Epidemic Dengue/Dengue Haemorrhagic Fever:
A Global Public Health Problem in the 21st Century*

By
Duane J. Gubler
Division of Vector-Borne Infectious Diseases
National Center for Infectious Diseases
Centers for Disease Control and Prevention
Public Health Service
U.S. Department of Health and Human Services
PO Box 2087, Fort Collins, CO 80522
Tel: (970) 221-6428, Fax: (970) 22106476
E-mail: DJG2@cidvbi1.em.cdc.gov

Abstract
Dengue/dengue haemorrhagic fever has been one of the most important resurgent tropical
diseases in the past 17 years, with expanding geographical distribution of both the viruses and
the mosquito vectors, increased frequency of epidemics, development of hyperendemicity (co-
circulation of multiple virus serotypes) and the emergence of dengue haemorrhagic fever in new
areas. This paper briefly reviews the changing epidemiology of dengue, discusses some of the
factors responsible for the recent resurgence, and reviews the current options available for
reversing the emerging trend of the disease.

Introduction
Dengue fever/dengue haemorrhagic fever
(DF/DHF) is caused by infection with four
dengue virus serotypes DEN-1, DEN-2,
DEN-3 and DEN-4, which are closely
related to each other antigenically[9]. This
results in extensive cross-reactivity in
serological tests, but infection with one
serotype does not provide cross-protective
immunity against the others; thus, persons
living in an endemic area can be infected
with each of the four dengue serotypes
during their lifetime.

Epidemic dengue fever is a very old
disease, but it was characterized during
most of its history by periodic, often
infrequent, epidemics. In the past
17 years, however, there has been a
dramatic resurgence of epidemic dengue
activity in the tropics worldwide. This
increased epidemic activity, which has
been caused by all four virus serotypes,
has been associated with the

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geographical expansion of both the mosquito vectors and the viruses, the development of hyperendemicity (the co-circulation of multiple virus serotypes in an area), and the emergence of dengue haemorrhagic fever. Hyperendemicity is the most constant factor associated with the evolution of epidemic DHF in a geographical area.

This paper reviews the changing epidemiology associated with dengue viruses and attempts to explain why such changes have occurred in the waning years of the 20th century.

Transmission cycle

Infection with dengue viruses is transmitted through the bite of infective female *Aedes* spp. mosquitoes (9). *Aedes aegypti*, the principal vector, is a small black-and-white, highly domesticated mosquito that prefers to lay its eggs in artificial water-containers commonly found in urban areas of the tropics. Containers found in and around the home, such as those used for water storage, flower vases, old automobile tyres, buckets and other junk items that collect rainwater are examples. The adult mosquitoes are rarely noticed, preferring to rest indoors and to feed on humans during daylight hours in an unobtrusive and often undetected way.

Infection with dengue viruses occurs when a person is bitten by an infective mosquito. After a period of incubation lasting 3 to 14 days (average 4 to 6 days), the person may experience an acute onset of fever accompanied by a variety of non-specific signs and symptoms (31). During this acute febrile period, which may be as short as 2 days and as long as 10 days, there is a viremia, which may vary in magnitude and duration (6,7). If uninfected *Ae. aegypti* mosquitoes bite the ill person during this febrile viremic stage, those mosquitoes may become infected and subsequently may transmit the virus to other, uninfected persons after an extrinsic incubation period of 8 to 12 days (9).

Clinical presentation

Dengue virus infection in humans of all four virus serotypes causes a spectrum of illness ranging from inapparent or mild febrile illness to severe and fatal haemorrhagic disease. Clinical presentation in both children and adults may vary in severity, depending on the strain and serotypes of the infecting virus, and the immune status, age and the genetic background of the patient. In dengue endemic areas, acute dengue infections are often clinically nonspecific, especially in children, with signs and symptoms of a viral syndrome.

Classical dengue fever is primarily a disease of older children and adults, characterized by a sudden onset of fever and one or more of a number of non-specific signs and symptoms such as frontal headache, retro-orbital pain, myalgias, arthralgias, nausea and vomiting, weakness and rash (1,9,31). Anorexia, altered taste sensation and mild sore throat are not uncommon. Clinical laboratory findings associated with dengue fever include leukopenia, and, in some patients, thrombocytopenia and elevated liver enzymes. Haemorrhagic manifestations may occur, the most common being skin
haemorrhages. Dengue fever is generally self-limiting and rarely fatal, the acute illness lasting 3 to 7 days. Convalescence, however, may be prolonged for weeks with weakness and depression. No permanent sequelae are known, and immunity for the infecting virus serotype is lifelong.

