HOOKWORM DISEASE A NATIONAL PROBLEM.*

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A new and illuminating chapter will ultimately be added to the already remarkable history of preventive medicine. Hookworm disease and the campaign for its eradication will form the subject of such a chapter, and it is safe to say that no other will contain so much of human interest. Through the combined activities of three score public health workers in this country, and in certain island possessions, it has been abundantly shown that hookworm disease no longer can be

than any other single disease we have to fight, with the possible exception of tuberculosis. It has, therefore, a nation-wide interest, and must be regarded as a national problem.

The subject may be conveniently discussed under the following heads:

1. The nature of the disease.
2. The causes underlying the existence and spread of the disease in its relation to the problem of soil pollution.
3. Its geographic distribution and how this affects the questions of immigration and quarantine.
4. Some results of the campaign as shown by statistics.

No. 1—Group of patients at Honoraville, Cranshaw County, Alabama; 109 patients treated on this day.

regarded as merely a local problem, affecting this or that Southern State. Still less can it be looked upon as a public health problem to be solved unaided in any given community within the borders of a commonwealth. These facts have been further emphasized by what has already been demonstrated in a short time during the remarkable campaign now being carried on throughout the Southern States in an effort to eradicate the disease. Such a malady, affecting as it does so many interests of all sorts and conditions of people throughout a tremendous area of densely populated territory, is probably more devastating

5. The economic and humanitarian questions involved.

Attention is called first to the nature of hookworm disease. A consideration of this is important in its bearing on certain observations which are to follow. First of all, the disease is specific and well defined, its whole train of signs and symptoms being dependent on an infection with a small thread-like worm, half an inch long, harbored within the small intestine. Moreover, this worm is a typical parasite whose victim is the human host, and, like others of its kin, it has a double life-cycle. Only one of these cycles—that of the adult stage—occurs within the intestinal tract of man. The worm is incapable of reproduction within the human host. This means,

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that every single one of the thousands of these little worms with which one individual may be infected represents that number of young larval forms, visible only with the microscope, which have made their way from polluted soil, through the skin and circulation, into the intestinal canal. The development of the first life-cycle of the parasite, which begins after the discharge of the eggs, must and does occur outside of the human body. A home ready prepared for this is immediately found in the soil. The soil so peculiarly adapted to the development of this first life-cycle is the warm, moist, sandy variety.

far more practical results—results that are really tangible—are obtained by concerted, systematized efforts directed toward a solution of both problems. Manifestly, however, of the two propositions here mentioned, the prevention of soil pollution would be considerably more far reaching in accomplishing greater things for sanitary medicine than would merely the curing of all hookworm sufferers; for, not only would hookworm disease itself then be eradicated, but the spread of other scourges, notably, typhoid fever, cholera, and the dysenteries, would be easily controlled. Soil pollution, therefore, the real underlying cause

No. 2—Waiting for dispensary to open at 8:30 A.M., Jemison, Chilton County, Alabama.

Briefly stated, then, the all-important underlying cause of the widespread existence of hookworm disease is soil which has been polluted by reason of man's unsanitary habits of living.

It is the consideration of these fundamental facts concerning the nature and cause of the disease which is important in this discussion.

The ultimate eradication of hookworm disease depends upon two fundamental propositions, namely: (1) the prevention of soil pollution; (2) the curing of all infected persons. Theoretically, if either one of these tasks were accomplished, the stamping out of the disease would be a finished job. Experience has shown, though, that

of the existence and spread of hookworm disease, is a question of special interest, so far as hookworm disease as a national problem is concerned; for, as already intimated, if we stamp out this malady by remedying the filthy, unsanitary conditions existing throughout the length and breadth of that territory affected by the disease, we will, too, solve the problem of prevention of other death-dealing diseases which also exist and spread so largely by reason of polluted soil.

