

Reviews and reports

Malaria as an emerging disease, with special reference to the Eastern Mediterranean Region

A.E. Beljaev¹

Malaria situation before the malaria eradication campaign

It is believed that malaria has been present in the Mediterranean since antiquity or even prehistoric times and was instrumental in the fall of at least some of the ancient Mediterranean civilizations [1,2]. A great deal of material evidence of the presence of malaria in predynastic Egypt (as early as 3200 BC) was obtained recently, when *Plasmodium falciparum* HRP-2 antigen was found in mummies belonging to that period [3].

During the first half of this century, malaria was highly prevalent all over the Mediterranean, including its European portion. Limited attempts to control malaria by land reclamation started very early and were later complemented by larviciding and the use of drugs [4]. In the Middle East, malaria control received a boost during the Second World War, being motivated mostly by the war effort [5,6]. However, only after the war, when dichlorodiphenyltrichloroethane (DDT) and chloroquine became available for civil use, did malaria control take its modern shape.

The rapid success of malaria control by residual insecticide spraying in Greece, Italy, the United States of America (USA) and in a few Middle East countries during the

late 1940s and early 1950s led to the formulation of an ambitious goal of malaria eradication.

Outcome of the malaria eradication campaign

The malaria eradication strategy, based on indoor spraying with DDT endorsed by the Eighth World Health Assembly in 1955 [7], led to rapid success, not only in temperate climates, but in more torrid ones as well. The heavy burden of malaria was eliminated from Greece, southern Italy, the southern USA and southern USSR, to name a few regions.

Although often referred to as world malaria eradication, this campaign was never a worldwide one. From the very beginning, doubt about the applicability of the strategy of malaria eradication was expressed; it was cited that in sub-Saharan Africa, "no large area had yet been cleared by the methods advocated by WHO and it was therefore impossible to plan for countrywide eradication with any assurance" [7]. Except for a few demonstration projects, most of which failed, very little was done to control malaria in sub-Saharan Africa from the 1960s to the 1980s. In 1970, a WHO Expert Committee acknowledged that in large ar-

¹Regional adviser, Malaria, World Health Organization, Regional Office for the Eastern Mediterranean, Alexandria, Egypt.

eas of tropical Africa time-limited malaria eradication programmes were often impracticable [8].

Most of the tropical and subtropical countries that embarked on malaria eradication have been successful in drastically reducing malaria, but have been unable to eradicate it. Stagnation of malaria control programmes usually began at the consolidation phase, when the interest of political bodies in malaria control waned, and the programmes themselves were becoming less and less flexible and increasingly bureaucratic. This was compounded by newly emerging technical problems, such as increasing insecticide and drug resistance and declining public interest in vector control.

As a result, malaria in those countries tended to re-establish its endemicity by spreading from a few residual foci. However, the re-establishment of malaria was seldom complete, and endemicity usually remained at a level well below that of the pre-eradication epoch. An excellent example is the evolution of the malaria situation on the Indian subcontinent. In prepartition India, the estimated annual number of malaria cases was 75 million with some 800 000 deaths in normal years, increasing further during epidemics [9]. In parts of British India that later became Pakistan, the Punjab epidemic of 1908 caused 300 000 deaths in a population of 20 million. Deadly epidemics continued to strike Punjab at intervals of eight years, and the situation improved only after a large-scale malaria eradication campaign was launched in 1961, which brought down the number of cases from the estimated 7 million in 1961 to just 9500 in 1967 [10]. In India, similarly, the number of cases was brought down from tens of millions to less than 100 000 in 1965.

Freedom from the burden of malaria facilitated rural development and a so-called green revolution in both countries. As a result, conditions for the spread of malaria became less favourable than before. Malaria continued to increase, but could reach maxima of only 6 400 000 cases in India (in 1976), and 643 000 cases in Pakistan (in 1972). However, by that time the public health structures capable of combating malaria had already been established and had gained the necessary experience. They could react promptly enough by developing and implementing modified plans of operation better adjusted to the new realities. This allowed them to stabilize the incidence of malaria at a level of about 2 million per year in India and 100 000 per year in Pakistan.

In view of this and many other similar examples, the often heard referral to the malaria eradication campaign as a "failure" is probably unfair. It would be more correct to call it a partial success. Most important, this success has been, by and large, sustainable, and only in countries where the public health system has been totally disrupted by war, as in Afghanistan, have the achievements of the eradication campaign been completely obliterated.