Dengue haemorrhagic fever is primarily a disease of children under 15 years of age, although it may occur in older children and adults as well. Like dengue fever, it is characterized by a sudden onset of fever and non-specific signs and symptoms, and is difficult to distinguish from dengue fever and other illnesses during the acute stage. The critical stage in DHF occurs at the time of defervescence when the patient develops a capillary-leak syndrome, with signs of circulatory failure and haemorrhagic manifestations, primarily skin haemorrhages. Thrombocytopenia (<100,000/mm³) and elevated haematocrit are prominent features. DHF can be a very dramatic disease with the patient’s condition deteriorating very rapidly with the onset of shock and resulting in death if the plasma leakage is not detected and corrected with fluid replacement therapy. Leukopenia, thrombocytopenia and haemococoncentration are constant findings; hepatomegaly and elevated liver enzymes are common. Risk factors for developing severe haemorrhagic disease are not fully understood, but, as noted above, include the strain and serotype of the infecting dengue virus, the immune status, age and genetic background of the patient.

Geographical distribution and incidence

Dengue fever and *Ae. aegypti* mosquitoes have a worldwide distribution in the tropical areas of the world, with over 2.5 billion people living in dengue endemic areas (Figure 1)(13,17,29). The currently known geographical distribution of the various dengue virus serotypes is shown in Figure 2, and reflects the development of hyperendemicity in most tropical areas of the world in the past 15-20 years. In 1997, DF/DHF has been the most important arboviral disease of humans, with an estimated 50 to 100 million cases of dengue fever and several hundred thousand cases of DHF occurring each year, depending on epidemic activity(13,14,24). Currently, DHF is a leading cause of hospitalization and death among children in many south-east Asian countries where epidemics first occurred in the 1950s(13). Epidemic DHF spread to the South Pacific islands in the 1970s, and reached the Caribbean Basin in the 1980s(6,13,14). The pattern of severe haemorrhagic disease has evolved in the American region in the 1980s and 1990s in a manner similar to the way it did in south-east Asia in the 1960s and 1970s(6,12). In Central and South America, dengue fever has an economic impact of the same order and magnitude as malaria, tuberculosis, sexually transmitted diseases (excluding AIDS), hepatitis, the childhood cluster (polio, measles, pertussis, diphtheria) and the tropical cluster (schistosomiasis, filariasis, Chagas’ disease, leishmaniasis and onchocerciasis)(23).
Figure 1. Global distribution of epidemic dengue and the principal vector mosquito, *Aedes aegypti*, 1997

Figure 2. Known global distribution of the four dengue virus serotypes, showing areas of hyperendemicity, 1997
Changing epidemiology

The epidemiology of dengue viruses changed with the ecological disruption in south-east Asia during and following World War II\(^{(9,18)}\). During the war, existing water systems were destroyed, and water storage was increased for domestic use as well as for fire control. War equipment was moved between cities and countries, and large amounts of equipment were also left behind. This material collected rainwater and made ideal larval habitats for *Ae. aegypti*, resulting in the transport of mosquitoes and their eggs to new geographical areas. The result of these ecological changes was a greatly expanded geographical distribution and increased population densities of *Ae. aegypti*. In addition, hundreds of thousands of Japanese and Allied soldiers, most of them susceptible to dengue virus infection, were constantly moving between countries in Asia and the Pacific. This provided ideal conditions for movement of viruses between cities, countries and other regions as well as susceptible individuals for epidemic transmission. The war years were thus responsible for creating the conditions (hyperendemicity and high densities of *Ae. aegypti*) for the emergence of DHF in south-east Asia.

In the years following World War II, unprecedented urbanization of south-east Asia began, with millions of people moving to the cities of the region. Urban centres in most countries expanded rapidly in an uncontrolled and unplanned fashion. Housing was inadequate, and water, sewer and waste management systems deteriorated. The *Ae. aegypti* populations and dengue viruses thrived in this new ecological setting, with increased transmission and increased frequency of dengue epidemics occurring in the indigenous populations of children. Moreover, economic expansion began in the region that continues even today. This led to continued urbanization and increased movement of people (and with them, of dengue viruses) between cities and countries. Those countries that did not already have multiple virus serotypes co-circulating quickly became hyperendemic. The viruses, often all four serotypes, were maintained in a human-*Ae. aegypti*-human cycle in most urban centres of south-east Asia.

The result of these changes was a dramatically increased dengue transmission and the emergence of DHF. In every country where the disease emerged as a major public health problem, it evolved in a similar manner, first as sporadic cases of DHF occurring for several years, ultimately culminating in a major epidemic. Following the first epidemic, a pattern of epidemic activity was established, with epidemics occurring every 3 to 5 years. Characteristically, succeeding epidemics became progressively larger as a result of geographical expansion of DHF within the country.

