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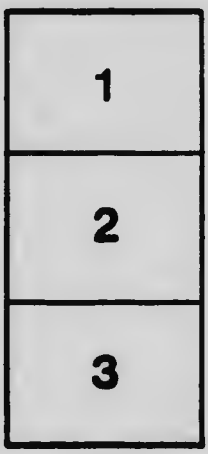

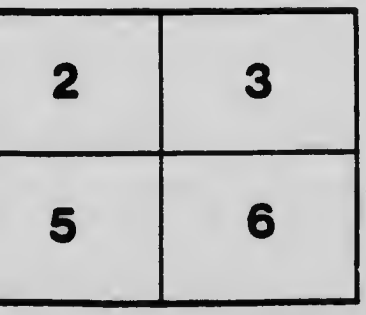

THE TRANSMISSION OF TYPHOID

BY

H. W. HILL, M.B., M.D., D.P.H.

Director, Institute of Public Health, London, Ontario

Presented at the Convention of the Ontario Medical Officers of Health,
May 7-8, 1914

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TYPHOID fever is of peculiar interest in epidemiology because, unlike any other disease of this part of the world except dysentery, it is transmitted by all the five great routes of infection, most of the other diseases being transmitted only by one, two or three. It has proved to be the simplest of all diseases to trace to its source in epidemics, probably on account of its long incubation. Epidemiology as applied to infectious diseases in general owes a great deal to the particular epidemiology of typhoid fever, because the investigative methods worked out for typhoid led the way to the finding of the simple direct applicability, *mutatis mutandis*, of similar methods to other diseases.

It is interesting to recall that typhoid fever has only been recognized definitely for about one hundred years. There is no question that it had existed for ages before that, but had been confused with typhus fever; even to-day remnants of this mistake are preserved in the form of the Latin name of the disease, *typhus abdominalis*, and in a clinical procedure which every student is taught, the testing of the rose spot with the finger to see whether or not it will disappear on pressure. This test originated when it was first attempted to distinguish typhoid from typhus, and we continue it now although the necessity for it has disappeared largely.

Typhus and typhoid were considered filth diseases originally, and were associated in the public and in the professional mind with dirt, poverty and ignorance, a run down system, general decrepitude.

It is interesting that both of these diseases, supposed to be typical filth diseases, have been shown not in any way connected with or dependent upon filth; typhus being purely and simply the result of the bite of an infected body louse (or head louse); while typhoid is simply and solely the result of putting into the mouth the discharges of a typhoid-infected person. No amount of filth can in any possible way generate either disease in the absence of the specific cause; no amount of cleanliness can prevent either one, provided that the specific modes of infection are given opportunity to act.

It may be well to review briefly and at the same moment cast aside, the alleged modes of transmission of typhoid in which our forefathers believed. Sewer gas; swamp air; organic matter in water, whether of animal or vegetable origin; evolution, from the ordinary intestinal bacteria, of the typhoid bacillus; a gradual "running down of the system;" stress, strain and "general unsanitary conditions;" these we know now definitely have no part in its causation, and it is difficult for us to conceive how our forefathers received the impression that scrubbing floors or cleaning up backyards could interfere with a water-borne outbreak. Two more fallacies are still heard repeated; one, the fear of typhoid from cows sick with typhoid. It will be remembered that Stokes of Baltimore fed typhoid cultures to a cow and a calf every day for a month and failed, not only to make them sick, but even to find the germs of typhoid in any of their discharges. The second is that typhoid is carried by flies in well-sewered cities. Of course we may admit an occasional case or two carried by flies from an exposed bedpan or similarly infected utensils or laundry, but practically speaking, typhoid fever is carried only where non-fly-proof, outdoor

toilets exist; and this means principally in the rural districts or in parts of the cities where sewers have not yet been installed.

Cause and Source.

The real cause of typhoid fever, as we know now, is simply the typhoid bacillus. Its real source is the living, human body infected with that germ. From the body, it is thrown out in the discharges of the bladder and bowel. In this it parallels cholera, but it differs from cholera in the fact that the causal bacilli are rarely found in the mouth. Hence typhoid is rarely, if ever, distributed by mouth discharges. Cholera, on account of the terrible vomiting, often stercoraceous, distributes itself by mouth-spray and vomit-spray, by sputum, and by the vomit itself in a mass. Doubtless this difference explains, at least in part, the terrible infectiveness of cholera cases as distinguished from the comparative innocence of typhoid; an innocence comparative only.

