

Falciparum Malaria among Drug Addicts* Epidemiologic Studies

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IN 1929, there appeared in Cairo, Egypt, a new vogue in drug addiction. This was the intravenous use of heroin and the practice by drug addicts using heroin, of sharing a common hypodermic syringe for its administration. On this fact hinges the explanation for the occurrence, in New York City, of a disease usually uncommon, but now endemic in it—falciparum malaria.

The origin of this practice has been variously explained. It is probably related to the knowledge among drug addicts that drugs used in the treatment of helminthic and protozoal diseases are more effective when given intravenously than when taken orally. Also, heroin administered intravenously produces a more rapid and heightened effect. Furthermore, the common use of a hypodermic syringe by many drug addicts reduces the likelihood of apprehension, arrest, and conviction for the possession of drugs or apparatus for their administration. Finally, from the economic standpoint it is possible for several addicts who are unable to purchase a small quantity of the drug, by pooling their resources to be assured of at least one or more doses by the wholesale purchase.

The epidemiologic implication of such a practice in Egypt, where malaria is common, is obvious and in 1929 Biggam¹ described the first epidemic of malaria among drug addicts resulting from the common use of a hypodermic syringe. All the cases were dysenteric in type, and the parasite in each was *Plasmodium falciparum*. Shortly afterward, there appeared in the United States reports of isolated cases of this disease in drug addicts, and in 1934, Helpert² described 49 cases in New York City. Clinically, these cases were principally of the cerebral variety, and were associated with a very high mortality rate.

During the past 5 years, this disease seems to be well established in New York City. There are now to be seen cases of falciparum malaria among drug addicts almost at all times on the wards of Bellevue Hospital. The author has had the opportunity of studying well over 200 cases. Dr. Helpert, in a personal communication, stated that he has performed 120 autopsies on drug addicts who have died from malaria in New York City. This is only a slight indication of the probable incidence of the disease among drug addicts in New York and other large cities. The knowledge of its occurrence among drug addicts is well known to them, and many treat themselves with quinine.

* Read before the Epidemiology Section of the American Public Health Association at the Sixty-eighth Annual Meeting in Pittsburgh, Pa., October 17, 1939.

TABLE 1

<i>A. Bellevue Hospital</i>			
	1928-1933	1933-1938	
Average yearly admissions	59,000	61,940	
Average yearly drug addicts	87	137	
Av. addicts 1,000 adms. per year	1.5	2.2	
Total malaria admissions	70	180	
Av. malaria 1,000 adms. per year	0.24	0.50	
<i>B. Third (New York University) Medical Division</i>			
	1928-1933	1933-1939	
Drug addicts	32	120	
Total malaria	20	42	
Malaria in drug addicts	0	34	
Malarial fatalities	0	8	
<i>C. Types of Malaria (Third Medical Division)</i>			
	1928-1933	1933-1939 Non-addicts	1933-1939 Addicts
<i>P. vivax</i>	12	6	1
<i>P. falciparum</i>	2	1	32
<i>P. malariae</i>	0	0	1
Undetermined	2	1	0
Diag. on history only	4	0	0
Total	20	8	34
Fatalities	0	0	42
8			
<i>D. Types of Malaria, Bellevue Hospital, 1938</i>			
	Non-addicts	Addicts	
<i>P. vivax</i>	7	1	
<i>P. falciparum</i>	1	45	
Total	8	46	
Fatalities	0	9	
<i>E. Psychiatric Division, Bellevue Hospital, 1938</i>			
Number of admissions	26,210		
Drug addicts	71		
Drug addicts with malaria	27		
Malaria fatalities	4		
<i>F. New York City, 1938</i>			
<i>Types of Malaria</i>	<i>Number of Cases</i>		
<i>P. vivax</i>	24		
<i>P. malariae</i>	2		
<i>P. falciparum</i>	50		
Unknown	16		
Mixed	1		
Total	93		

TABLE 2

Mortality in *Falciparum* Malaria in Drug Addicts

Year	Psychiat. Div.		3rd Med. Div.		Combined	
	Cases	Deaths	Cases	Deaths	Cases	Deaths
1933	5	3	3	3	8	6
1934	2	1	7	2	9	3
1935	10	4	2	0	12	4
1936	4	2	4	0	8	2
1937	11	4	3	1	14	5
1938	23	4	12	2	35	6
Total	55	18	31	8	86	26

It is therefore likely that the number of acute patients who seek admission to the hospital represents only a small percentage of the cases among the drug addict population.