The first DHF epidemic ever recorded as such occurred in Manila, Philippines, in 1953-54\(^{(19)}\), although retrospective analysis suggests that outbreaks had occurred earlier as well before the dengue etiology was known. During the first 20 years that epidemic DHF was known, it was localized in several south-east Asian countries where it had become a major cause of hospitalization and death among
children by the mid-1970s. The 1980s saw a dramatic geographical expansion of epidemic DHF in Asia; it moved west into India, Pakistan, Sri Lanka and Maldives, and east into the People’s Republic of China. There was also a resurgence of the disease in Singapore, which has continued through the 1990s.

Surveillance for DHF is passive, with only severe cases reported to the World Health Organization by most countries. Thus, only the tip of the iceberg is reported, making DF/DHF one of the most under-reported tropical infectious diseases in the past 20 years. Even so, approximately four times as many DHF cases have been reported in the last 15 years (1981-1995) than in the previous 30 years (Figure 3). In 1997, DHF has been a leading cause of hospitalization and death among children in many countries of Asia.

Activities related to World War II also resulted in expanded geographical distribution and increased densities of Ae. aegypti in the South and Central Pacific islands. A major regional pandemic of DEN-1 occurred on most islands from 1942 to 1945, affecting both indigenous and military populations. Following the war, the isolation of the Pacific islands and their small human populations resulted in the disappearance of dengue viruses from the area until the mid-1960s when a small outbreak of DEN-3 occurred in Tahiti. In late 1971, DEN-2 was introduced into the Pacific, followed in 1975 by a new strain of DEN-1, in 1979 by DEN-4 and in the early 1980s by a new strain of DEN-3. All virus serotypes caused major epidemics of dengue fever, and some islands experienced severe haemorrhagic disease compatible with DHF. The events in the Pacific have recently been reviewed in detail(16).

Epidemic dengue occurred only rarely in the Caribbean Basin countries after the 1930s, and from 1946 to 1963, there was no recorded epidemic transmission despite the evidence that at least one serotype (DEN-2) was endemic in the region(5). Epidemic dengue never re-emerged as a public health problem in the Americas until the late 1970s. This 40-year quiescence was likely due to several factors, the most important of which was the Ae. aegypti eradication programme initiated by the Pan American Health Organization (PAHO) in 1946 to prevent urban epidemics of yellow fever(30,32). The programme was successful and eradication was achieved in most countries of the region. Unfortunately, the programme was discontinued in the early 1970s, and failure to eradicate Ae. aegypti from the whole region resulted in repeated reinfections by this mosquito vector of those countries that had achieved eradication. During the 1970s, support for Ae. aegypti surveillance and control programmes waned as these were merged with malaria control programmes in many countries. By the end of the decade, many countries had been reinfested with Ae. aegypti(9,10,26). The reinfestation of the region continued during the 1980s and 1990s. In 1997, Ae. aegypti had a distribution similar to that in the 1940s before eradication was initiated (Figure 4).
**Figure 3.** Emergence of dengue haemorrhagic fever – Reported cases to WHO, 1950-1995

**Figure 4.** Reinfestation of the Americas by *Aedes aegypti*, 1970-1997
The expanding geographical distribution of *Ae. aegypti* in the 1970s and 1980s coincided with increased movement of dengue viruses both into and within the American region\(^{(6,12)}\). Prior to 1977, only DEN-2 and DEN-3 viruses were known to be present in the Americas, although DEN-1 was probably present during the early 1940s\(^{(6,8,12)}\). DEN-3 caused the first epidemics in nearly 20 years in Jamaica and Puerto Rico in 1963, and DEN-2 caused epidemics in 1969 and the 1970s, again in the Caribbean islands that never achieved *Ae. aegypti* eradication. Both of these viruses were maintained in the region as district genetic genotypes\(^{(21,22)}\), and the DEN-3 caused subsequent epidemics in Colombia and Puerto Rico in the mid-1970s before apparently disappearing from the region\(^{(6,12)}\). A characteristic of dengue in the Americas from the 1950s through the early 1980s was non-endemicity (no viruses present) or hypo-endemicity (only a single serotype present) in a country\(^{(5,6,12,16,26)}\).

DEN-1 was re-introduced to the American region in 1977, with epidemics occurring in Jamaica and Cuba in 1977 and in Puerto Rico and Venezuela in 1978\(^{(26)}\). In the succeeding four years, this serotype spread throughout the Caribbean islands, Mexico, Texas (USA), Central America and northern South America, causing major or minor epidemics\(^{(6,12,26)}\). The illness in all of these epidemics was classical dengue fever. In 1981, DEN-4 was introduced into the eastern Caribbean islands\(^{(6,12)}\). Like DEN-1, this serotype also spread rapidly to other islands in the Caribbean and to Mexico, Central America and northern South America, causing major or minor epidemics in countries that had recently experienced DEN-1 epidemics\(^{(6,12)}\). Some of these outbreaks (Suriname, 1982; Mexico, 1984; Puerto Rico, 1986; El Salvador, 1987) were associated with the emergence of DHF for the first time, occurring sporadically for the most part, and although DEN-4 was the predominant virus isolated in each of these epidemics, other dengue virus serotypes were also present\(^{(6,12)}\).

