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S. Public Health and Marine-Hospital Service

WALTER WYMAN, *Surgeon-General*

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G. M. GUITERAS

FEBRUARY, 1909

WASHINGTON
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Treasury Department, U. S. Public Health and Marine-Hospital Service

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THE PROPHYLAXIS OF YELLOW FEVER.

By G. M. GUITERAS, *Surgeon, U. S. Public Health and Marine-Hospital Service.*

The study of yellow fever has ever been an interesting one from the time it was first observed in the Western Hemisphere to the present day.

Whether the disease is indigenous to America or was introduced from the west coast of Africa, is a mooted question. From the historical data which we have on the subject it would appear as though the latter opinion was the correct one.

The disease has been a scourge to the fair and fertile regions of tropical and subtropical America and has greatly retarded their material progress. Its existence in an endemic form at various points, such as Habana, Rio de Janeiro, and Vera Cruz, has given these ports an unenviable reputation with travelers and seriously hampered their commercial interests, and carried from these foci to other infectible territory it has caused widespread epidemics resulting in great loss of life, interference with commerce, and financial disaster.

The peculiar characteristics of the disease and the mystery which shrouded its etiology and method of propagation have invested it with remarkable interest, and in our day the solution of this mystery, in so far as the method of propagation is concerned, has given us one of the most important advances in modern science.

The work of the United States Army Board in establishing beyond a doubt the hypothesis enunciated by Carlos Finlay, in 1881, as to the transmission of yellow fever by the mosquito, was indeed brilliant. I had the pleasure of being present at the International Sanitary Congress held in Habana when Doctor Reed presented his

memorable report proclaiming the new dogma. The work therein described was so thorough and the results so clearly established as to leave no doubt in the minds of his hearers as to the truth of his conclusions. Considering the number of able men who had been studying the subject, it is remarkable that a period of nearly twenty years should have elapsed before Finlay's ideas were seriously considered and finally accepted. It is still more remarkable when we consider that since the early part of the nineteenth century various observers had indicated the mosquito as in some way related to the disease under consideration. There is no doubt but that the interesting work of Dr. Henry R. Carter, of the Public Health and Marine-Hospital Service, in establishing, in 1898, the " extrinsic " period of incubation of yellow fever—that is, the interval between the infecting and secondary cases—gave renewed impetus to the study of the mosquito as a factor in yellow fever and indirectly brought about the confirmation of the truth of the hypothesis of Doctor Finlay.

PRINCIPLES OF PROPHYLAXIS.

The prophylaxis of yellow fever, which up to a few years ago was founded on ideas so uncertain and insecure, is to-day firmly based on the discovery of the transmitting agent of the disease. This agent can be destroyed and may be prevented from becoming itself inoculated and, if inoculated, from transmitting the disease to the well.

In the abstract the measures necessary to accomplish this are perfectly feasible. No extraordinary means or intelligence is required to make them effective; only a careful attention to details. But in practice, when the peculiarities of human nature, the rights of the individual as guaranteed by the law, and the ignorance of the people have to be taken into account, the problem becomes both difficult and onerous.

The subject of the prophylaxis of yellow fever has been thoroughly thrashed out during the last few years, and as the matter is so simple in itself there is but little that may be added to what has already been said. Within the time stated the writer has been connected with the two epidemics which have occurred in the United States—at Laredo, Tex., in 1903, and at New Orleans and Vicksburg in the general epidemic of 1905—and has carried out with success the principles of prophylaxis which will be referred to in this article. It is not, however, the purpose to enter herein into the minutiæ of the methods of prophylaxis, but rather to invite attention to some of the difficulties to be encountered and to suggest some of the means whereby, in the opinion of the writer, the obstacles found in the practical application of the principles involved may be lessened or eliminated.

IMPORTANCE OF EARLY DIAGNOSIS.

The knowledge that we now have of the transmission of yellow fever gives us a secure basis upon which to lay our plans against the introduction of the disease or to prevent its spread when introduced. There is, however, one link wanting to give us absolute control of the disease, and that is the etiological factor. The consensus of opinion up to the present time is that it is a micro-organism, ultramicroscopic, and as yet beyond our means of detection. The importance of determining this causative agent is apparent from every point of view, but especially so as an aid to diagnosis, for the prompt and positive diagnosis of yellow fever is one of the most important factors in the prophylaxis of the disease, especially when it appears in a locality where it was previously unknown or that has been free of it for some time.