EPIDEMIOLOGY

Naturally acquired malaria is very rare in the metropolitan area of New York City. In the 5 years, 1928-1933, there were only 70 cases recorded in Bellevue Hospital. In the 5 years, 1933-1938, the period under consideration in this report, there occurred 180 cases of malaria in approximately the same number of admissions. This difference is due to the continued admission to the hospital of drug addicts suffering from falciparum malaria in the latter period.

This is borne out in the Tables (1a, 1b, 1c, 1d) by the fact that prior to 1933, when this form of malaria was first recognized, the number of cases caused by *Plasmodium falciparum* accounted for only a small number of the total, whereas following 1933 the number of cases of falciparum malaria made up by far the majority of the total.

In 1938, there were 54 cases of malaria seen in the entire hospital, of which 45 were falciparum occurring in drug addicts. There were 9 fatal cases, and these were in the addict group. There were only 8 cases in non-drug addicts and naturally acquired, of which 7 were due to *Plasmodium vivax*.

Prior to 1933, one very rarely saw a case of malaria in the Psychiatric Division of Bellevue Hospital. During the period of this study, however, more than 50 cases of malaria, all falciparum, and many of them fatal, were observed in this division.

The incidence and mortality of malaria in the metropolitan area of New York is therefore almost entirely due to the occurrence of the malignant form of the disease among drug addict

population, who practise the common use of hypodermic syringes.

TRANSMISSION

The technic of injection and transmission is very simple. In some cases a complete medical hypodermic syringe and needle were used. In other instances, the apparatus is improvised by fitting a needle to the end of an eye or medicine dropper with the aid of a piece of rag or newspaper or cigarette paper. The drug is often dissolved in a teaspoon, aided by the heat of a burning match. If the injection is for one individual, he draws the drug into the syringe and attempts to insert the needle into a vein. The successful trial is known by the appearance of blood in the syringe. The drug mixed with the blood is now forced into the vein and to insure that it is all obtained,

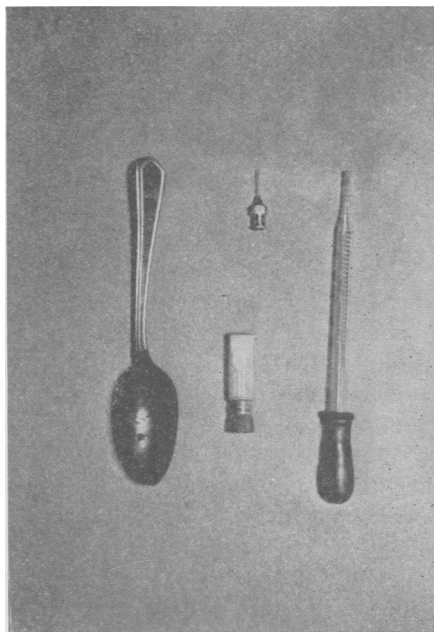


FIGURE 1.—IMPROVISED HYPODERMIC APPARATUS

Improvised hypodermic apparatus for self administration of heroin. The drug shown in the vial is dissolved in the spoon and drawn up into the medicine dropper, which acts as a syringe.

the syringe is again filled with blood and the contents emptied into the vein. Frequently, another addict is waiting his turn to use the apparatus and to have his share of the drug. Without washing or other attempt at cleaning the syringe, he repeats the process described. It is obvious that if the first individual has plasmodia in his blood in fair numbers, the addict following him will not only receive his share of the drug, but plasmodia as well.

PARASITE

The outstanding species of parasite in this disease is *Plasmodium falciparum*. Although a few cases have been reported in which the parasite was either of the quartan or benign tertian variety, the majority of cases, by far, in the larger epidemics studied have been due to *Plasmodium falciparum*. In a careful study of the morphology of the plasmodium in approximately 200 cases, I have found only one infection with *Plasmodium vivax* and one with *Plasmodium malariae*. All the others were caused by *Plasmodium falciparum*.

CULTURE

Numerous attempts to culture the parasite obtained fresh from the blood of untreated individuals were unsuccessful. Often blood was used which contained an overwhelming infection and occasionally moderate or light infections were tried. Various methods and culture media were utilized. This experience coincides with that of Coggeshall³ at the Rockefeller Institute, who made many attempts to culture the parasites obtained from the cases in the New York drug addict series.