To illustrate the force of this statement consider, for example, certain facts bearing on typhoid fever. It is admitted that this disease is preventable, and that its prevention depends, in its last

analysis, upon the sanitary disposal of human excreta. The same conditions identically which give rise to soil pollution, as regards hookworm disease, equally admit of soil pollution with the discharges of typhoid sufferers and typhoid carriers. Then, if we eradicate hookworm disease by the prevention of soil pollution, we will also control the spread of typhoid fever. In the light of these facts, consider the tremendous significance of the following statistics, reported by Dr. Allan J. McLaughlin,* of the United States Public Health Service. In the year 1910 fifty registration cities in the United States, having a combined population of over 20,000,000, showed an aggregate typhoid death rate of 25 per 100,000 inhabitants. It is conservative to say that 25 deaths per 100,000 population represent 200 cases of the disease. These figures show, then, that because of im-

occurred in the United States during the same period one million and a quarter cases of typhoid fever, or more than four cases of typhoid fever in the United States for every case of cholera in Russia. In Italy in 1910 there occurred 16,000 cases of cholera with 6,000 deaths; yet in the same period we had in the United States more than half a million cases of typhoid, with 50,000 deaths. In 1909 there were more cases of typhoid fever in the United States than there were cases of plague in India; yet the population of India is two and a half times that of the United States. Many of us would not hesitate to say that these foreign countries are pest-ridden. Hookworm disease and typhoid fever are less dramatic, perhaps, in their ravages, but their toll of human life is far greater.

This significant relationship, then, of typhoid

No. 3.—Rural school, Washington County, Alabama. Seventy-five per cent of these children found infected with Hookworm Disease.

proper disposal of human excreta of typhoid sufferers and typhoid carriers, there occurred in these fifty cities in one year 5,000 deaths among 40,000 cases of a preventable disease. These are startling figures; yet when we estimate such statistics for the United States as a whole, the figures are even more appalling, for undoubtedly the number of cases and deaths from typhoid fever in the smaller cities and towns, and throughout rural communities where soil pollution is so extensive, must be even greater than in the fifty registration cities. It is estimated, therefore, that there occur in the United States every year 16,200 deaths among 175,000 cases of this filth disease.

From January, 1907, to October, 1911, there occurred in Russia 283,684 cases of Asiatic cholera. According to a conservative estimate there

fever and hookworm disease to the question of soil pollution is sufficient in itself to justify one in considering hookworm disease and the campaign for its eradication as a national problem.

No phase of this subject is of greater significance than the geographic distribution of hookworm disease. The results of a survey of this and other countries to determine this question have forced a consideration of several important problems, the most interesting of which concern questions of immigration and quarantine, and some of the tremendous economic issues involved. The findings of this survey have also emphasized how enormous is the undertaking which proposes to eradicate hookworm disease, and how great is the need for a world-wide movement by definite, concerted action.

Certain reports by Wickliffe Rose, Administrative Secretary of the Rockefeller Sanitary Com-

*U. S. P. H. Rep., Vol. XXVII, No. 12.

mission, give the most recent facts brought to light by this survey, and the following statements are quoted from these reports.

"Hookworm infection belts the earth in a zone about 66 degrees wide, extending from parallel 36 degrees north, to parallel 30 degrees south; practically all countries lying between these two parallels are infected."

Extensive areas, having varying degrees of infection, have been definitely defined on the continents of the two Americas, Europe, Asia, Africa, Australia, and many island possessions of these countries. Aside from our own Southern States, reports show that hookworm disease has become a very serious problem in fifty-four foreign countries. In at least forty-six of these the infection is general and widespread, thus affecting nearly 920 million people, and an area of more than fourteen million square miles. To this may be added eleven of our own States, with a population of almost twenty-one million, and an area of 510,000 square miles. "Of the total population of the globe—about 1,600,000,000 in round numbers—about 910,000,000 live in countries where hookworm disease is prevalent."

"Infection has been demonstrated in 93 of the 100 counties in Virginia; in 99 of the 100 counties in North Carolina; in 140 of the 146 counties in Georgia; in every county in South Carolina; in every one of the 67 counties in Alabama; in 77 of the 79 counties in Mississippi; in 27 of the 59 parishes in Louisiana; in 57 of the 75 counties in Arkansas; in 95 of the 96 counties in Tennessee; in 22 of the 119 counties in Kentucky, and in 83 counties in Texas. In addition to the States above mentioned, infection has been demonstrated in Florida, California, Nevada, Oklahoma, West Virginia, with very strong clinical evidence of its presence in Maryland."

In the light of these facts concerning the wide spread distribution of hookworm disease, the importance of immigration regulation is obvious; indeed, it is a question which becomes more and more serious from year to year, in view of the ever-increasing stream of immigration into this country. The National Government has given some recognition to this fact. Accordingly, the immigration act, regulating the admission of aliens into the United States, and providing for medical examination of immigrants, now prohibits the admission of any immigrant who is found to have hookworm infection.