Also in 1981, a strain of DEN-2, new to the region, was introduced into Cuba from south-east Asia\(^{(13,20,22,28)}\). Unlike the DEN-1 and DEN-4 epidemics, the 1981 Cuban DEN-2 epidemic was associated with thousands of cases of severe haemorrhagic disease (Figure 5); this was the first major DHF epidemic in the Americas\(^{(20)}\). Although there were an estimated 10 000 cases of DHF, the case fatality rate was low (158 deaths), most likely because of hospitalization and effective management of suspected DHF cases\(^{(20)}\). In the three-month period of the epidemic, over 116 000 persons were hospitalized and placed on fluid replacement therapy. Although the viruses isolated in Cuba have been unavailable for study, DEN-2 viruses isolated in Jamaica at the time of and shortly after the Cuban epidemic (Gubler DJ, unpublished data) were sequenced and the data suggest that the virus causing the epidemic was a new strain introduced from Asia, most likely from Viet Nam, where several thousand Cuban aid personnel were working at the time\(^{(20)}\) (Gubler DJ, unpublished data).

The second major epidemic of DHF in the Americas occurred in Venezuela in 1989-90 with over 6 000 cases and 73
deaths\(^{(27)}\). The virus serotype responsible is not definitely known since DEN-1, DEN-2 and DEN-4 viruses were all isolated from patients. However, DEN-2 appeared to be most frequently associated with fatal cases (F. Pinheiro, PAHO, personal communication); this virus was the same genotype as the virus thought to have caused the Cuban epidemic in 1981\(^{(22)}\).

Epidemic DHF of variable intensity caused by this genotype of DEN-2 subsequently occurred in Colombia (1990), Brazil (1992 and 1994), Puerto Rico (1994) and Mexico (1995), but none of these epidemics was of the same magnitude and severity as the Cuban epidemic of 1981.

In 1994, a new strain of DEN-3 was introduced into the American region, causing a major epidemic of DF/DHF in Nicaragua and a small outbreak associated with classical dengue fever in Panama\(^{(4)}\). This virus was shown to be genetically distinct from the DEN-3 that previously occurred in the Americas and has been shown to belong to the same genotype as the virus that caused the recent DHF epidemics in Sri Lanka and India \(^{(21)}\) (Lanciotti R, Quiros I, Clark GG and Gubler DJ, unpublished data). This strain of DEN-3, which apparently was also a recent introduction from Asia, subsequently spread throughout Central America and Mexico in 1995, causing major epidemics. Surprisingly, by early 1997, it was yet to be detected in the Caribbean islands or South America.

There is a potential for epidemic dengue transmission in the United States.
On three occasions in the past 16 years, autochthonous transmission, secondary to importation of the virus in humans, has occurred in Texas (1980, 1986, and 1995). Although the outbreaks were small, they underscore the potential for dengue transmission in the United States, where two competent mosquito vectors are prevalent. *Aedes aegypti*, the most important and efficient epidemic vector of dengue viruses, has been in the country for over 200 years and has been responsible for transmitting major epidemics in the past\(^5\). Currently, this species is found only in the Gulf Coast states from Texas to Florida. *Aedes albopictus*, an Asian species, was introduced into the continental United States in the early 1980s and has since become widespread in the eastern half of the country. It currently occurs in 678 counties in 25 of the continental states; this species has also been found in Hawaii for over 50 years. However, it has yet to be associated with dengue transmission in the New World. Both *Ae. aegypti* and *Ae. albopictus* can transmit dengue viruses to humans, and their presence in an area increases the risk of autochthonous dengue transmission, secondary to imported cases\(^{15}\).

The sequence of events associated with the changing epidemiology of dengue in the Americas in the 1970s, 1980s and 1990s was nearly identical to that which occurred in south-east Asia in the 1950s, 1960s and 1970s\(^{6,12}\). Thus, re-invasion of Central and South America by *Ae. aegypti* in the 1970s and 1980s, combined with increased urbanization, increased movement of people and, with them, of the dengue viruses, resulted in most countries evolving from non-endemicity (no viruses present) or hypo-endemicity (one virus present) to hyperendemicity (multiple virus serotypes co-circulating). This resulted in increased frequency of epidemic activity and the emergence of DHF as a major public health problem. Several countries (Cuba, Venezuela, Brazil and Nicaragua) have had major epidemics of DHF in recent years. Moreover, outbreaks with sporadic or small numbers of cases of DHF have occurred in Nicaragua, Honduras, El Salvador, Guatemala, Mexico, Colombia, French Guiana, Suriname, Aruba, St. Lucia and Puerto Rico, and sporadic cases of DHF have been confirmed in the Dominican Republic, the U.S. Virgin Islands, Panama and Costa Rica. In 1980, DHF was not considered endemic in any American country. Between 1981 and 1997, however, there was a dramatic emergence of DHF, with 17 countries reporting laboratory-confirmed DHF that met the WHO case definition. This disease is now endemic in most of those countries where multiple dengue virus serotypes co-circulate and the number of cases reported to PAHO have increased dramatically (Figure 5). If the disease pattern continues to evolve in the Americas as it did in south-east Asia, the first ten years of the 21st century will bring more frequent and larger epidemics of DHF\(^{6,12}\).

