

WHO/Mal/258 ✓
7 April 1960

ORIGINAL: ENGLISH

NOTE ON THE EPIDEMIOLOGY OF RECEDING AND RESURGENT MALARIA

by

Dr D. K. Viswanathan,¹

Senior Regional Malaria Adviser to the WHO Regional Office
for South-East Asia

1. The most significant change in the epidemiology of receding malaria from that of endemic malaria is the reduction of the reservoir to an epidemiological zero level. Thus with the return of vector species after the withdrawal of insecticidal spraying, there is no genesis of secondary cases in the first unit incubation interval and no further crops of cases in subsequent units of incubation intervals. The point to note is that the human reservoir need only be epidemiologically zero and not absolutely zero - this is often missed and occasionally leads to controversies between the purists-biologists and the more complacent public health workers. If one primary case leads to less than one secondary case in unit incubation interval, it may be deemed that the reservoir factor has been reduced to an epidemiological zero level.

2. The above end point of the quantum of residual infection should, however, be determined by a thorough examination of the entire population (after some preliminary screening) and not by random sampling as one would be content with in the case of post operational evaluation in the earlier phase of eradication or at all times during a control programme. This need is due to the epidemiology of reappearing malaria. The genesis of epidemics is generally considered from a mathematical approach. The present tendency is to give prominence to the 'deterministic theory'. According to this theory, a certain number of infected persons brought in contact with a certain number of susceptible individuals through the agency of the vector and in a given environment would bring about a specific number of secondary cases as a result of interaction between the basic factors involved in

¹ This note was received by the Division of Malaria Eradication, WHO Headquarters, shortly before Dr Viswanathan's untimely death. The author's obituary is appended to this issue of the WHO/Mal series.

the reproduction of the disease. This view put forward already by Ross was found to fail to 'match life' with respect to the data that were available from time to time. More recently Macdonald has revived this theory by primarily introducing the element of superinfection which Ross failed to account for. But the new theory still refers to a certain number of primary cases giving rise to a certain number of secondary cases which can be determined if the basic factors could be quantitatively appraised. This would be largely true when stability is maintained, i.e. during the pre-eradication phase. In receding malaria, however, the factors of basic reproduction are greatly altered. The mosquito factor in particular is profoundly changed. The change in all factors is so dynamic that it is difficult to provide a mathematical quantitative expression for them. One is therefore primarily concerned with the resultant or the residual human reservoir of infection as referred to previously.

3. In reappearing malaria, the 'deterministic theory' is likely to fail, for the beginnings of the reappearing disease would consist of single or patchy foci of autochthonous malaria transmission determined by the operation of the laws of chance. Thus any single female of the vector species living beyond the dangerous age may fail to have established contact with a reservoir of infection on account of extreme paucity of the latter in one area and under identical conditions may bite one or more infective individuals in another. Per contra a mosquito which bites one of the rare residual infectors may not live beyond the dangerous age to be able to transmit the disease in one area, but under similar conditions may do so in another area again due to chance. Hence the resultant secondary infections will be distributed either in terms of a continuous infection type exhibiting stochastic¹ characteristics or as a series of point binomial occurrences - more often the latter in the case of malaria. It is only when these events are allowed to occur for successive units of incubation intervals that a well established epidemic is noticeable. In the earlier phase given the same quantitative factors to react with one another, one may get in one focus a much greater number of secondary cases than in another focus.

¹ A stochastic process is an ordered set of observations in one or more dimensions, each observation being considered as a sample of one item from the probability distribution. (Editor's remark)

where there may even be none, mainly on account of the operation of chance. The deterministic theory may hold good when these events lead, on account of failure to detect them, to a sizeable epidemic, say, in two or three months. The surveillance mechanism either by active or passive detection of malaria cases should be most stringent to be able to detect these earlier events as and when they occur. Thus the entire population should be included in surveillance and not a random sample.

4. The progress of reappearing malaria would depend upon the characteristics of the primary donor and the mosquito factors. Let us assume that the vector densities have returned to pre-spraying level and that the daily survival rate which was greatly held in check during the attack phase on account of insecticidal spraying has also increased to pre-spraying levels. If the primary donor is an individual who had the infection before the commencement of the spraying and has only had relapses during the attack phase and has had no further stimulation of his immunity due to the infection with different strains and different species of plasmodia, it is conceivable that the gametocytes in such a primary donor do not readily transmit the infection to the mosquito in the first place and through the mosquito to susceptible human beings. It is also further conceivable that such a transmission will be attended by symptomless parasitaemia. The freedom from symptoms in the secondary human hosts would be due to the persistence of the immunity factor in the primary donor which has altered the characteristics of the plasmodium. Evidence of such a situation might be available if symptomless parasitaemia occurs as much in the young age groups as in the older age groups indicating that it was not immunity, per se, that accounted for the phenomenon in the secondary cases. On the other hand, the primary donor may have had a primary infection obtained either in the locality itself or from some other area where the progress of malaria eradication has not progressed far enough. In such a case the resultant infections in the mosquito and secondary human hosts will be of the classical type and are not liable to be associated with symptomless parasitaemia. Symptomless parasitaemia may also be found in areas exposed for a long period of time to malaria infection and where the people have acquired a considerable degree of immunity mainly of the so-called "anti-toxic" variety. Generally, however, a low degree of the immunity level in the absence of fresh infections during the attack phase of malaria eradication rapidly reduces the quantum of immunity and when the parasites multiply beyond a certain limit,

symptoms are produced. It is possible that various intervening grades of infection will be found in different parts of the world depending upon the level of immunity acquired by the community as a result of exposure to infection through several generations. (We are not dealing here with the so-called genetic or racial immunity, observed in African negroes to P. vivax.)

