intestinal antiseptics and vaccines have been tried without any success. Excision of the gall-bladder has been claimed as a

means of cure.; it is, however, hardly conceivable that all proven enteric carriers would be in the least willing to consent to this somewhat drastic treatment.

Modern sanitation is our biggest asset in protecting us from the danger of these enteric carriers, and accompanying this there must be careful control over water and milk supplies, and of the collection and sale of shell-fish. The known carrier must never be allowed to handle or to assist in the preparation of food or drink for human use, and careful attention to excretal and self-disinfection must be insisted on.

But for every known carrier how many unknown exist? Simon, of New York, estimated in 1915, that the enteric carriers in that city numbered roughly 25,000.

Carriers of cholera and dysentery are only of passing interest to us in this country. It would appear that the number in cholera is not proportionately very high, and the carrier condition is said not to last any length of time. The carrier in dysentery is, however, a fruitful source of danger, and may continue to be so for lengthy periods; the condition here, to some degree, arises from the fact that there is a great tendency to chronicity in the disease (particularly in the amoebic variety), and the person becomes actively infectious whenever a mild recrudescence occurs.

Permit me now to review the situation. I have shown that the carrier is not an oddity; on the contrary he probably is, and certainly becomes during epidemic periods of some diseases, quite an appreciable percentage of the population. His discovery, unless he happens to be a member of a small community, such as a family, may prove a matter of extreme difficulty and entail much expense.

Treatment of the really chronic carrier has so far proved eminently unsatisfactory, and a claim to cure may prove later to have been only co-incidental with a period of intermission in infectivity.

If isolation of all chronic carriers were to be insisted on until apparent cure had resulted, some cases, notably certain enteric carriers, might easily become inmates of an isolation hospital for life. Even convalescent diphtheria carriers have been proved to continue as such for several years.

The healthy carrier in diphtheria and cerebro-spinal fever cannot be considered to be suffering from an infectious disease, and such being the case one has no legal power compelling his isolation. Where isolation and treatment of discovered healthy contact carriers is indulged in, it is rare to find a direct refusal to comply with the request. If such refusal were met with, however, one could do nothing more than point out to the carrier the danger he is to the general public, and instruct him as to precautions he should take to avoid spreading infection; such instructions directing

him to abstain from the use in common of eating and drinking vessels, and to refrain from kissing. But when all is said and done, the known direct contact carrier of diphtheria and cerebro-spinal fever is but a trifling percentage of the undetected ones. When a satisfactory treatment for this group of carriers is discovered, then legislation could be obtained enforcing submission to it. Enormous expense would be involved in discovering the carrier population, but it would certainly be justified, if one could succeed thereby in stamping out, or even appreciably reducing, the incidence of such a scourge as diphtheria; meantime, I consider that immunisation with toxin-antitoxin mixture promises the most hopeful outlook in reducing diphtheria incidence, and one awaits with great interest further reports as to its efficiency.

The Pneumonia, Malaria and Dysentery Regulations of 1919, are the sole piece of legislation in regard to carriers. By them, powers are granted prohibiting dysentery and enteric carriers from taking part in food preparation, and entailing on the carrier in question obedience to orders from the Local Authority as to disposal of excreta and precautions as to self-disinfection. Meagre enough these powers are, and difficult to enforce satisfactorily.

In Typhoid, Cholera and Dysentery, protective inoculation has proved its worth, and, if anything approaching a large epidemic of one of these diseases should ever threaten, this would of necessity be our chief means of guarding ourselves against it and the crop of carriers arising from it.

I have confined my remarks to the human carrier; we must remember, however, that animal carriers of disease are comparatively common. The ordinary house-fly is a carrier of particular danger in typhoid, cholera, dysentery and summer diarrhoea in children. Different varieties of the mosquito in malaria and yellow fever, the tse-tse fly in sleeping sickness, fleas in plague, lice in typhus and relapsing fever, and the goat in Malta Fever.

Of the animal carriers, the house-fly alone is of particular national importance to us, and we can all assist in his destruction, and help thereby to reduce the heavy yearly loss of infant life caused by summer diarrhoea.