Surveillance for dengue in Africa has been poor during this century. Prior to the 1980s, the last recorded epidemic was in Durban, South Africa, in 1927-28. Endemic transmission of DEN-1 and DEN-2 was documented in Nigeria\(^3\), but outbreaks were not reported. Although surveillance has not improved, reports of
epidemic dengue fever have increased dramatically since 1980 (Figure 6). Limited outbreaks have occurred in West Africa (Angola, 1986 and Senegal, 1990), but the most recent epidemic activity has occurred in East Africa and the Middle East, including the Seychelles (1977), Kenya (1982), Mozambique (1985), Sudan (1985), Djibouti (1991), Somalia (1982, 1993) and Saudi Arabia (1994)\(^{(16)}\). All four dengue serotypes have been involved, but to-date, epidemic DHF has not been reported in Africa or the Middle East. However, sporadic cases of the disease clinically compatible with DHF have been reported from Mozambique, Djibouti and Saudi Arabia.

Factors responsible for global resurgence of dengue

The reasons for the dramatic resurgence of epidemic DF/DHF in the waning years of the 20th century are complex and not fully understood, but are most likely associated with demographic and societal changes that have occurred over the past 50 years\(^{(13,16)}\). Several important factors can be identified. First, major global demographic changes have occurred, the most important of which has been the unprecedented population growth, primarily in tropical developing countries. Coincidental with this has been the uncontrolled and unplanned urbanization in these countries. These changes have resulted in large, crowded human populations living in urban centres in substandard housing with inadequate water, sewer and waste management systems, creating ideal conditions for increased transmission of mosquito-, rodent- and water-borne infectious diseases. Second, most consumer goods

![Figure 6. Geographical expansion of epidemic dengue in Africa and the Middle East, 1980-1996](image-url)
are packaged in non-biodegradable plastic or cellophane materials, which are discarded into the environment where they collect rain-water and provide ideal larval habitats for the vector mosquito. Also, making ideal larval habitats are used automobile tyres, the number of which has increased dramatically in the past 20 years, and which are very difficult to dispose of from the environment. All these factors have contributed to the expanded geographical distribution and increased population densities of the principal mosquito vector *Ae. aegypti*. Third, effective *Ae. aegypti* mosquito control is virtually non-existent in most dengue-endemic countries. Emphasis over the past 25 years has been placed on ultra-low-volume space sprays of insecticide for adult mosquito control\(^{(10)}\). This has been shown to be ineffective in controlling *Ae. aegypti*\(^{(10,25)}\). Thus, hundreds of millions of people in urban centres of the tropics are living in intimate association with large populations of an efficient epidemic mosquito vector of dengue viruses.

A fourth factor which has had a great impact on the emergence of DF/DHF is the increased travel of people by jet airplane. The reinfestation of the American tropics by *Ae. aegypti* placed at risk for dengue infection large numbers of susceptible individuals living in permissive urban areas. The numerous epidemics and increased transmission of dengue that subsequently occurred there and in Asia and the Pacific provided increased opportunity for the viruses to move between countries, both within and between the regions. Air travel by humans, who are incubating the virus, provides the ideal mechanism for transporting dengue viruses between population centres of the tropics and results in a constant exchange of dengue viruses and other pathogens. An illustration of the increased human air travel is seen in the U.S. Department of Transportation data from 1983 to 1994\(^{(15)}\); the number of international departures from U.S. airports doubled from 20 to nearly 40 million, with over 50% of those departures destined for tropical areas.

Finally, the public health infrastructure required to deal with epidemic vector-borne infectious diseases has deteriorated during the past 30 years in most countries. Limited financial and human resources, and competing priorities for those resources, have resulted in a ‘crisis mentality’ among public health officials. The emphasis has thus been on implementing emergency control measures in response to epidemics rather than on developing programmes to prevent epidemic transmission\(^{(10)}\). This approach has been particularly detrimental to dengue prevention and control because in most countries surveillance is very poor; the passive surveillance systems relied on to detect increased transmission are dependent upon reports by local physicians, who often have a low index of suspicion and do not consider dengue in their differential diagnosis of dengue-like illness. As a result, the epidemic has often reached or passed peak transmission before it is detected and emergency control measures are implemented, too late to have any impact on the course of the epidemic\(^{(10)}\).
Prospects for the future

There is currently no vaccine for DF/DHF. Although live, attenuated vaccine candidates for all four virus serotypes have been developed\(^2\); it will likely be at least 10 years before they are available for general use. Prospects for reversing the trend of increased epidemic DF/DHF must rely on mosquito control, which are not promising in the near future. New dengue virus strains and serotypes will likely continue to move between areas where *Ae. aegypti* occurs in infected air travellers, resulting in continued hyperendemicity, increased frequency of epidemic activity and increased incidence of DHF if effective prevention programmes are not implemented early. This will require changing the emergency-response mentality of government officials, public health professionals and the public to one of epidemic prevention.