ANIMAL INOCULATION

Efforts were made to transmit this species of plasmodium to monkeys (*Macacus rhesus*) by injecting 20 cc. of fresh, heavily infected blood intra-

muscularly. The monkeys failed to show evidence of infection, clinically or hematologically, and when killed later, there were no signs of malarial infection in the organs. This, too, coincides with Coggeshall's experience.

MOSQUITO INFECTION

The itinerant nature of drug addicts, the fact that many self-treated later become gametocyte carriers, and that routine blood study of many drug addicts disclosed a moderate number of symptomless carriers, made it desirable to see whether anopheline mosquitoes could be infected by feeding them on treated and untreated drug addicts.

Female *Anopheles quadrimaculatus* mosquitoes were obtained through the courtesy of Dr. Coggeshall of the Rockefeller Institute. They were allowed to feed on the thigh of a drug addict who had recovered from an attack of severe malaria, which he had contracted by the method described. The patient was afebrile and showed a moderate number of gametocytes in his peripheral blood. After the elapse of a week, Dr. Coggeshall dissected a few mosquitoes each day. The last 3 insects of 8 dissected were positive, containing 15, 21, and 23 oocysts respectively, proving the infectivity of drug addict blood containing gametocytes for anopheline mosquitoes.

If a sufficient number of addicts, whether recovered but incompletely treated, or asymptomatic carriers of gametocytes should accumulate in an area where suitable mosquitoes are abundant, a serious epidemic of malaria involving the healthy population may occur. Likewise, an epidemic may occur if a sufficient number of suitable mosquitoes should accumulate in a non-malarious area where infected addicts are abundant.

It is of particular note in this connection that "Light Traps" for mosquitoes placed in and around New York

City and Nassau County in Long Island revealed that there was local *Anopheles quadrimaculatus* production!

CLINICAL ASPECTS OF THE DISEASE

The outstanding clinical feature of the cases seen early in the history of this disease in New York were predominantly cerebral. In fact, many of the original cases were severe instances of cerebral malaria with a high mortality rate. This feature differed from that reported in the first Egyptian series, in which dysenteric symptoms seemed to predominate almost exclusively. Some investigators felt that this difference, and the tendency for the disease to be manifest clinically through one system complex (central nervous), suggested a specific neurotropic strain

of *Plasmodium falciparum* as the etiologic parasite.

Time, however, and the distribution of the disease among a fairly large number of individuals, has given us the opportunity to see the different clinical varieties of malignant malaria, including the simple, the cerebral, the dysenteric, and even the relatively uncommon "blackwater" type of *Plasmodium falciparum* infection.

The author is of the opinion that except for the non-biological mode of transmission the disease as it is seen in the drug addicts in New York or elsewhere simply represents the usual course of infections with the malignant tertian parasite, in no way different from that seen even in tropical Africa.

A complete description of the clinical

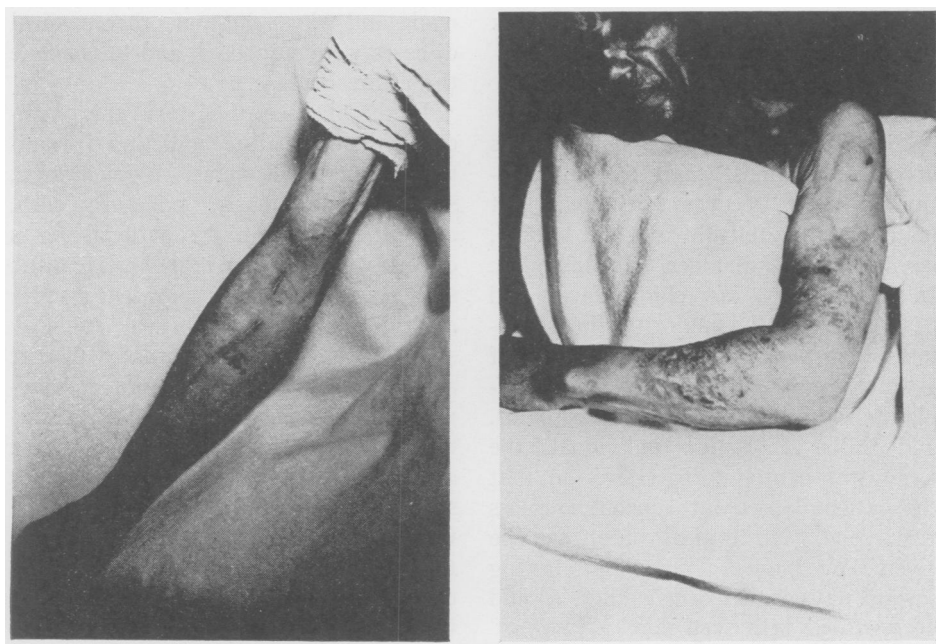


FIGURE 2—EVIDENCE OF DRUG ADDICTION

(a) Forearm of intravenous heroin addict. Note the prominent vein over the forearm and in the antecubital fossa. These veins are pigmented and often scarred and partially thrombosed.