Re-emergence of malaria

As a result of the lack of progress in Africa, combined with full or partial success of malaria eradication elsewhere, the world configuration of malaria changed in such a way that more than 80% of the problem has become concentrated in Africa [11]. Taken as a whole, malaria distribution has preserved the configuration it took after the malaria eradication campaigns of the 1950s and 1960s. Malaria has been able, however, to stage spectacular comebacks in a number

of areas. Because of better public awareness on the one hand and changes in the disease epidemiology on the other hand, these comebacks have caused widespread concern and apprehension. The most prominent features of re-emerging malaria are:

- the continuing spread of resistance of *P. falciparum* to chloroquine, so that nowadays some degree of resistance is present practically wherever this species is endemic;
- the increase in the proportion of *P. falciparum* in highly endemic areas, at the expense of other species; one such species, *P. malariae*, has now become rare (this is probably due to an increased use of antimalarials to which *P. falciparum* was always less sensitive than other species);
- the growing resistance to insecticides of many vectors;
- a more prominent role played by man-made malaria linked to various economic activities, economic crises, civil strife and wars.

These features have tended to increase the level of malaria transmission. On the other hand, some factors have acted in the opposite direction:

- antimalarials have become more easily available to laymen, which limits, to some extent, the deleterious effects of malaria;
- in some cases, environmental pollution and degradation of natural ecosystems have led to a decrease in anopheline breeding and a fall in malariogenic potential; this particularly applies to African cities.

The impact of this change on malaria morbidity and mortality and, consequently, the perception of the importance of the disease by the public is not always straightforward. For example, a transition from a

highly endemic situation to a decreased, but still continuing transmission is usually accompanied by a delay in the development of immunity and its decreased effectiveness in protection from overt attacks of malaria. At the same time, the population at risk continues to receive infective bites quite often, perhaps several times a year instead of several hundred times. Malaria, which previously affected mostly young children in whom it was an ill-defined part of a mixture of a multitude of diseases, was gradually becoming more noticeable to the public. The population was becoming aware of a higher attack rate in adults, the appearance of severe and fatal malaria in adolescents, and increasing difficulty in getting rid of malaria attacks (due to increasing drug resistance). This is the case in big urban agglomerations in tropical Africa in which areas of low or no transmission have emerged, while the countryside has remained highly malarious.

Factors leading to local emergence of malaria

An important factor limiting the spread of malaria is altitude. Its action is indirect, through the decreasing temperatures which make the successful development of sporozoites impossible. These low temperatures are not always prohibitive for anopheline mosquitos, and they may quite often be found in previously nonmalarious areas at high altitudes [12]. The limit is between about 2500 m near the equator and about 1500 m at the northern limits of the Eastern Mediterranean. This limit is not, however, stable, and malaria can move upward during years with higher temperatures. The ensuing epidemics may be particularly deadly because they propagate among an immunologically naive population.

There are concerns that the world warming could lead to a spread of malaria at higher altitudes [13]. During the 1990s "highland epidemics" were documented in Burundi, Ethiopia, Madagascar, Swaziland and Zimbabwe [14]. It has been stated in a number of cases that malaria appeared at altitudes where it had not been known before in Kenya [15,16] and Rwanda [17]. There are fears that a similar trend has occurred in Yemen as well.

In the countries of the Horn of Africa and in the south of the Arabian peninsula, increased rainfall, often in the wake of a prolonged drought, has also contributed to a tremendous increase in malaria transmission in Djibouti, Ethiopia, parts of Sudan and Yemen.

An abrupt cessation of vector control (usually because of economic difficulties or sometimes because of rash political decisions) may lead to such an increase in malaria that the situation becomes worse than it was before the intervention. This happened in Gezira, an important agricultural area of Sudan, where intensive vector control was carried out for 10 years, but was abruptly stopped in 1989. As a result, malaria prevalence among children, as measured by the slide positivity rate, increased from 0.5% in 1988 to 33% in 1994.

Importation of more efficient vectors may result in a drastic deterioration of the malaria situation. In the Eastern Mediterranean Region, there are three ecological types of malaria, of which the Afrotropical type of malaria is much more resilient and destructive than the other two [18]. This is mostly due to the presence of the most effective known vectors belonging to the *Anopheles gambiae* complex. The barrier for the spread of *A. gambiae* from the Afrotropical area is formed by the Sahara, and the only probable way for penetration northward is the Nile valley. Such penetra-

tion occurred at least once, in the 1940s. With the new vector, the transmission of malaria that was always present in the area increased tremendously. The epidemic that followed resulted in 180 000 deaths in Upper Egypt from 1942 to 1943 [6]. Fortunately, *A. gambiae* (*A. arabiensis*, according to the new nomenclature) was not perfectly adapted to the new environment and was relatively easily eliminated in less than 11 months. It seems that Egypt is by no means immune to such catastrophic, albeit brief, events in the future.