Effective, sustainable prevention programmes for DF/DHF must have several components\(^3\). First, an active, laboratory-based surveillance system that can provide early warning for epidemic activity is essential. Moreover, there must be effective information exchange and international cooperation. The second component is a rapid-response contingency plan to prevent an incipient epidemic when the surveillance system predicts increased dengue transmission. Political support to implement this rapid response in a timely manner is critical to its success. The third component of a sustainable prevention programme is education of the medical community. Experience has shown that case fatality rates can be kept acceptably low if physicians and nurses understand the pathophysiological changes that occur in DHF; therefore, early diagnosis and effective management are the key to preventing fatalities in this disease\(^1\). The fourth component is community-based, integrated *Ae. aegypti* control. Sustainability of the prevention programme will depend on decreasing the reliance on government mosquito control agencies and the transfer of more responsibility for *Ae. aegypti* control to the inhabitants in urban areas where most dengue transmission occurs. This will require community participation and community ownership of the programme. Lastly, there is also a great need for research and improved public health infrastructure. Research is desperately needed to develop more effective prevention strategies, including new mosquito control technology and dengue vaccines, and on the epidemiology and disease pathogenesis of DF/DHF. Only with an improved public health infrastructure to support community-based prevention programmes will it be possible to reverse the trend of emergent epidemic DF/DHF.

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Geographical expansion of epidemic dengue in Africa and the Middle East, 1980-1996

*Data from Pan American Health Organization

*Millions of Cases

*Data from Pan American Health Organization
Re-Emergence of Dengue and Emergence of Dengue Haemorrhagic Fever in the Americas

By
Francisco Pinheiro
Pan American Health Organization,
525, 23rd Street N.W., Washington, DC

and

Michael Nelson
Repartição Sanitária Panamericana,
Caixa Postal 08729, 70912-970 Brasília, Brazil

Abstract

Dengue has been known in the Americas since the 18th century. During the 1960s and 1970s dengue pandemics occurred in the Caribbean, northern South America and Central America, and, during the 1980s and 1990s, virtually every country in the Americas experienced dengue epidemics. Dengue serotypes 1, 2 and 4 circulate widely and, since 1994, DEN-3 has circulated in Central America and Mexico.

The first epidemic of dengue haemorrhagic fever in the Americas occurred in Cuba in 1981 with the introduction of DEN-2 four years after an epidemic of DEN-1, resulting in 344 203 cases, of which 10 312 were severe cases with 158 deaths. Subsequently, occasional cases of DHF occurred in the Americas until 1989-1990 when an epidemic occurred in Venezuela with 3 108 DHF cases and 73 deaths. Between 1981 and 1996 a total of 42 246 cases of DHF and 582 deaths were reported by 25 countries. Countries which reported more than 1000 cases each were Venezuela, Cuba, Colombia, Nicaragua and Mexico.

Aedes aegypti, the vector of dengue in the Americas, was eradicated from 21 countries in the region during 1948-1972, but due to inadequate surveillance against re-infestation, these countries got infested again and suffered dengue epidemics. As of October 1997, all countries in the Americas, except Bermuda, Canada and Chile, are infested. Aedes albopictus, a vector of dengue in Asia, was first found in the Americas in 1985 and is now present in eight countries. Until now this mosquito has not been incriminated as a vector of any virus in the Americas.

In 1997 the Directing Council of the Pan American Health Organization (PAHO) called on the Member countries to follow the hemispheric plan to expand and intensify efforts to combat Aedes aegypti with a view to its eventual eradication in the Americas.
Historical overview

The first description of a dengue-like disease in the Americas relates to an outbreak that occurred in Philadelphia, U.S.A., in 1780[1]. In the following century four large epidemics, which occurred during 1827-28, 1850-51, 1879-80 and 1897-99, affected Caribbean countries and the southern United States[2]. Interestingly, small-joint arthritis, including swelling, which are commonly found in infections associated with the arboviruses Chikungunya and Mayaro, were among the clinical manifestations observed during the dengue outbreaks between 1827-1880 but not during the ones which occurred after this period. In the first half of this century, four epidemics were reported in the same countries, the last one occurring during 1941-1946, which affected cities in the Texas Gulf, several Caribbean islands including Cuba, Puerto Rico and Bermuda, Mexico, Panama and Venezuela[2]. In Brazil, epidemics of dengue were recorded during 1846-1848 and 1851-1853. Since then, until 1982, only two outbreaks were reported in 1916 and 1923[3,4]. Peru reported cases of dengue during the 1950s but not in the following three decades[5]. In 1953, dengue virus, which was identified as DEN-2, was isolated for the first time in the Americas in the island of Trinidad. Several isolates of DEN-2 were obtained from persons in the same island during 1953-1954 but, interestingly, no outbreaks were reported in this period in Trinidad nor in any other Caribbean island[6].

