CURRENT EPIDEMIOLOGY OF MALARIA IN SOUTHEAST ASIA

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INTRODUCTION

The nine countries of Southeast Asia (Burma, Indonesia, Kampuchea, Laos, Malaysia, the Philippines, Singapore, Thailand, and Vietnam) cover an area of nearly 4.5 million square kilometres with a population of over 343 million persons. Inspite of their vast geographic spread and the diversity of their peoples, the countries have shared some common experiences with malaria in the past 30 years. The purpose of this paper is to summarize the current epidemiology of malaria in these countries, to emphasize the common features, and to point out important factors that are unique to each country.

The countries fall into two administrative regions of the World Health Organization (WHO), the South East Asia Region and the Western Pacific Region. The information presented was obtained primarily from the two regional offices, which initially received the data from the governments of the member countries. In some countries only limited information was available, while in others systems of data collection and analysis have been well developed, In nearly all malaria remains a major public health problem. In 1978, 224 million persons in the region, or 65% of the total population, lived in areas where malaria transmission occurred. A total of 698,123 malaria cases were reported by the countries to WHO that year (1978).

BURMA

Since 1962, Burma has had a 13-fold increase in detected malaria cases. Malaria was the leading cause of hospitalisation and the ninth most common cause of outpatient morbidity in 1977 (WHO, 1980). However, the annual blood examination rate has declined in the past decade to about 1%, a level insufficient to define accurately the current epidemiologic situation. It is estimated that total morbidity from malaria is about 45 cases per 1000 persons annually compared with a reported annual parasite index of 0.6 infections per 1000 persons. The proportion of cases caused by *Plasmodium falciparum* infection had declined from 1973 to 1977, but in 1979 was 75% of all cases.

Of the population of 33.1 million people, 30.7 million live in malarious areas. Transmission is highest in the hilly and foothill forest regions, where the predominant vectors are *Anopheles balabacensis*, which breeds in jungle pools, and *A. minimus*, a hill-stream breeder. Other important vectors are *A. sundaicus*, which breeds in brackish waters along the coast, and *A. culicifacies*, which is found in irrigated areas of the central dry zone. Prevalence is low in the nonirrigated dry zone, the southern plains, and the deltas.

In 1970, the malaria eradication programme was revised to one of control, with eradication as the ultimate goal. Although malaria is recognized as one of the most important public health problems, the programme has received 2% or less of the health budget since

1977. The control programme is centrally directed but relies heavily on multipurpose workers supervised by township medical officers. In areas of high prevalence, where access is difficult and the health infrastructure is poorly developed, chloroquine is used for suppressive and clinical treatment. Selective house spraying with DDT is done in development projects and when outbreaks occur. In accessible areas with high prevalence and where the vector is susceptible to DDT, the programme sprays annually just before the onset of the transmission season. Chemoprophylaxis is also provided to vulnerable groups especially migratory workers. Where prevalence is low, the principal measures are active and passive case detection, augmented during outbreaks with selective DDT spraying.

The malaria programme is faced with two serious constraints. Since the mid-1970s, *A. culicifacies* has been resistant to DDT in the central plain of Burma, and *A. annularis*, a less important vector, is also resistant to DDT in limited areas. The second factor is widespread resistance of *P. falciparum* to chloroquine at the R I and R II levels, a particularly significant problem since drug distribution is a mainstay of the programme and *P. falciparum* accounts for more than 70% of malaria cases.

INDONESIA

The first efforts at malaria control were made in Bali and Java in 1952 at which time it was estimated that 30 million cases and 120,000 deaths due to malaria occurred in Indonesia each year. An eradication programme was launched in 1959, and by 1964 Java and Bali were practically malaria free. Setbacks occurred thereafter. In 1968 malaria services were incorporated into the general health services. Though residual house spraying with DDT in limited areas and case detection and treatment were continued, especially in East Java, reported cases rose from 9,000 in 1965 to 346,000 in 1973. With improvement in spraying operations and treatment programmes, the number of cases detected decreased to between 100,000 and 125,000 per year after 1974. In 1979, further reductions occurred in Java and Bali.

The malaria programme is decentralised, with autonomous peripheral health services and central responsibility for planning, manpower, and research. Because the proportion of the health budget allocated to the Malaria Operations Command has decreased from 12.0% to 6.7% in the last two years, a planned expansion beyond Java and Bali has not been fully realised, although transmission occurs on all of the islands. Spraying with DDT is carried out twice a year where *A. aconitus* is the vector. Passive case detection and treatment are used in all areas, as is monthly active case detection. On the outer islands DDT spraying is done only in priority areas, and reliance is placed on case finding and treatment.