Note that the chief source of typhoid is the living, human body. Dead bodies distribute the disease but little because dead bodies have no discharges if reasonably cared for. The old idea that typhoid might come from cemeteries has never been confirmed in my experience; indeed, I have never known cemeteries to act as sources of any disease. It it theoretically possible in limestone districts, but highly improbable even there. Old wells standing unused for years have often been held to breed typhoid, while the fact is that the typhoid germ will seldom live longer than two weeks; and the best way we know of purifying water is merely to store it for a month. Old houses having sheltered typhoid away back in their history have sometimes been held responsible for cases developing amongst new occupants; but the typhoid germ has no spores, and the old fears of prolonged infection in dust from typhoid are quite as unfounded as similar fears concerning scarlet fever, diphtheria or tuberculosis.

For similar reasons old cesspools are equally innocent. In fact, typhoid germs, like most other pathogens, must be transmitted while still fresh from their sources if they are to be transmitted successfully, for they rapidly die out under almost every condition apart from the living human body.

The cause of the disease being typhoid bacilli, and the vehicles in which these are carried being the bladder and bowel discharge of infected persons, the routes of transmission are naturally those routes by which such discharges may travel. Although one can imagine many possible routes, some very intricate, even bizarre, yet probably the main everyday routes for 999 cases out of each thousand are water, food, flies, milk and contact.

Water.

Although water receives so much attention, it is not so great a factor as common belief would suggest. Our studies in the State of Minnesota where we had about ten thousand cases a year, made us believe that water-borne typhoid constituted only about one third of the total. I think that the reason why water-borne typhoid has absorbed the bulk of attention paid to the routes of typhoid infection is this; water-borne typhoid is seen chiefly in great crushing outbreaks, which make a great impression, are remembered long; while the less spectacular outbreaks, less concentrated and more spun out, due to the other routes, are not so well understood or remembered, although they may actually total a greater number of cases.

Water-borne typhoid is but seldom traced to a well; yet most physicians on seeing typhoid will rush out at once to the pump, fill any old bottle with water and send it away to be analysed. I need not go into the folly of such a procedure further than to state that in my own personal experience covering over seventy personally investigated outbreaks of typhoid, and involving intimate knowledge and control of a good many more, I have yet to encounter a single case traceable to a private well. That such may occur where the well is sunk in limestone or crevieed rock, I can quite believe; indeed I know they are on record; but in soils of sand, clay or gravel, or composed of other good filtering material, infection of wells through the soil is practically out of the question, and such wells must receive their infection if they receive any, through the mouth of the well, perhaps

from an open curb allowing a back drip, which carries in with it infecting material dropped on the curb from bedpans; or from the feet of humans or animals crossing the curb. Theoretically possible though this be, I think that universal experience shows such methods seldom work in practice. In the few public wells I have known to give rise to typhoid, the infection occurred by direct entry of sewage into the well; in one case by the backing up of a sewer directly into the well; in another by percolation through crevices rock. The great mass of waterborne typhoid comes from open surface waters, rivers, lakes or ponds, and such waters. Outbreaks occur chiefly in winter for in summer the sunlight interferes with the germs.

Two important points should be noted: first, that communities should not be trusted with double water supplies, of which one is open to infection. This is sometimes done where the good drinking water supply is small, and the second polluted supply is carried in for fire protection. In such cases, the public will drink from the polluted water despite all warnings. The other point is somewhat like it; that the frequent practice of connecting a good water supply with polluted water by auxiliary pipes to provide for fire emergencies should never be allowed. Many and many an outbreak has developed under such circumstances, following a fire in which the fire chief thought he needed the extra polluted water to keep up his pressure.

The characteristics of a water outbreak are suddenness; the extensive development of many cases; and a distribution corresponding with the distribution of the water supply. When due to gross contamination of water with sewage, such outbreaks of typhoid fever are often preceded by very sharp outbreaks of diarrhoea. These diarrhoea outbreaks occur on the day, or the day or two after, the admission of the sewage to the supply. The typhoid outbreak comes on later; the first cases usually not diagnosed for three weeks or a month. In the interval the diarrhoea cases have all recovered; and the outbreak of diarrhoea is likely to be forgotten before the typhoid outbreak appears.

Food.