Re-emergence of dengue

During the 1960s two extensive pandemics of dengue affected the Caribbean and Venezuela. The first one which broke out in 1963 was due to DEN-3 and swept the Caribbean after almost 20 years of silence. Jamaica, Puerto Rico, islands of the Lesser Antilles and Venezuela were among the countries affected but, interestingly, Cuba, Hispaniola and Trinidad were spared in this outbreak. The second epidemic occurred in the Caribbean and Venezuela during 1968-1969, and although DEN-2 was pre-dominantly isolated, DEN-3 was also recovered from persons in some islands[2]. During the 1970s these two serotypes caused extensive epidemics in Colombia where dengue had not been recognized since 1952[7]. The first epidemic occurred during 1971-1972 and was due to DEN-2 whereas the 1975-1977 epidemic was associated with DEN-3. It was estimated that more than a half million persons became infected; however, both the outbreaks occurred ‘silently’ for the most part or were confused with other illnesses and did not attract much attention of the health authorities.

A milestone in the re-emergence of dengue in the Americas was the introduction of DEN-1 in 1977. This was followed by a devastating pandemic that lasted until 1980[8]. The virus was initially detected in Jamaica, possibly having been imported from Africa, and from there the epidemic spread to virtually every island of the Caribbean. The epidemic in South America began in 1978, affecting
Venezuela, Colombia, Guyana, Suriname and French Guiana. The epidemic in Central America was also detected in 1978 which affected Honduras initially and subsequently El Salvador, Guatemala and Belize. Spreading to the north the epidemic reached Mexico at the end of 1978 and during 1979-1980 continued to affect other Mexican states, and arrived in the state of Texas in the second half of 1980. About 702,000 cases were reported to the Pan American Health Organization (PAHO) for the period 1977-1980, but the incidence was much higher since estimates from Colombia, Cuba and Venezuela alone indicated that over five million persons were infected. In 1981, a DEN-4 strain, probably imported from Pacific islands, emerged in the Americas causing a series of outbreaks in the Caribbean, northern South America, Central America and Mexico. With some exceptions DEN-4 infection has generally been associated with mild disease \cite{8}.

During the 1980s five countries in South America, namely, Brazil, Bolivia, Paraguay, Ecuador and Peru, that had not experienced dengue before or had been free of the disease for several decades were affected by explosive epidemics caused by DEN-1 \cite{8}; in the epidemic in Peru, DEN-4 was also isolated \cite{9}. The first epidemic which occurred in the state of Roraima in northern Brazil in 1982 was associated with DEN-1 and 4 \cite{10}. Vector control measures were implemented and, since then, no dengue activity was reported in this area until 1996. In 1986, DEN-1 was introduced in Río de Janeiro, Brazil, causing major outbreaks \cite{11}. It was subsequently disseminated to most states in Brazil. Following its introduction in those countries, DEN-1 virus has continued to cause major epidemics in Brazil, Ecuador and Peru in subsequent years.

During 1993 the last two tropical Latin American countries which had been free of dengue for several decades, namely, Costa Rica and Panama, reported indigenous transmission of dengue; the agent was DEN-1 and its introduction in Costa Rica was associated with severe outbreaks in this and subsequent years \cite{12}. In 1994, DEN-3 was reintroduced in the Americas after an absence of 16 years when it was last isolated in Puerto Rico in 1978 \cite{13}. This serotype was initially detected in Panama and Nicaragua and, in the following year, it spread to other Central American countries and to Mexico, causing numerous epidemics of dengue. In Nicaragua, in 1994, the introduction of DEN-3 was associated with a countrywide epidemic of dengue/DHF but DEN-1 was also present. The introduction of DEN-3 in Mexico in 1995 coincided with an increased number of DHF cases; however, only DEN-1 and particularly DEN-2 were associated with DHF \cite{14}. It should be noted that this DEN-3 virus belonged to the genotype that caused major epidemics of DHF in Sri Lanka and India in 1996. Since October 1997, DEN-3 has not been isolated outside Central America and Mexico.