In the South-East Asia Region of the World Health Organization these possibilities are borne in mind and constantly taken into account. The need for the surveillance mechanism to be established and implemented with at least as much thoroughness as the spraying operations is constantly stressed. While in many countries it may be necessary to employ full-time staff for this mechanism as part of the malaria eradication service, every effort is being made to utilize fully all existing resources, e.g. hospitals, dispensaries, primary health units, health assistants, voluntary associations, private medical practitioners, etc. to make an integrated system of detection of all malaria cases and their suitable handling in case they are proved microscopically positive.

There are several other aspects of the technical developments in surveillance - and the South-East Asia Regional Office has two teams studying some of them. A detailed paper on all or most of these aspects is under preparation.

D. K. VISWANATHAN

IN MEMORIAM

Dr Dharmavadani Krishnier Viswanathan, Senior Regional Malaria Adviser to the Regional Office for South-East Asia, died on 27 March 1960.

Dr D. K. Viswanathan was born on 1 March 1901 in Tirunelveli (Madras State). He obtained his medical degree at the Medical College in Madras in 1923 and his Diploma in Public Health at the same school five years later. In 1937 he obtained a degree of Master of Public Health at the Johns Hopkins School of Hygiene, Baltimore, United States of America. From 1943 until 1952 he held the post of Assistant Director of Public Health with the Government of Bombay State. In 1952 he became the Director of Public Health Service of the Government of Bombay, in charge of Public Health Administration, and held this post until 1956 when he joined the World Health Organization and became Senior Regional Malaria Adviser to the Regional Office for South-East Asia.

Dr Viswanathan was a Member of the Committees of the Indian Council of Medical Research, the Council of Scientific Industrial Research, the WHO Expert Advisory Panel on Malaria and a Fellow of the Indian Academy of Sciences.

The loss of "D. K.", as he was affectionately called, came as a brutal shock to all his friends. It is difficult to believe that this unforgettable man, whose boundless energy and brilliant intellect were so widely known, has gone for ever. Malariology has lost in Viswanathan one of its outstanding specialists, a man who has blazed a trail towards malaria eradication in India and in the world. Viswanathan's interest in malariology dates from 1927 when he was Assistant Medical Officer in Madras. In 1935, in the capacity of Malaria Officer of the Madras Presidency, his was the task of controlling malaria over an area of 142 000 square miles with a population of 47 000 000. In this he was assisted by one entomologist and by a budget of about \$ 26 000!!

The DDT era in India started on 1 July 1945 in Dharwar and Kanara districts of Bombay Presidency, at Viswanathan's insistence and thanks to a small supply of the insecticide given by the Army. The success of this first trial was such that by 1949 about 6 000 000 people were under protection in Bombay State. By 1952 over 30 000 000 people were successfully protected from Malaria in India and in 1955 the Indian National Malaria Control Programme came into being, only to be succeeded two years later by the organization of the present National Malaria Eradication Service which, assisted by WHO and ICA, protects a population of 390 000 000.

Although the part played by Viswanathan in the early stages of this programme was limited to Bombay State alone, there is little doubt that "D. K.'s" experience, drive and extraordinary talent of persuasion contributed greatly to the success of this largest malaria eradication campaign in the world.

"D. K.'s" numerous published papers and countless letters and notes are marked by his deep understanding of the epidemiological bases of malaria, by the originality of his approach and his facility of expressing his thoughts. His book "Malaria and its Control in Bombay State", published in 1950, contains many ideas which were in advance of that time. His 1958 monograph "Conquest of malaria in India" makes delightful reading because of its liveliness and interesting historical sketches.

For the past four years Viswanathan held the post of WHO Senior Regional Malaria Adviser responsible for malaria eradication programmes over an enormous area of the South-East Asia Region where 506 000 000 people were exposed to the disease. He took up and carried on this difficult job with a phenomenal energy and without sparing himself. His work as an inspired leader, careful guide and critical judge has been outstanding and his departure has left a gap that will be difficult to fill.

Viswanathan had a double personality in which the East and West were extraordinarily blended. He was a Western man with his belief in material progress and his respect for Cartesian logic; but he was also (and even more) a devoted Brahmin Hindu, a mystic regarding all earthly phenomena as evanescent and aspiring to the union with the Infinite.

Viswanathan was a brilliant conversationalist able to quote John Donne and the Bhagavad Gita with equal facility and fervour. He was an excellent speaker, amusedly aware of the fact that his eloquence was at times a sore trial to clock-conscious chairmen. He had a noble courage of his own beliefs, and convictions and could be a formidable adversary in polemical jousts. A kind, loyal and generous friend, he is mourned by all those who knew him. Our deep sympathy goes to his wife, Lakshmi, his son and two daughters.

Nothing can show D. K. Viswanathan's personality better than an extract from his last letter written to some friends in the World Health Organization two weeks before his death.

"The medical pundits have at last declared that my condition is one of myeloma. . . . They are exploring the possibility of my getting treatment by irradiation in India. . . . but if it is not available there is no option . . .

. . . I have some notes and bits of news on the strategy of eradication of malaria and on our present knowledge of the epidemiology of disappearing malaria. It will not be unfitting if I present the Organization with this humble token of my last testament. I can dictate it during those moments that are available between my bouts of pain, prayer and pethidine. I am able to do this for about one hour every day; I hope to have the notes completed by the end of May but these 60 minutes a day have to be made up of at least 12 snatches of 5 minutes each, when I am physically able to concentrate my attention.

Though not over-modest in the past, during the last few years my service with an international organization has taught me a few basic virtues like humility, patience and human understanding.

All things must come to an end in this world. I am not worried about it. I have lived well, served well, have a good family and above all, excellent comradeship in my official work. So I am quite prepared to meet my Maker."

(L.J. B.-C.)