Food in the family circle receives the family discharges and thus often aids the transmission of typhoid from person to person in the household if one case is present; but food as it is distributed from supply centres to families rarely conveys infection to them from outside, because after it is received into the family it usually is cooked. Practically, food outbreaks of typhoid from sources outside the household are rare, and when they occur are usually due to oysters eaten raw, raw vegetables or such similar matters. (Milk and milk products form such an important route of typhoid that it is well to consider them separately).

Flies.

Flies carry typhoid without question when typhoid discharges are open to them. They carry the material on their feet and deposit it upon food as a rule, although it is possible that a fly might, as sometimes happens, blow or fly directly into an open mouth.

Fly typhoid is well known in Insane Asylums for the reason that typhoid-infected persons, recognized or unrecognized, are often admitted; and since, on account of their physical condition if sick, or their mental condition if well, such persons are apt to distribute their discharges quite loosely, flies can get at them readily if there are flies about. In camps with exposed discharges and in that one-half our population which lives in the country districts with crude toilet facilities, paralleling camps in this regard, fly typhoid is prevalent. In well-sewered cities, however, fly typhoid can hardly exist because the discharges which flies might carry if they were deposited outside, are swept away by the sewers. It is true that in some cities whole districts may not be connected with sewers and in such, fly typhoid may exist. It must not be forgotten that a great deal of summer diarrhoea and dysentery is carried by flies.

Milk and Milk Products.

Milk to quite an extent, butter sometimes and possibly cheese may carry the typhoid bacillus. It is usually only in fresh milk that the typhoid germs will live long enough to make a successful

entry to human bodies. Undoubtedly it is for this reason that milk-carried typhoid is not common in big cities. The great disadvantage which big cities suffer in using comparatively old milk gives them this one advantage; infection with pathogens tends to die out because of that very disadvantage, the age of the milk.

Typhoid infection of milk usually occurs by the placing of human discharges in the milk at some stage at which it is handled by humans, as, for instance, a walking case or carrier or attendant on a case of typhoid fever who milks the cow, washes the cans, caps the bottles, or in some way gets fingers into the milk.

It is possible that adulteration of milk with typhoid infected water might give rise to an outbreak, and it has been suggested that cows standing in typhoid-infected rivers or ponds might, when being milked, shed typhoid bacilli picked up from the water by their skins or their hair. Practically speaking, however, the great method of milk infection is by hands. Milk typhoid outbreaks are usually sudden but scattered, and in close correspondence with the consumers of some one given milk supply. It is usual to find that the milk is infected only on one single date; but if a walking case should continue to handle the milk for some length of time, the milk might for that period be continually dangerous. In one instance which I worked out for myself, I found that milk had been responsible for all the typhoid of a certain small community during a period of about five years. Previous to this period, native typhoid had been unknown there. At the beginning of the period, a new family had come to town and opened a milk route. Every case which occurred during the five years was on the milk route of this family or at least had access to that milk. At the time I investigated, I found that the only suspicious person was the old mother who washed out the milk cans. She had had typhoid twenty-two years before. The family left the town then and in the five years that have elapsed since, no native typhoid has occurred there at all. It is, however, rather unusual to find a typhoid outbreak from one such source continuing so long.

I have seen but one butter outbreak of typhoid. The ordinary routes were eliminated, although with some difficulty, and a certain grocery store was shown to be the centre of radiation of cases; but no source of infection could be discovered there.

The one material used in common, however, by all the cases, was found to be a certain day's sale of butter; and by persistent visiting of dairies all around the neighborhood, a part of the butter contributing to this day's sales was traced to a family where a walking case, a girl, had helped to make this particular butter while her mistress who usually made the butter was sick.

Contact.

Contact is a very common method of typhoid transmission. Never mind what the original route may be, water, food, flies or milk, the cases arising from that route often may give rise to others by direct contact. This means that the nurse or attendant takes the discharges on her fingers and puts them into her mouth or into the food of the others. The contact may be more or less round about, but in the great mass of cases, hands are the principal factor. In handling all typhoid outbreaks, the first thing to do, it is true, is to find such a general source as water, milk, etc., if such is responsible for the main outbreak; but it is equally essential to carry out the strictest supervision to prevent the continuation by contact of the original outbreak.

Mixed Routes.

Outbreaks sometimes may occur from two or more independent sources happening to operate together. Thus I have seen an outbreak of typhoid and dysentery in one community due to flies; and in a hotel in that community another outbreak of typhoid carried by the hotel well into which sewage had backed. In investigating this place more or less confusion might readily arise if one did not take into account the chance of two separate outbreaks existing at once.