In order to take measures against the spread of a disease it is first of all necessary that we should be aware of its presence. In the case of yellow fever considerable embarrassment presents itself in determining this fact, both on account of the inherent difficulty in making the diagnosis and the natural fear of the attending physician of the alarm and other unfortunate consequences which will usually follow a declaration of its presence, and especially the fear that he may be, after all, mistaken in the diagnosis. This applies particularly to those localities where yellow fever is a new or an infrequent visitor and where there exists an unreasonable fear of the disease.

It is foreign to the purpose of this paper to enter into a discussion of the differential diagnosis of yellow fever, but I desire to impress upon the reader the importance, from a prophylactic point of view, of the early diagnosis of all cases of this disease. We know that the *Stegomyia calopus* can only become infected by biting the patient during the first three days of the illness; hence the diagnosis should be made in its very incipiency. Frequently it is not easy to do this, especially in mild cases. It is here that our knowledge is at fault and all our energies should be bent to discover some means of making a positive diagnosis, one which can not be controverted. When this is achieved the citadel will have been won and the last vestige of danger from this disease removed.

USUAL CONDITIONS WHEN YELLOW FEVER IS DECLARED.

Under present circumstances the following conditions almost invariably confront us in an outbreak of yellow fever in a locality usually free from it, such as, for instance, our South Atlantic and Gulf coast: A case of fever presents itself to a physician who is not on the lookout for yellow fever and who perhaps has never seen the disease. If it be a mild case of yellow fever, it will probably get well without his suspicions being even aroused. If, however, it be

of moderate severity and the physician careful and observant, he will soon note symptoms which do not square with the fevers which he has been accustomed to see. He may then suspect that all is not right and begin to think of the possibility of yellow fever. Immediately the purely medical and scientific character of the case becomes clouded by the material considerations involved. Is the diagnosis positive? Shall the case be reported or not? From where could the infection have come? This last question is always given undue weight, with fatal results, because as a rule it is impossible to answer, and its consideration leads to uncertainty and delay. But why should we pause to answer? Do we do so in a case of measles, scarlatina, or smallpox? Why not make the diagnosis on the symptoms of the disease as presented to us and not bother at that critical moment with the abstruse study of its possible origin? That surely would be the most rational and practical way to proceed. In any case, it is indeed a heavy responsibility to satisfactorily answer these questions under the conditions at present affecting our Southern States or other localities similarly placed. The usual course of action is as follows: The attending physician will consult with his confrères. Some will opine that it is, others that it is not, yellow fever. One who has had some experience with the disease, a so-called expert, is finally called in and, we will presume, verifies the diagnosis of yellow fever. As an immediate result of this declaration the physicians of the place, and with them the public, divide into two antagonistic camps, one maintaining that the disease is yellow fever, the other that it is not. And thus, with much wrangling and disorder and under the most discouraging circumstances, the work of preventing the spread of the disease is inaugurated. The effort to stamp it out then becomes a veritable campaign, not only against the mosquito, but against a usually small but determined party of opposition among the people. Such a condition of affairs would not exist if the diagnosis could be promptly established beyond question or cavil.

To attain this being impossible with the diagnostic means at present at our command, I pass on to speak of what seems to me a most important indirect prophylactic measure, one which may do much to offset the results of our present inefficiency to promptly establish an absolutely correct diagnosis—and that is education.

EDUCATION AS A PROPHYLACTIC FACTOR.

The people in general, and the medical profession as well, should be taught the truth about yellow fever, its comparatively low mortality as treated at present, and the facility with which the disease may be avoided and controlled. In a community which is well informed

on these points the presence of a case of yellow fever could be announced without any fear of alarm or panic and the measures to prevent its propagation put in force at once without clamor or delay. The physician could act simply on the merits of the case from a professional standpoint. If the disease under observation presented the symptoms of yellow fever, he would announce it as such without stopping to consider or, for the time being, trying to determine from whence it came or obscure his judgment with considerations as to the effect of his diagnosis on the business interests of the locality or on his own personal interests. Such a condition of affairs is much to be desired and with patience and preserverance may be attained.

The education of the public on this subject acts not only in this indirect manner, but directly as well, for it will so guide public opinion that it will be possible to practically eliminate the transmitting factor of the disease, the mosquito, the *stegomyia calopus*. And as it is impracticable to select only the *stegomyia calopus* for destruction, a campaign against this mosquito must be a general one, and also include those responsible for the transmission of malaria, filaria, etc., thus removing from the Tropics and subtropics some of the most important causes of morbidity and mortality, and which heretofore have been serious obstacles to their political, commercial, and industrial progress. Education on this subject, therefore, I consider of prime importance in the prophylaxis of yellow fever, and it is surprising how little has been done or is being done on this line.