To show the urgent need of a rigid enforcement of this regulation, the following figures may be cited: At the station on Angel Island, San Fran-

cisco, from September 23, 1910, to November 30, 1911, the stools of 2,255 immigrants were examined microscopically. Of this number, 1,077, or nearly 50 per cent, showed hookworm infection. Japanese, Chinese and Hindus constituted over 80 per cent of the total number examined. These figures, though small, and representing the results as shown at but one immigration station, are none the less significant, especially in view of the fact that the southern two-thirds of the Chinese republic has a heavy infection, reaching in some places as high as 70 per cent, and that 60 to 80 per cent of the 300 million people of India are victims of the disease.

The economic loss resulting from hookworm disease is enormous. Agricultural pursuits of all

No. 4—Family of nine, all heavily infected, en route to free dispensary.

kinds the world over are suffering tremendous losses; likewise the mining industries in this and foreign countries.

Space does not permit a detailed discussion of this problem, but one or two examples may be cited which will serve to point out the relation of this question to the campaign for the eradication of the disease.

It is conservative to say that the loss in efficiency occasioned by hookworm infection ranges from 20 to 60 per cent. This statement is borne out by information gathered from all sources throughout the widely infected territory.

Take, as an example, the economic loss from hookworm disease in one of the more mildly infected counties of this, or any State. The average population of our counties is 30,000; the average heavy infection in those campaigned is over 30 per cent. To be unduly conservative, let us

estimate the loss in an average county of 30,000 people with a 10 per cent infection. Further, that we may err, if err we must, on the safe side, let us assume that this 10 per cent infection is so mild that each of those infected can, in an eight-hour working day accomplish a good seven hours' work. In such a county we would have 10 per cent of thirty thousand; that is, three thousand people losing one hour a day—a loss of three thousand hours per day. Dividing by eight—the working period—we get the number of

No. 5—Twin sisters, age 18. Smaller girl heavily infected. Shows dwarfing effect of the disease.

working days lost every year—three hundred and seventy-five, which figures, of course, also represent the annual loss of work in years. Is there any county in any State which can afford to lose three hundred and seventy-five years' work annually—an amount of work that, figured in dollars and cents with a wage of only three hundred dollars a year taken as an average, amounts to no less than \$112,500?

But we need not avail ourselves of theoretical statistics, striking thought they may be. We have a mass of facts and figures, gleaned from a number of different countries and a variety of sources, in-

cluding coffee and cocoa plantations, cotton mills, coal and gold mines, etc., from which facts and figures we may pick a few examples which typify the whole.

The physically sound coffee-picker in Porto Rico picks from five hundred to six hundred measures of coffee per day. Scores of anemics report that they can pick only from one hundred to two hundred and fifty measures per day. According to estimates from the managers of the large plantations there hookworm disease has reduced the average efficiency of the labor on these plantations to from 35 to 50 per cent.

In one of the largest cocoa plantations of Brazil, at Babahoyo, of three hundred laborers, more than two hundred are incapacitated by the ravages of hookworm disease and chronic malaria.

In California, in Mine No. 2, at Jackson, where over three hundred men are employed at an average salary of \$2.50 per day, the average annual loss in wages alone is over \$20,000; and this estimate is for one mine only.

It is needless to multiply these examples. The story told by one is the story of all. Speaking for Porto Rico, Dr. Ashford says: "Anemia in Porto Rico is a medico-socio-economic problem, which cannot be solved without her physicians. Once solved, she will enter upon an era of prosperity which today our most extravagant dreams cannot foreshadow."

A review of certain features of the campaign throughout the Southern States brings to light the real human-interest side of this whole problem. For a more detailed discussion of the various activities of this campaign, reference should be made to the second and third annual reports of the Rockefeller Sanitary Commission.* It will suffice here to quote from a summary just issued by Wickliffe Rose. In 1911 and 1912, in the Sanitary Survey, a total of 103,346 farm homes, taken at random in 308 counties, scattered over eleven States, have been inspected. Of these, 50,637 have no privies. The preliminary infection survey has been completed in 230 counties in eleven States. The total number of rural children between the ages of six and eighteen years examined microscopically is 158,555. Of these, 78,572, or 50.9 per cent, were found infected.

In the same period 233 counties have appropriated a total of \$36,543.06 to aid in the work of the campaign.