(b) Forearm and arm of a subcutaneous heroin addict. There are numerous superficial and deep scars. The skin is pigmented and thin over healed injection sites.

syndromes encountered will be published elsewhere.⁴

GENERAL CLINICAL CONSIDERATIONS

1. *Age, Sex, Occupation, and Geographic Origin:*

There were only two females in this series and both died; one of the cerebral malaria and the other of acute diffuse glomerular nephritis.

The males were of young and middle adult age. Most of them had no given occupation; some were sailors; the rest worked at various unskilled trades when they did have a job.

The majority of the addicts lived in and about New York. Many were born in the United States, Puerto Rico, Cuba, and the West Indies. In recent years the patients have been predominantly young colored males from Puerto Rican and Negro sections of the city. Most of them had not been out of New York for many years.

2. *Onset, History, Temperature:*

There were no characteristic modes of onset. In most cases careful questioning after recovery revealed that for weeks they felt ill. In some, nausea, vomiting, and diarrhea predominated. In others they felt chills, fever and headache. In the majority the symptoms were very vague and consisted of a mixture of gastrointestinal complaints with headache, muscle pains, and chills. In a few individuals the onset was acutely progressive, so that the patient lapsed into unconsciousness very soon. No typical onset can be given. Any "queer" complaints lasting several days in the drug addicts should be regarded with suspicion.

The temperature reaction in *Plasmodium falciparum* malaria is classically unpredictable. There may be a suggestion of the tertian cycle (Figure 3, Chart 4), but in general the temperature curve follows no given pattern. Some of the cases exhibited the double

daily rise (Figure 3, Chart 3) often described in malignant tertian malaria; others had quotidian fever (Figure 3, Chart 1); and others were totally irregular (Figure 3, Chart 2). The fever often showed little alteration during treatment in the fatal cases (Figure 3, Chart 1), and in the cases which recovered there was considerable fever even several days after treatment was begun. In some cases there was little or no fever. Any fever in a drug addict should be suspected of being related to malaria no matter how little the fever may be and no matter what the chart may look like.

3. *Diagnosis:*

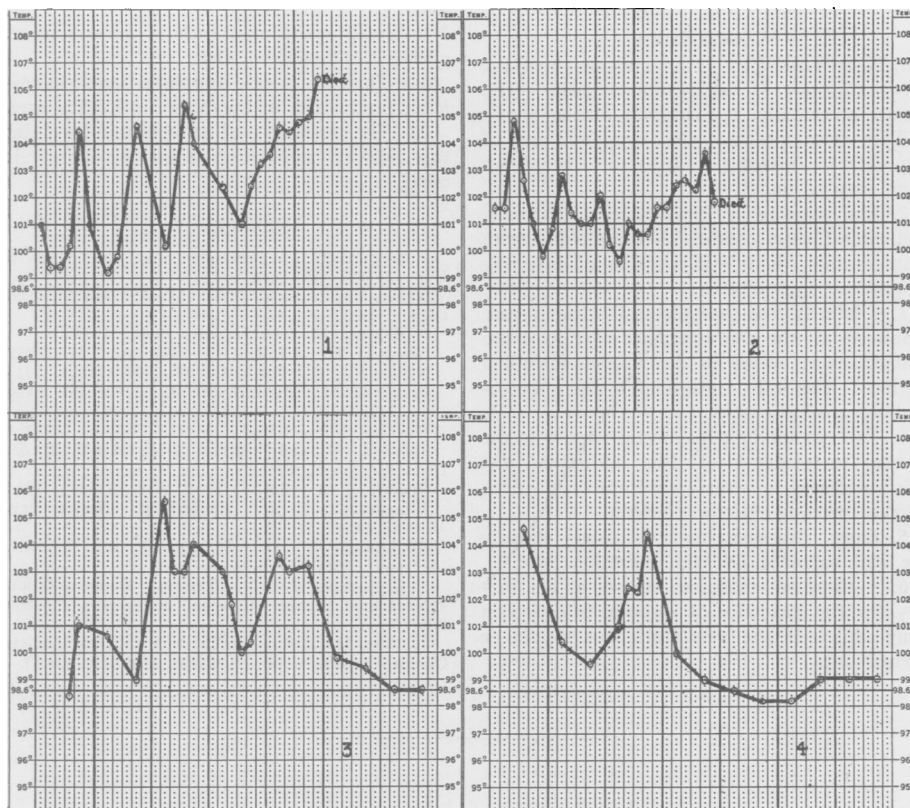
Before the disease was well known the diagnosis may have been difficult. It is easy to understand why diagnoses of various cerebral syndromes were made and why a host of other medical diseases were suspected, and to condone the errors made.