The writer in his report to the surgeon-general on the yellow fever epidemic at Laredo, Tex., in 1903, said:

"Insistent and continued efforts should be made through the public press and other available means to educate the people within the sphere of influence of the *stegomyia fasciata* (*calopus*), so that they will learn to protect themselves against the invasion or spread of yellow fever among them by destroying the means for the propagation of said mosquito and by protecting themselves against the mosquito by efficient screening. Above all, to eradicate the existing fear in the medical profession as well as among the laity, of declaring the presence of yellow fever. If the first case presenting the slightest suspicious symptoms of that disease were promptly made public and the proper modern precautions taken, there would be no danger of the disease spreading. In fact, the public should be taught to acknowledge the existence of yellow fever in their midst with the same equanimity as they do in the case of measles or scarlatina."

And again, in the report of the epidemic in Vicksburg, Miss., in 1905, the writer stated:

"There is still much ignorance and skepticism (on the subject of the method of transmission of yellow fever). An effort should be

made to overcome this by widely distributing pertinent literature on the subject. And as it is reasonable to suppose that in spite of the progress already made and being made to eradicate this disease from Tropical and subtropical America, it will continue to harass us for many years to come, it is believed that a campaign of education should be begun with the young. All important facts pertaining to the transmission of yellow fever by the *stegomyia fasciata* (*calopus*), and the mode of propagation of this mosquito should be taught in the public and private schools and colleges in infectible territory. There may be seen in this way a good chance to completely destroy the *stegomyia* in its present habitat, and even if not successful in entirely destroying it, the great advantage will have been gained that when yellow fever should make its appearance in a locality the work of the sanitarian in checking or stamping out the disease would be made easy indeed and the usual panic with its discomforts and financial losses avoided."

My experience in these two epidemics and what I have seen elsewhere has confirmed in my mind the importance of this matter. I believe and would recommend that the method of transmission of yellow fever, and malaria as well, be taught in the schools wherever these diseases are liable to occur. The subject should be taught in the primary grades, for what children then learn they will retain. To obtain the desired result the most elementary teaching would suffice. Children may be taught to dread a mosquito as they now do other insects that are less harmful. In the higher grades, with little labor or time, the reasons for this fear of the mosquito may be demonstrated, as also the methods of exterminating the insect and of protecting one's self against its bite.

ULTIMATE RESULTS OF EDUCATION.

With the above idea disseminated among the people it would not be long before public opinion would demand with irresistible force the drainage of swamps and lowlands and the inspection of houses and premises to see that they were free of breeding places for mosquitoes.

To have open cisterns, water barrels, bottles, broken crockery, or, in fact, any receptacle capable of holding water exposed for any length of time, would be considered as much a nuisance and a menace to the public health as ill-ventilated and crowded tenements, dirty streets, defective sewerage, and the many other dangers which at present excite the social and political activities of national, state, and municipal authorities. Such a system would, within a comparatively short time, eliminate all danger from both yellow fever and malaria.

PROPHYLACTIC MEASURES INDICATED IN INFECTIBLE TERRITORY.

We will now consider more in detail the prophylactic measures that should be observed in infectible territory. These may be divided into two classes, to wit: (*a*) Measures directed against the introduction of yellow fever from abroad; (*b*) those looking to the prevention of its spread when it has been introduced.

Maritime quarantine.—Measures employed to prevent the entrance of infection from abroad are usually included under the term "maritime quarantine" and are at present well provided for in the United States by an efficient national quarantine establishment, which is an integral part of the United States Public Health and Marine-Hospital Service.

The measures ordained against the introduction of yellow fever by the quarantine regulations of this service are based on its well-known period of incubation and the processes of disinfection on the mosquito transmission of the disease, and are directed to the destruction of this insect both in its larval and adult stage. These measures may be stated briefly as follows:

Vessels which may possibly be infected are detained at the port of arrival five days after disinfection; vessels known to be infected, six days. The service has medical officers stationed at all the important ports within the yellow-fever zone, and if the vessel is disinfected at the port of departure under the supervision of this officer, the vessel on arrival at a port of the United States within the infectible area is subject to the following modified treatment: If arriving in five days or less, she may be admitted to pratique without disinfection or further detention than is necessary to complete the five days. If arriving after five days and within ten days, she may be immediately fumigated and admitted without detention. If arriving after a longer voyage than ten days, she will be considered as not having been subjected to any previous treatment. This last disposition is based on the possibility that a case of yellow fever may have occurred aboard and recovered within the time mentioned.