In Central Java the level and extent of *A. aconitus* resistance to DDT has increased in recent years. Studies have been made of ultralow-volume application of fenitrothion, thermal fogging with fenitrothion, and intermittent irrigation of rice fields to control this vector. Resistance of *P. falicparum* to 4-aminoquinolines compounds has been documented in East Kalimantan, in Irian Jaya, and since 1980, in Timor and Sumatra. Since *P. falciparum* accounts for 30% to 50% of infections in Indonesia, this places a serious constraint on the malaria programme.

LAOS

In Laos antimalaria measures were first taken in 1956 with DDT house spraying and case detection and treatment. Early results were promising, but from 1960 to 1975, activities were essentially curtailed because

of war. In 1975, the government recognized malaria as one of the major health problems in the country.

Over 90% of the population of 3.75 million people live in originally malarious areas. In the high mountains above 1000 meters' elevation, the disease is nonendemic, though occasional epidemics may occur (Pholsena and Detvongsa, 1980). On the plateaus and in the forest between 200 and 1000 meters' elevation, malaria is meso- and hyper-endemic. On the plains below 200 meters, where the human population is more dense malaria is hypoendemic and the incidence varies from year to year. *A. minimus* and *A. balabacensis* are the major vectors. *P. falciparum* accounts for between 80% and 85% of cases.

Antimalarial measures were restarted in 1976 with parasite surveys and entomologic investigations in the Vientiane Plain and mass drug distribution. Active case detection was also begun in the Nam Ngum Dam area. The next several years will be devoted to the development of a primary-health-care infrastructure and to the establishment of an Institute of Malariology and Parasitology.

Recently, Vietnam has provided considerable support to the antimalarial programme. A pilot project has been started in Champassak Province, which borders on Thailand and Kampuchea. Using residual DDT spraying and a sulfonamide pyrimethamine combination, the programme has succeeded in reducing the annual parasite index in the province from 19.1% to 9.2% during the last two years.

A high proportion of *P. falciparum* cases in Vientiane and Champassak Provinces are resistant to 4-aminoquinoline compounds at the R I and R II levels, and it is presumed that resistance is widespread in the rest of the country. The rugged terrain, poor communications, scarcity of trained manpower, and limited resources are other impediments to antimalaria operations.

KAMPUCHEA

No information is available on the current malaria situation in Kampuchea. Over 80% of the total area of 180,000 square kilometers is estimated to be malarious, with hyperendemic areas along the borders with Vietnam, Laos and Thailand. Slide positivity rates in these areas averaged near 30% annually during surveys taken from 1969 to 1972, with about 50% of infections due to *P. falciparum*. Towns in the Central Plains, including Phnom Penh, are considered to be malaria-free.

DDT house spraying and distribution of antimalarials was started in 1953 and gradually expanded to cover about 300,000 inhabitants in 1959 with in general a dramatic success. However, these measures were not very successful in forested hilly areas because of the exophilic habits of the vectors, the types of houses and farm huts in which people live, and the tendency of people to be outside during peak biting hours. It is believed that resistance of *P. falciparum* to 4-aminoquinoline compounds is widespread throughout the country. Because of internal strife, there has been no antimalarial programme for several years.

MALAYSIA

After a successful pilot project carried out from 1960 to 1964, Peninsular Malaysia embarked on an eradication programme in 1967. A pre-eradication survey conducted in 1965 showed a slide positivity rate of 3.9% with 46.8% of infections being *P. falciparum*. Malaria was present in 65% of villages. Spraying of DDT emulsion and case detection and treatment reduced reported malaria cases from 300,000 - 400,000 annually before 1967 to 10,000 in 1978 and 1979. Only 11%

of the population lives in areas still in the attack phase, i.e., total coverage with residual house spraying.

The major vectors are *A. maculatus*, which breeds in streams in hilly regions, *A. sundaicus*, a coastal breeder, and *A. campestris*, which breeds in rice fields, ponds, and swamps. *A. balabacensis* is of very limited importance in the north toward Thailand.

Particular problems occur with temporary workers in land development projects, military and police personnel working in malarious areas, villagers working in small land projects in the jungle, and persons entering from Thailand and Indonesia. Resistance of *P. falciparum* to choloroquine (R I type) occurs in foci, but has not been a serious impediment to control measures.