In the absence of history, the physical evidence of drug addiction (prominent superficial veins, pigmentation, scarring, thrombosis, puncture sites, and subcutaneous and superficial ulcers or scars) is the one reliable diagnostic sign (Figure 2). This knowledge and a careful examination of a properly stained blood smear are usually all that are necessary to make a proper diagnosis. Other physical signs or laboratory aids which may be helpful in the diagnosis of malaria did not occur with sufficient regularity to be entirely relied upon. Splenomegaly occurred in less than half the cases; the temperature curve is not characteristic; monocytosis was found in only about 1 out of every 6 cases; and other laboratory findings are not exclusive of a great many diseases.

It has already been stated, but it may be repeated with benefit, that any acute illness or unexplained clinical syndrome in a known addict or in an

FIGURE 3—Temperature Charts—Falciparum Malaria in Drug Addicts

CHART 1—Fatal Case—Quotidian Type of Fever
 CHART 2—Fatal Case—Irregular Type of Fever
 CHART 3—Recovery—Double Peaks
 CHART 4—Recovery—Tertian Type of Cycle



individual showing evidence of heroin addiction warrants entertaining a provisional diagnosis of malignant malaria. A well stained blood smear should be carefully and repeatedly examined for plasmodia. If as a result of inexperience or improper facilities a diagnosis of malaria cannot be made the matter of quinine therapy must be considered. Unless other specific measures are indicated, and the condition of the patient fails to improve, the drug should be given. It cannot harm the patient and should not interfere with other diagnostic measures or steps to arrive at a correct diagnosis if this should not be malaria.

4. Mortality:

The disease, even after early diagnosis and intensive therapy, is a serious one. The table of mortality (Table 2) bears this out.

In the last few months of 1933, when the epidemic first was recognized in New York, most of the patients died. In some instances the condition was not recognized and in others, when the diagnosis was made, the disease had progressed to such a stage that treatment was of no avail.

In more recent years, the mortality experience in the cases observed on the Psychiatric Division is somewhat higher, probably due to the fact that

many of the patients seen on that service entered the hospital in the well advanced cerebral form of the disease.

SUMMARY, CONCLUSIONS AND SUGGESTIONS

1. New York City is an endemic area for the occurrence of falciparum malaria. The disease occurs almost exclusively among heroin addicts who practise the common use of hypodermic syringes. Infection is direct from man to man.

2. The parasite is *Plasmodium falciparum* and after 5 years of asexual transmission from man to man, it is still capable of infecting anopheline mosquitoes.

3. Clinically and pathologically the disease manifests all the characteristics of falciparum malaria as it occurs in the tropics, including various cerebral, intestinal, and hemoglobinuric syndromes.

4. The outstanding diagnostic feature is the history or evidence of drug addiction. On this evidence obscure syndromes in drug addicts warrant specific therapy.

5. Early diagnosis and intensive therapy are still followed by high mortality rate.

6. A thorough mosquito survey and a survey for the incidence of malarial infection in drug addicts in the New York area should be carried out.

7. Drug addicts recovered from malaria should be under the legal jurisdiction of the city department of health.

8. All available contacts with drug addicts should be explored and latent or asymptomatic carriers treated.

9. Treatment should include the use of an effective gametocidal drug.

10. There is local *Anopheles quadrimaculatus* production in the New York City area.

11. The possibility of an epidemic involving the healthy population must be borne in mind.

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Voluntary Agencies

I HAVE sometimes heard the fear expressed that the National Health Program would do away with the need for the voluntary agencies. Nothing could be further from the facts. The implications of the National Health Program are that more responsibilities, more work, and for many years to come

an intensification of service, is the lot of the voluntary agency. We shall need all of our facilities, public and private, if the program is to meet its objectives. —Paul V. McNutt, Federal Security Administrator, in address before the National Health Council, New York, February 15, 1940.