Increased travel is a widespread phenomenon contributing to the spread of infectious diseases. For malaria in this Region, immigration of the workforce is of particular interest. The most steady flow of imported malaria is from the Indian subcontinent to the affluent countries of the Arabian peninsula, which receive mostly *P. vivax*, which dominates in the countries of origin. However, for Oman, with its traditional links to east Africa, importation of the African *P. falciparum* is quite important. Another way of importation of malaria is through refugees, which has become a considerable problem in Sudan and in countries bordering Afghanistan.

Various developmental projects often lead to an exacerbation of malaria through improvement of the breeding of vectors (due to excavations, irrigation, etc.) and also due to immigration of the workforce.

Finally, wars, which lead to the destruction of health infrastructure, which make it impossible to conduct control activities due to combat, land-mines and shortages of essential funds, supplies and equipment, and which displace huge numbers of people, take a heavy toll on malaria control programmes. In this Region, severe repercussions of local conflicts are still felt in Afghanistan, Djibouti, Iraq, Somalia and Sudan. Wars may also seriously undermine

Table 1 Summary of the malaria situation in the countries of the Eastern Mediterranean Region, 1996

Country	Malaria situation
Bahrain Cyprus Jordan Kuwait Lebanon Libyan Arab Jamahiriya Qatar Tunisia	Receptive countries where malaria transmission has been interrupted or (in the case of Kuwait) never documented
Morocco	Residual foci (<i>P. vivax</i> only). Malaria eradication is feasible
Egypt	Residual foci only in parts of Fayoum governorate. Malaria eradication is feasible
United Arab Emirates	Residual foci on the border with Oman
Oman	Mostly <i>P. falciparum</i> . Transmission greatly reduced during the 1990s, due to intensified malaria control efforts
Iran, Islamic Republic of Saudi Arabia	Malaria transmission in limited territories. The situation is generally under control
Pakistan Syrian Arab Republic	Increase in malaria incidence in some areas (only <i>P. vivax</i> in Syrian Arab Republic), but malaria is mostly contained
Iraq	A runaway malaria epidemic (<i>P. vivax</i> only) started in 1991, in the aftermath of the war. The situation seems to have stabilized due to intensified control efforts from 1995
Djibouti Sudan Yemen	Increase in malaria transmission and epidemics (overwhelmingly <i>P. falciparum</i>) in the areas where malaria was under control, following a decline of control activities due to financial constraints and political instability, amounting sometimes to civil war, and further aggravated by climatic change. Malaria control programmes exist, but organized control activities cover only parts of national territories
Afghanistan	Runaway malaria epidemics (mostly <i>P. vivax</i>) in a country where an efficient system of malaria control was destroyed by war. Control activities under way in limited areas but not coordinated at the national level
Somalia	Increase in malaria endemicity due to a complete halt of malaria control following the deterioration of the public health system

malaria control in countries sending troops abroad, as demonstrated recently by the example of the countries of the former USSR during and in the aftermath of the Soviet intervention in Afghanistan [19].

Current malaria situation in the Region

The current situation in different countries of the Region is summarized in Table 1.

Countries of the Region rank from highly endemic ones, to countries in which malaria is effectively under control, to those that have achieved an interruption of malaria transmission. At present, about 45% of the population of the Region live under the risk of both *P. falciparum* and *P. vivax* malaria, and an additional 15% under the risk of *P. vivax* alone. The estimated number of cases occurring in the Region annually is of the order of 13 million, of which 70% are

caused by *P. falciparum* and the rest by *P. vivax*. Of all the estimated cases, 96% occur in just five countries: Afghanistan (mostly *P. vivax*), Iraq (exclusively *P. vivax*), Somalia, Sudan and Yemen (mostly *P. falciparum*). The estimated number of deaths due to malaria is about 35 000 a year, the majority of them occurring in Somalia, Sudan and Yemen.

Conclusion

Although, so far, there has been no major spread of malaria from the areas to which it was confined as a result of the malaria eradication efforts of the 1950s to 1970s, the disease has staged local comebacks in a number of areas. In addition, the epidemiology of malaria has changed considerably, and this locally re-emerging disease still has a substantial potential for more widespread re-emergence.

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