In Sarawak an eradication project was started in 1961 and succeeded in reducing reported cases from a level of 40,000 - 50,000 a year in a population of 1 million to about 1,500 in 1970 and 1971. However, difficulties were encountered in reducing further the incidence of malaria, and the programme was converted to a control project. Since 1976, fewer than 1,600 cases a year have been detected; of these, 85% are due to *P. vivax*. Over half of the cases are in areas bordering on Indonesia and Sabah.

The principal vectors in Sarawak are *A. balabacensis* and *A. leucosphyrus*. A total of 81% of the population live in areas that are no longer routinely sprayed. The rest live in previously hyperendemic areas or in border areas where routine spraying continues.

Malaria has continued to be a serious health problem in Sabah. In 1955 it was estimated that over 250,000 cases a year occurred in a population of 400,000. Anti-malarial activities started with DDT spraying and mass drug administration in 1958. In 1968 only 11,517 cases were reported. Between 1974 and 1978 the incidence of malaria increased, but in 1979, 25% fewer cases were detected than in previous years. Regular or selective spraying is done in areas comprising 46% of the population, and additional treatment posts have been established in highly malarious areas.

A. balabacensis is the principal vector and is not well controlled by DDT. *P. falciparum*, which accounts for the majority of infections is resistant to chloroquine in 85% of cases.

PHILIPPINES

Countrywide antimalarial measures, first undertaken in the Philippines in 1954, were expanded to an eradication programme in 1956. Marked success was seen in the first few years, but after decentralisation of the programme in 1959, the malaria situation deteriorated. In 1969 it no longer seemed feasible to eradicate malaria in a limited period of time, and spraying was limited to areas of highest transmission where malaria had been a major health problem.

Reported cases increased from 35,482 in 1970 to 104,826 in 1978 and then decreased to 87,421 in 1979. *P. falciparum* accounted for two-thirds of all cases over the decade, with no difference between areas with and without regular spraying. The highly malarious areas are in the foothills, hills, and mountains and on the fringes of the forests. *A. minimus flavirostris*, a hill-stream breeder, is the most important vector.

Between 1972 and 1979 the number of houses routinely sprayed with DDT decreased from 1.6 million to 300,000. The Malaria Eradication Service was allocated less than 1% of the 1979 health budget to administer a programme for 14.9 million people. Along with limited residual spraying activities, case detection and treatment remains a fundamental means of malaria control in the Philippines. Active case detection produces more

than half the total slides but only 20% of the positive slides. Nonetheless, the positivity rate with active case detection is relatively high (2.8%) because it is used selectively in areas without a system of passive case detection. Passive case detection provides about one-quarter of the slides but 60% of the positive ones. Malaria Eradication Service Dispensaries and rural health units detect the most cases. Mass blood surveys account for the remainder of slides.

The malaria programme is faced with two serious constraints. Political insecurity in some highly malarious and remote areas limits access by the programme. In 1971 the first case of chloroquine resistance of *P. falciparum* was documented and resistance is now present in all but limited areas. Vector resistance to insecticides has not been described.

SINGAPORE

Early in this century, malaria was a leading cause of death in Singapore. Vigorous antilarval measures were undertaken, and by 1922, many miles of subsoil pipes and open-channel drains had been laid. Drainage projects and oiling of breeding sites continued after World War II. In recent years essentially all cases of malaria have been imported. Since 1976, the number of reported cases has fallen, largely because of the launching of a programme in Johore State of Peninsular Malaysia and the disappearance of malaria from the offshore islands as these have been developed.

THAILAND

In 1947 malaria was the leading cause of death in Thailand, producing 297.1 deaths per 100,000 population. The first efforts at control with use of residual insecticide spraying began in 1949 and succeeded in reducing the death rate from malaria to 30.2 per 100,000 by 1960. In that year a policy of malaria eradication was adopted, and a countrywide project, with assistance from the World Health Organization and the United States Agency for International Development, began in 1965. After a period of success in the late 1960s, the programme faced a series of setbacks. The principles of malaria control were accepted in 1975 and implemented in 1978, with the objective of maintaining control in the border and mountainous regions and preventing the reestablishment of endemicity in the remaining areas.