Free dispensaries for the examination and treatment of hookworm sufferers have been operated

*725 Southern Bldg., Washington, D. C.

in 237 counties, and for the two years 1911 and 1912 a total of 327,265 microscopic examinations have been made, and treatment has been given to 223,904 patients.

The total number of persons treated in eleven States for three years is 393,556. This means the treatment of 359 persons a day for every day since the work began.

Deserving of special mention also are some figures given in the report of the work on the island of Porto Rico, as set forth by Dr. Bailey K. Ashford,* Major of the Medical Corps of the United States Army, who with King and Igaravidez formed the (first) Anemia Commission, whose monumental work on this island furnishes one of the most interesting and instructive chapters in the history of endemic disease. It would be impracticable to attempt any review of this work in this discussion. The elaborate reports of the commission make it unnecessary to give here any detailed account of the work.

After reciting in detail the "history of a ten-years' campaign against uncinariasis in Porto Rico," Dr. Ashford concludes the chapter with the following statement: "The sum total of persons treated for uncinariasis to June 30, 1910, is 287,568. This represents the work of the commission and its successors, the anemia dispensary service, and the service of tropical and transmissible diseases, since the beginning of the campaign of 1904. We estimate that at least 30,000 more have been treated apart from government work, and of which we have no record. We are entirely safe in saying that over 300,000, or nearly one-third of the population of Porto Rico, have received specific treatment for uncinariasis."

The Hookworm Commission of the Alabama State Board of Health is entitled to the credit of first successfully establishing the type of free dispensary now operated throughout the Southern States for the examination and treatment of hookworm sufferers. This dispensary work has become a permanent part of the activities of the Hookworm Commissions of the several State boards of health which are carrying on this campaign. It is but one of the means employed, however, in reaching the people. Space does not permit a discussion of other important phases of the educational campaign which is being carried on by means of illustrated public lectures, school inspections, and distribution of hundreds of thousands of leaflets, bulletins, etc.

Nothing is more appealing than many of the

*Uncinariasis in Porto Rico, Senate Document No. 808.

stories told by patients, who flock to these free dispensaries. They often come, too, despite severe weather conditions. In communities where the infection is heavy, and after the dispensary has had a few days within which to demonstrate its effectiveness, the people come in throngs; they come by boat, by train, by private conveyance, for twenty and thirty miles. Our records contain stories of men, women and children walking in over country roads ten and twelve miles, the

No. 6.—Patient, age 57. Heavy infection; haemoglobin, 23 per cent. Incapacitated for four years. After five treatments, was greatly improved, and reported that she was able to do a day's work for the first time in four years. Case reported by Dr. Grote.

more anemic at times falling by the way, to be picked up and brought in by neighbors passing with wagons. As many as 455 people have been treated at one place in one day. Such a dispensary group will contain men, women and children, from town and country, representing all degrees of infection and all stations in life. In this connection it is interesting to note a statement which has been made by Dr. Elliot, President Emeritus of Harvard University. He says: "On the whole, the evidence seems to show that the

campaign of the Rockefeller Sanitary Commission against hookworm disease is the most effective campaign against a widespread disabling disease which medical science and philanthropy have ever combined to conduct. Although the mortality is not so great from this disease as from smallpox, cholera, diphtheria, and bubonic plague, yet the human misery and disability it causes is probably greater in the long run than any one of those somewhat spasmodic or periodic plagues occasions."

A story of a physician's own case, as related by him in a letter to Dr. S. D. Porter, of Louisiana,

No. 7—Fatal case hookworm disease. Death resulted from intestinal perforation. 2,300 hookworms were recovered from this patient. (Reported by courtesy of Dr. A. G. Fort, Atlanta, Ga.)

is of special interest in this connection. The letter, written by Dr. J. M. Moseley, of Arcadia, La., reads as follows:

"Since my experience with hookworm disease has been unique, I take pleasure in giving you a rather detailed account of how it served me. In the fall of 1907 I noted that I was unable to do as much work as I had done before; the only symptom was a feeling of lassitude. My appetite was good, and, with the exception of a disinclination for work, I was in very good condition. This

continued until January, 1908, when I gave completely out and had to take a rest. After one month spent in the country I was able to resume work again. After two months' work I noticed that my feeling of lassitude was coming back again, and, added to this, I began to suffer with indigestion. I suffered with pain in the right hypogastric region; at times it would be intense. Pressure over the region of the gall bladder was intensely painful most of the time. I realized that some serious trouble was brewing in that neighborhood, and consulted my friends in North Louisiana. They palpated the region; they asked me all the questions a man must answer; they figured on every possibility, and at last decided that so much suspicion was directed to my appendix that it must come out. In June, 1908, I was operated on for appendicitis. Apparently my symptoms gave way for a while, but within a few weeks the old pain returned, and my inability to handle food rendered my life almost intolerable. In October, 1909, I gave up work again for thirty days, returning to work in November, and after two weeks I completely collapsed. During 1908 my condition would improve, then get worse, and so I passed the year merely living, doing what work I could best handle without much effort. From time to time I was examined by our best men in North Louisiana, several of whom wanted to drain my gall bladder. I found considerable relief in salol and castor oil, taking about three doses a day. This gave me more relief than anything else. I was unable during this time to handle any type of food except the very lightest and most easily digested, going for days on two or three glasses of milk, and that diluted. During 1910 the story of 1909 was repeated, except that I had about decided that no one knew my trouble; and, as I could neither die nor get well, and my condition had hung fire over a period of two and one-half years, I had begun to catch at straws. In January, 1911, I developed a jaundice that lasted two weeks, my other symptoms remaining the same. When the health train came through my town, Dr. Cary examined me for 'hookworms,' and found that I was heavily infected. I took the treatment that night, and my improvement from that day to this has been to me phenomenal. The first month I gained ten pounds. I could eat all types of food that other people ate; my appendicitis was well, the gall-bladder symptoms disappeared; I felt like a new man with new aspirations and renewed energy. I have made investments in real estate, as well as

other things, and some of them have given good results; if I could have invested one thousand dollars (\$1,000) in two doses of thymol two years ago, it would have been the greatest investment of my life. The loss to me during this time in being unable to handle properly my practice has been more than double this amount. I have treated many cases of hookworm disease. I have seen the roses come back to the cheeks and color to the lips of children and adults; I have seen them go back to work with renewed energy and brighter hopes. During this time it never occurred to me that I was harboring those same little parasites. My friends who worked so diligently to discover the cause of my trouble were just as much shocked as myself to know the cause that kept me down during this time. You may rest assured that I am enthusiastic, and that I will render all aid in my power to assist you in the campaign."

Dr. C. L. Pridgen relates the following story of a case treated in his dispensary work in North Carolina. His letter is as follows:

"The case in point was seen at the dispensary held in Chadbourne, Columbus county, and served to bring many others in to us. The boy was about fifteen years of age when seen. His father had heard his neighbors speak of the work that we were doing, and had read the pamphlets and dodgers that we had sent out. His curiosity was aroused, and when he heard the results of the treatment given to two other boys in similar condition to his son, he determined to bring his boy to see me. The boy was a typical subject. His skin had a cadaverous appearance; the membranes were almost white, and there was extreme lassitude and apathy. He seemed to take no notice of the crowd or the exhibits on display, and submitted himself to a physical examination with the most profound indifference. When the examination was completed he at once turned, without waiting to hear the diagnosis, and went to a log near by and sat down, apparently very fatigued.

"There were so many similar cases in the great crowd that pressed upon me that no further attention was given the boy except to caution the father as to treatment, explaining that I was giving him a small dosage, and asking him to return for a second treatment, and to let me know how the boy progressed. The case was forgotten until at a later dispensary the father came back to see me to pour out his thanks and tell me of the wonderful improvement. He said that the boy had always been of no account—worthless, tri-

fling. He said that he regarded it as a case of laziness and worthlessness. He said that the boy would lie on the porch like a dog, day after day, apathetic. He could not be aroused to either work or play. The father said he could not believe that it was sickness, because whenever the bell rang for meals the boy was up, the first at the table and the last to leave, and ate more than the farm hand.