Method of Epidemics:—

Water.

Water outbreaks are most readily ended, so far as the water is concerned, by

installing hypochlorite treatment. In Minnesota we kept ready for shipment the necessary plant for treating a million gallons a day. The whole thing cost less than fifty dollars. When packed, we could ship this plant in a very short time with instructions how to install it, thus purifying the water long before notice to boil the water could be propagated through the community so as to really reach the inhabitants. If immediate chlorination is impossible, instructions to boil the water printed on placards and publicly posted up on at least three points on each side of every block in the community, is the shortest way to notify the people. This notice should be a very condensed one in very large type, such as, **TYPHOID—BOIL THE WATER.** and signed by the Board of Health. Newspaper notices are usually far too slow in reaching the public effectively. Permanent reformation of the water supply should then follow of course.

Food.

In food outbreaks the infection of the food which is responsible has usually ceased before the typhoid develops; if not, however, the indications are to see that the guilty food is cooked or eliminated from the diet, and to search for and stop its contamination if possible. (See Milk).

Flies.

Fly outbreaks can almost invariably be stopped instantaneously by merely fly-proofing the outdoor toilets except in those rare cases where deposits of human discharges in the open may be responsible. Such fly-proofing means only stopping all holes in the walls or ceiling and placing a weight or a spring on the door. It does not mean necessarily any elaborate structure of fly screens, etc. Lineing of closets is often recommended, but is almost invariably a fallacy since it is a process that must be continued day after day for efficiency and usually will not be so continued in any large percentage of cases.

Milk.

In milk outbreaks the search for the person infecting the milk should be tried at once and if successful within a few hours, the elimination of that person stops the outbreak. Should there be difficulty in finding the infecting person, however, the milk supply must at once be stopped or pasteurized and this status should be continued until the infecting person is found and eliminated. Occasionally neither stopping the supply nor pasteurizing the milk is practicable. In such a case the safest way, if the infector cannot be found, is to transfer the handling of the milk to a totally new set of persons. Of course, in the rare cases where the addition of infected water to the milk is the source of the trouble, the elimination of such addition would be sufficient. It is a wise precaution in all cases to have a thorough disinfection of all utensils.

(Note—Infection of milk with typhoid is comparatively rare; with bovine tuberculosis, almost continuous. Milk should be pasteurized always for the sake of the latter, even if typhoid were unknown.)

Contact.

Contact outbreaks can only be stopped by the most rigid and consecutive attention to the washing of hands after each contact with the patient or the patient's discharges, or by the immunization of those who are in attendance on the sick. The precautions regarding hands must be insisted on even after immunization, for the sake of the unimmunized to whom the immunized may carry infection in contact. Hence proper precautions about hands are really more inclusive than immunization.

Summary.

To sum up: Handling of typhoid from the standpoint of prevention involves, first, the purification of any infected route which may exist, by the various methods already outlined. Second, the immunization of those exposed to infection; this sounds hopeful and when it can be enforced as in armies has proved very useful. I do not expect it to be a great factor in civil life, however, for we have had one hundred years of vaccination against smallpox and still have a large percentage unimmunized against that disease. It does not seem likely that vaccination against typhoid will become any more popular. Third and to my mind the greatest method of all is the prevention

of infection of the various routes through supervision of the sources of infection, that is, the infected persons themselves. Once typhoid discharges are eliminated from water supplies even water purification would become unnecessary. Once human infected discharges are excluded from outdoor toilets, even the fly-proofing of the toilets, would become unnecessary to eliminate typhoid, although still vital for other reasons. In brief, if we had no typhoid bacilli there could be no typhoid, and there can be no question that by supervising these sources of infection, the elimination of typhoid is best secured. Supervision of sources is much cheaper as well as much more efficient than the purification of routes. The expenditures necessary to purify properly sewage, water supplies, food, milk, etc., are enormous. Supervision to eliminate need of such protection would not cost a tithe as much and would abolish disease, not merely affect a small part of it. Were typhoid all purely water-borne, enormous expense to secure purification of water would still be less advisable than the supervision of typhoid infected persons, to prevent them from infecting water. But since no amount of purification of water will eliminate more than a fraction of the typhoid, and will leave fly, food, contact and milk typhoid still untouched directly, supervision which will go to the heart of every source and each route is evidently far more needed, far more effieient, less costly. Finally, a mechanism for supervision of typhoid would be applicable to the supervision of all other infections diseases as well as typhoid.