The number of detected malaria cases rose without interruption from 92,409 in 1972 to 329,388 in 1978. The first decline in seven years occurred in 1979, when 302,721 cases were detected. During this period the proportion of malaria infections due to *P. falciparum* decreased from 80% to 53%. However, falciparum malaria has again increased slightly and now accounts for about 60% of all cases. While the malaria death rate of 14.4 per 100,000 population in 1975 showed malaria to be the eighth commonest cause of mortality, the rate of 9.7 per 100,000 in 1978 was the lowest ever recorded for this disease in Thailand.

Though government funding for the Malaria Division increased from 1975 to 1980, the proportion of the health budget allocated to malaria decreased from 7.6% to 3.8%. Antimalarial measures protect 9.3 million people, primarily with residual DDT spraying, generally done twice a year. The Malaria Division carries out surveillance in areas of consolidation, where 2.2 million people live. The provincial health services are responsible for surveillance for the 31.2 million people residing where malaria activities have been partially integrated into primary-health-care services. Recently, malaria clinics with microscopists have been established at regional, zonal, and sector offices and at some hospitals and health centers in high-incidence areas.

The two major vectors, *A. minimus* and *A. balabacensis*, continue to be susceptible to DDT in selected index villages where routine testing is carried out. However, both species have a tendency to bite and to live outdoors. A more serious problem is resistance of *P. falciparum* to multiple drugs. Resistance to 4-aminoquinoline compounds especially chloroquine, has been documented for 20 years and now occurs in 90% of cases throughout the country. In 1980, following the influx of Kampuchean refugees, resistance of *P. falciparum* to the sulfonamide-pyrimethamine combination Fansidar was documented along the Kampuchean border (CDC,1980). The appearance of resistance to what has been a standard treatment for *P. falciparum* malaria since 1971 is a disturbing development. The geographic extent of Fansidar-resistant strains and the potential for spread by population movement within Thailand is under careful study.

VIETNAM

In the southern provinces of Vietnam, below the seventeenth parallel, malaria control was first undertaken in 1954 with DDT spraying. The programme succeeded in reducing the parasite rate from 7.2% to 2% annually after 1953. Control in the northern provinces began in 1958; the overall parasite prevalence was reduced from 5.64% in 1958 to 0.28% in 1964 (Can, 1980).

Originally, the entire country had endemic malaria. At present, the high plateaus and the jungle-covered mountainous areas bordering on the southern coastal provinces have the highest parasite indices. *A. balabacensis* and *A. minimus* are the main vectors, but *A. jeyporiensis*, which breeds in clear streams, canals, and rice fields, is also a vector in the highlands (Phan, 1980).

The malaria control programme for the southern provinces was inaugurated in 1977. The total number of cases was approximately 30,000 in 1978 and 1979, in part due to improved surveillance. The proportion of cases due to *P. falciparum* has declined from over 70% to about 50%. Currently, 4.3 million of the 15 million people living in the southern provinces have annual DDT spraying at their homes. For another 2.2 million residing in highly malarious areas, spraying is done every six months. Half a million people live in scattered coastal communities where *A. sundaicus* and *A. subpictus* are the vectors. The former, which reaches peak densities at the end of the dry season, remains responsive to DDT. However, *A. subpictus* is tolerant to DDT in some areas; thus, control depends on case finding and treatment. Eight million people live in areas of low endemicity to the extreme south of the country.

Malaria in the northern provinces is focal, and the annual parasite index is less than 2 infections per 1,000 population. Protective-barrier spraying is done along the international border, where 4 million people reside. The densely populated area of Hanoi and the delta are virtually malaria-free.

Most *P. falciparum* infections in the southern provinces are resistant to 4-aminoquinoline compounds. While chloroquine-resistant parasites were first detected in the North in 1967, their distribution remains localised (Phan and Anh, 1980).

DISCUSSION

Many countries of Southeast Asia undertook antimalarial activities in the early 1950s, usually with residual DDT house spraying in limited areas. Initial successes encouraged these countries and others to embark on eradication programmes with WHO assistance and, sometimes, with other foreign aid. Most countries initiated eradication measures in the late 1950s or early 1960s, though, in some, internal strife and war prevented the adoption of countrywide eradication pro-

grammes. In Peninsular Malaysia the eradication programme began in 1967, and in Singapore antilarval measures that had been effective in controlling malaria since the 1920s were extended.