Passenger traffic from infected ports, without detention, is also permitted by these regulations under the following conditions:

Vessels carrying such passengers must be in the best sanitary condition and must lie at approved moorings in the open harbor. The crew must not be allowed ashore at the port of departure. The entrance of mosquitoes into the vessel must be prevented, and if they do find ingress must be destroyed. Passengers and crew must be certified as immune by the medical officer issuing the bill of health. The evidences of immunity which may be accepted are proof of a previous attack or ten years' residence in an endemic focus of yellow fever. These regulations apply, of course, only during the close quarantine season—that is, from the 1st of May to the 1st of November.

It will be noted that the above restrictions are liberal enough and at the same time give adequate protection.

Referring for a moment to the evidence upon which certificates of immunity are based, the writer is of the opinion that a ten years' residence in an endemic focus should no longer be considered sufficient, for with our present knowledge of the method of transmission of yellow fever it is quite clear that any intelligent person taking certain simple precautions might very well live a lifetime in an endemic focus and yet never be exposed to infection.

Measures against the spread of yellow fever.—With reference now to class *b*—that is, preventive measures against the spread of yellow fever once it has been introduced, we find that as a rule we are not so well equipped. The principle of prophylaxis is, of course, precisely the same, but is much more difficult of application because we have to deal with local and conflicting interests and the ignorance of the people. Municipalities usually have a sufficiency of ordinances and regulations covering prophylactic measures against yellow fever, but unfortunately these are completely ignored except when menaced by an epidemic, and then enforced with difficulty. These ordinances have been enacted during a period of stress and excitement, when yellow fever was present or dangerously near, and quickly forgotten once the danger had passed. Now, this should not be, for there is no reason why every port in infectible territory should not be so administered as to make it noninfectible, so that if yellow fever should gain an entrance from abroad its spread would be impossible. To attain this I would outline the following plan: Education and the formation of a public opinion that would look upon the mosquito not only as a disagreeable pest but a very dangerous one as well; proper drainage; a corps of inspectors to examine all premises every ten days, preferably once a week, to see that they are free from water containers capable of harboring mosquito larvæ; the screening or covering with oil of water containers which can not be destroyed, or the use of small fish where the above methods are not available; the removal of unnecessary vegetation; the screening of dwellings and other buildings.

In carrying out the above measures there is nothing that requires any great expenditure of money or labor, and if efficiently performed and consistently kept up it would be but a short time before the introduction of a case of yellow fever into a locality so governed would be unattended with danger and scarcely cause a ripple of excitement.

GENERAL PLAN FOR HANDLING AN EPIDEMIC.

Where the ideal conditions above mentioned do not prevail there is, of course, imminent danger of the disease spreading. Steps must be taken at once to prevent this. The bases of preventive measures may

be stated succinctly as follows: To prevent the infection of Stegomyia mosquitoes by properly protecting all persons ill with yellow fever during the first three days of the illness; to protect the well from the bite of the mosquito; and, as a corollary to the above, the destruction of all mosquitoes and their means of propagation. Given the requisite personnel, sufficient funds, and the necessary authority to enforce measures to this effect and there would be little danger of the disease spreading. These desiderata, however, are usually wanting or only imperfectly supplied. The practical adaptation of the above propositions may be considered under the following heads:

1. Detection of cases or inspection.
2. Yellow fever hospital.
3. Martial law.
4. Detention camp.
5. Protection against the bite of the mosquito; screening, etc.
6. Extermination of mosquitoes, including oiling, fumigation and the screening or destruction of water containers.

The details of the two latter are so well known and, in fact, so simple that it seems unnecessary to take up the reader's time with a discussion of them. Relative to the first three, which I consider of great importance and which, in a way, form the tripod on which the others rest, it is well to say a few words.

1. *Detection of cases or inspection.*

In order to put in force efficient prophylactic measures it is absolutely necessary that all cases be reported immediately. For reasons before stated this is difficult, and to those already given we may add that during an epidemic many cases of fever do not call a physician at all. To surmount these obstacles, as well as the difficulty of definitely recognizing the disease in its early stages, all cases of pyrexia in which the reason of the abnormal temperature is not manifest should be treated prophylactically during the first three days as though they were yellow fever, or until a positive diagnosis to the contrary is made. For the purpose of reaching all cases of fever a thorough inspection is required. Every dwelling in the infected area must be inspected daily, or, better, twice a day, by competent inspectors, persons capable of reading the clinical thermometer. All cases of pyrexia discovered by the inspectors should be immediately reported to the officers in charge of the screening and fumigating parties for proper action. The patient having been protected against the bite of the mosquito by screening and his dwelling and the surrounding houses fumigated for the purpose of destroying any possibly infected mosquitoes, the question of diagnosis may safely be left to be determined later. Whenever possible the patient should be removed to the hospital.