"The boy responded at once to the treatment and picked up vitality in a remarkable way. He began to take interest in many things and to help with the work. The economic value of this treatment can be best presented just as the old farmer told it to me. 'Aside from saving my boy,' said he, 'this thing means money in my pocket. Be-

No. 8—Illustrating how patients who come to the free dispensaries are given instruction in the cause and prevention of hookworm disease. Two physicians are in charge of dispensary: Dr. C. A. Grote, standing; Dr. Johnson, Clanton, Ala., at the microscope.

fore I saw you I had to feed and clothe him and care for him at a great expense, and with no hope that it would ever be different. I had to hire a man to take the work I had counted on his doing, which cost me \$1 a day. Now I have figured this thing out this way: I am not only saved the dead expense of his doctor's bills and medicine, and all that, but I am saved the price of the hand which I have discharged, which is \$1 a day, not for a day or two, not for one or two years, but for many years, until he is grown and leaves me to make his own way in the world. I consider, he said, 'that this is the darnedest best investment I ever made.'"

The following is typical of hundreds of similar stories on record, told by patients who seek re-

lief at free dispensaries: On January 24 of this year I visited one of our dispensaries in Clarke County, Alabama. Dr. W. W. Perdue was in charge of the field work in this county. The day was dark, cold and rainy; but, despite the weather, we examined and treated that day 101 hookworm sufferers. Seventy-five per cent of these patients had come distances of three to ten miles over wet, muddy roads.—ragged, rain-soaked, weak, pale little children; in the face of every one a pitiful story was written. It was distressing to note their utter lack of development in every way—each a victim of hookworm disease, which was destroying their very potentiality, physically, mentally, and morally. One man came seven miles with his five children, ages 2, 5, 7, 9 and 10 years. He held in his hand little bottles containing hookworms obtained from each of them by previous treatments. He said to Dr. Perdue: "I want another dose, too, for the little fellow who give out on the way." I asked this man if any of his children were in school. He replied: "No; I would like to send them, but I have to work 'em to make a living."

Viewed in the light of its humanitarian aspects, in the light of its methods of reaching out and uplifting the common human lot, and considering what is daily being accomplished towards the building up of a better race, and noting further the tremendous economic importance of the task, I believe this movement is without a parallel in the whole history of human endeavor.

When one goes out into the field and there meets face to face hundreds of little children, pale, weak and anemic, bloated and ill-nourished, crippled in mind and body, existing in utter poverty, often indeed in base illiteracy, all as a result of hookworm infection, and then later sees these conditions all changed and bettered, often times indeed sees even a real transformation brought about through this campaign of education and the curing of these children—when one notes these facts, for facts they are, and then listens to some ill-informed individual declaring that "there is nothing in this hookworm business," proclaiming his alleged patriotism by denouncing what he imagines is a base slander of "this fair Southland of his," one is forcibly reminded of the closing lines of the verses by the distinguished ex-Secretary of State, John Hay, who, after reciting a story of the saving of a little boy from a tragic death, observed: "... That saving a little child, is a durned sight better business than loafing around the Throne."

SOME PRACTICAL PHASES OF THE TYPHOID PROBLEM.*

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Typhoid fever is such a common disease that, like rabies in Alabama, many persons have come to look on it with more or less indifference and consider it a thing to be endured; a part of life, just as cold, rainy weather in winter, or extremely hot days in summer. To a student of public health problems, it is always interesting to note the excitement of the laymen and the lay press over a sporadic case of meningitis or some such infrequently occurring disease, and the utter indifference for the most part to thousands of cases of such a disgraceful disease as typhoid fever; and what is worse is the fact that while we do not pretend to know all about its prevention, we do know so much that is not made use of.

A few figures will serve best to illustrate how prevalent this disease is: In the registration area of the United States alone, about 130,000 cases and 13,000 deaths occur each year due to this scourge; and it is estimated that these figures represent only about one-third of the cases which actually occur. In the English army in twenty years, from 1890 to 1909, there were 26,510 cases with 6,494 deaths.

The mortality ranges from 5 to 30 per cent, varying with the severity of the epidemic.

The manner of the distribution of the disease may be discussed under five heads as follows: (a) water, (b) milk, (c) other food products, (d) contact, including flies, (e) carriers.

The large epidemics are usually caused by an infected water supply, and this is probably the most important means by which the disease is spread. It is doubtful if typhoid bacilli persist in any water more than a month or two even under the most favorable conditions, and in shallow, flowing water, especially when exposed to the direct rays of the sun, it is usually agreed that they die out in a few days; it is also interesting to note that they will live longer in comparatively clean water than in dirty water in which various heartier bacteria are abundant. Clean, still, warm water, not exposed to the sun, offers the best conditions for their preservation and propagation, but even extreme cold and moderate drying does not always kill them. They have been known to live for months in frozen snow and have been capable

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