Again, in the early years of eradication, success was the common experience, in some cases very dramatic success. Indeed, malaria came to be regarded as less of a threat, not deserving the importance attached to it. Gradually, the malaria situation began to worsen, beginning as early as 1963 in Burma and 1966 in Indonesia and affecting all the countries except Peninsular Malaysia, Sarawak, northen provinces of Vietnam, and Singapore by the early 1970s. The gradual worsening changed to a rapid deterioration, so that by 1976 most countries had reported many times the number of cases experienced in the early years of the eradication effort.

Between 1968 and 1977 the countries of this region abandoned the concept of eradication accomplished in a limited period of time and adopted the objective of eliminating mortality and reducing morbidity to a level that would not interfere with development. These goals are consistent with the resources available to the malaria programmes. Since 1976, the malaria situation has stabilized in some countries and actually improved in others, in part because of natural factors and in part because of an emphasis on problem areas.

Along with a dramatic increase in detected cases, there have been other significant developments in the last decade. *Plasmodium falciparum* resistant to chloroquine, first reported from South America in 1961 (More and Lanier, 1961), and from several Southeast Asian countries shortly thereafter is now present in all countries of the region. (Eyles *et al.*, 1963, Montgomery and Eyles, 1963; Young *et al.*, 1963; Legters *et al.*, 1963; Harinasuta *et al.*, 1965). In Burma, Thailand, Laos, and Kampuchea, essentially all falciparum infections are resistant to 4-aminoquinoline compounds at the R I or R II level. In Eastern Malaysia and in Indonesia, the geographic distribution of these resistant strains is increasing, especially in areas of highest endemicity. Only Peninsular Malaysia has not found sufficient levels of resistance *in vivo* to interfere seriously with malaria control activities.

A more recent and more serious development is the confirmation near the border between Thailand and Kampuchea of significant resistance of *P. falciparum* to the combination sulfadoxine/pyrimethamine (Fansidar) (Center for Disease Control, 1980). Sulfonamide/pyrimethamine combinations have become the standard drugs for radical cure of falciparum malaria in several countries of Southeast Asia. It is a disturbing prospect that, in some places, treatment of falciparum malaria may in the future require longer courses with more toxic drugs, unless newer antimalarials become available.

In contrast to drug resistance of the parasite resistance of vectors to insecticides has created problems for only two countries in the region. In Burma DDT-resistant *A. culicifacies* is found in the central plain and DDT-resistant *A. annularis* occurs focally.In Indonesia the extent of DDT-resistant *A. aconitus* has been increasing on the island of Java. In neither case has vector resistance become so widespread as to create the extensive problem encountered in such regions as Central America.

Though still susceptible to DDT, two major vectors in Southeast Asia appear to be poorly controlled by this insecticide. *A. balabacensis* in certain forested areas of all countries where it occurs is poorly controlled by DDT. It is reported that *A. minimus* in part, of Burma, Thailand, and Vietnam are increasingly demonstrating elusive behavior toward DDT,

though a true change in anopheline behavior has not been demonstrated. The types of houses and huts in which people live also reduce the effectiveness of residual insecticides. In addition, people in hot and humid climates tend to spend the evening hours outdoors, when vectors bite the most. Fortunately, a few vectors, such as *A. sundaicus* are well controlled by residual DDT spraying.

Several factors that contributed to the increasing incidence of malaria in the last decade still place serious constraints on malaria control programmes in these regions (Harinasuta *et al.*, 1976). War has disrupted programmes in Kampuchea and its neighboring countries. Internal insecurity in remote areas that often have hyperendemic malaria interferes with malaria control efforts in several countries. The appearance of resistant parasites and vectors has necessitated the change to more expensive drugs and insecticides. These increased costs combined with rapid inflation and diminishing appropriations have placed severe financial limitations on most programmes. The movement of people within countries and across international boundaries places nonimmune persons at increased risk of acquiring malaria and threatens to reintroduce the disease into receptive malaria-free areas. The most serious aspect of migration is the possible spread of resistant *P. falciparum* by infected travellers. Other common difficulties include lack of equipment, vehicles, insecticides, drugs, and properly trained staff. People themselves are often unwilling to cooperate with long-term control measures such as drug distribution and insecticide spraying.

In the last few years, malaria control programmes have been turning increasingly toward integration with general health services. The intent is to train multipurpose workers with responsibilities for spraying, case detection, and treatment, along with other health activities in the community. It remains to be learned whether intergation will be effective in all areas or only in those of relatively low endemicity. The malaria control programmes of Southeast Asia face major challenges. It will be interesting to participate in the evolving epidemiology of malaria in the years ahead.

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