2. *Yellow-fever hospital.*

This brings us to the second prophylactic measure advocated above—the advantage, and indeed necessity, of a yellow-fever hospital in dealing successfully with an epidemic.

There is a prejudice among the people against the term "yellow-fever hospital," hence it would be as well to yield to this prejudice and call it an "isolation" or "observation" hospital. The important point is that this hospital be absolutely mosquito proof, and that it be made attractive, be clean and well managed, so that the people may be drawn to it and feel that they will be as well or better cared for in the hospital as in their own homes. The greater the number of fever patients that can be removed to the hospital the easier will be the task of stamping out the disease.

Such cases as in the opinion of the sanitary officer can not be properly screened in their homes should be compelled to go to the hospital. The transfer of the patient must be accomplished with such precautions as will prevent the possibility of his being bitten by a mosquito—under a mosquito-bar or in a screened ambulance.

3. *Martial law.*

To make the inspection thorough and effective and to compel the transfer of the sick to the hospital when necessary, authority is required. In a republican form of government this authority is usually wanting and these measures have to be carried out inefficiently and in the face of great opposition.

To obviate this the writer would advocate that martial law be declared in epidemics when the conditions are such as to warrant it. This legal procedure is frequently invoked when the menace to life and property is not nearly so great as in an outbreak of yellow fever or other infectious or contagious disease.

With martial law to support the sanitary officer the prophylactic measures herein advocated could be enforced in every detail and an outbreak of yellow fever effectually controlled. It is easy to understand why this agent was not invoked prior to the demonstration of the transmitting factor of yellow fever, when our efforts to control the disease were rather vague and uncertain; but to-day, when our system may be made so precise and certain it seems almost criminal not to take advantage of such a powerful auxiliary.

In our epidemics the sanitarian, unsupported by authority, is obliged to lose much precious time and energy in his efforts to gain the good graces and plaudits of the populace, so that he may be permitted to perform his work untrammeled.

4. *Detention camp.*

In most epidemics it is necessary to provide means to permit persons to leave the infected district without danger of carrying the disease elsewhere. This may be accomplished by a so-called "detention camp," where those wishing to leave the infected locality may do so after being detained under observation for the time requisite to assure their freedom from infection.

With our present knowledge of the transmission of yellow fever it is unnecessary to establish these "camps," as heretofore, in out-of-the-way or inconvenient places. On the contrary, they may be located with perfect safety within the infected district so long as the detained persons are kept in mosquito-proof quarters and, when their period of observation has terminated, are taken to their destination in mosquito-proof conveyances while within the infected area.

It is plain, however, that in a properly educated community where the measures above advocated can be put in practice, there will scarcely be any necessity for a detention camp.

In the foregoing pages the writer has endeavored to outline a scheme or plan of prophylaxis which he feels quite sure will do the work expected of it. The machinery is there, but where is the power to set it in motion? To start it successfully, smoothly, and without friction, some central authority with the necessary means and power, acting surely and swiftly, must be provided. This should be the function of the Government.

PROPHYLACTIC MEASURES SUGGESTED BY THE FRENCH COMMISSION OF THE PASTEUR INSTITUTE.

Much interest is attached to the means of prophylaxis suggested by the results obtained by the French commission of the Pasteur Institute in their report on the investigation of yellow fever, published in the Annals of the Institute in November, 1903, to wit:

1. An injection of virulent blood serum which has been heated for five minutes at a temperature of 55°C. confers a relative immunity, which may become complete if followed by the injection of a very small quantity of virulent serum.

2. The injection of defibrinated blood which has been kept under liquid vaseline for eight days confers a relative immunity.

3. The serum of a convalescent is endowed with preventive properties.

4. The immunity conferred by the serum of the convalescent is still in evidence at the end of twenty-six days.[a]

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[a] Abstract of Report, French Yellow Fever Commission; Annual Report, U. S. Public Health and Marine-Hospital Service, 1904.

Further study on this line may give us an immunitive serum which will be of great value in controlling yellow fever.

However, even though we attain this and, furthermore, discover the etiological factor in yellow fever we will still, in a great measure, have to depend on the means of prophylaxis herein outlined, and I desire, therefore, to impress upon the reader the importance of education as a prophylactic factor and the necessity of clothing the sanitary officer with the requisite power and authority to enforce the measures that we now have at our command, which are simple and efficient.

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