The number of dengue and DHF cases reported annually in the Americas during the period 1980-1996 varied from 39,307 cases in 1984 to 388,591 cases in 1991.
An increase in the number of reports has been observed since 1994, especially in 1995 when over 315,000 cases were notified. In 1997 (as of October), over 270,000 cases had been reported.

The emergence of DHF

In 1981, Cuba reported the first major outbreak of DHF in the Americas. Prior to this, suspected cases of DHF or fatal dengue cases had been reported by five countries or territories, namely, Venezuela, Jamaica, Honduras, Curacao and Puerto Rico, but only a few of them fulfilled the WHO criteria for the diagnosis of dengue haemorrhagic fever/dengue shock syndrome (DHF/DSS) and most were not laboratory-confirmed. During the Cuban epidemic a total of 344,203 cases of dengue were notified, of which 10,312 were classified as severe cases (WHO grades II-IV) and 158 were fatal; a total of 116,143 patients were hospitalized, the majority of them during a three-month period. The Cuban DHF epidemic was associated with a strain of DEN-2 virus and it occurred four years after DEN-1 had been introduced in the island causing epidemics of dengue fever and infecting almost half of the country’s population.

The epidemic was rapidly brought under control and the last cases were reported in October 1981. Aedes aegypti was nearly eradicated from the island which became free of dengue virus circulation until 1997 when an outbreak broke out in the Santiago province, eastern Cuba. As of August 1997, 2,946 cases were reported, of which 205 were DHF cases with 12 deaths, all of whom were adults (Cuban Ministry of Health, August 1997).

The outbreak of DHF/DSS in Cuba is the most important event in the history of dengue in the Americas. Subsequent to it, in every year except 1983, confirmed or suspected cases of DHF have been reported in the American region. A marked increase in the annual incidence occurred in 1989 which was due to a countrywide epidemic in Venezuela. This was the second major DHF epidemic in the Americas with 3,108 DHF cases and 73 deaths being reported between December 1989 and April 1990 when it was declared to be over. DEN-2 was the predominant serotype isolated from cases but DEN-1 and 4 were also recovered from patients; although no isolates were obtained from fatal cases, immunohistochemical analysis performed with formalin-fixed paraffin-embedded tissues of the fatal cases revealed the presence of DEN-2 antigen in the liver of four of them. The epidemic recurred in the second half of 1990 and since then Venezuela has suffered epidemics of DHF every year.

Between 1981 and 1996 a total of 42,246 cases of DHF and 582 deaths were reported by 25 countries in the Americas. The figure below shows the distribution of cases by country where it can be observed that 22,170 (53%) of the reports originated from Venezuela. It can also be seen that, excluding Cuba and Venezuela, the number of cases by country varies from 1 to 3,929 cases. Colombia, Nicaragua and Mexico have each reported over 1,000 cases, most of
them during the period 1992-1996. In Brazil, four fatal cases which exhibited fever, haemorrhages and shock, occurred during 1986-1987 and were associated with DEN-1 virus; confirmation was obtained by virus isolation or by antigen detection (16). In 1990-1991 an outbreak of DHF was recorded in Rio de Janeiro, Brazil (17), and 24 cases with 11 deaths occurred in the Brazilian state of Ceará (18).

The age distribution of DHF cases in the Americas is different from that observed in Asia. In the outbreaks in Cuba and Venezuela, the disease occurred in all age groups, although children under 15 years of age comprised about two-thirds of the fatalities. Studies of DHF cases in Brazil that fulfilled WHO criteria (19) showed a modal age range of 31-45 years. Observations made in Puerto Rico showed distinct age distribution patterns of cases that fulfilled WHO criteria: in 1986, two-thirds of the cases were under 15 years of age but during 1990-91 the mean age of patients was 38 years (20,21). This age distribution pattern is different from that found in south-east Asia where predominantly young children are affected. It should be noted, however, that a marked increase in the number of DHF cases in persons over 15 years has been observed in the Philippines and Malaysia during recent years (22). Regarding the sex distribution, Cuba reported no significant female predominance - a finding that is in contrast with observations from Asia.

Figure. Number of Reported Cases and deaths of Dengue Haemorrhagic Fever in the Americas by country, 1981-1996*
The epidemics of DHF in Cuba and Brazil were clearly associated with DEN-2 virus. In both countries DEN-1 had been introduced four years earlier, after a period of several decades of absence of dengue virus circulation. However, Cuba suffered a major epidemic of DHF while only relatively small outbreaks have been observed in Brazil. Other countries such as Peru and Ecuador have experienced a similar sequence of dengue infections with these serotypes but no DHF epidemics were recorded. A distinct epidemiological pattern was observed in Venezuela and in French Guiana where dengue was endemic for over 20 years before the emergence of their first epidemics of DHF in 1989-1990 and 1990-1991 respectively: DEN-2 was predominant in Venezuela\(^{(15)}\) and in French Guiana\(^{(23)}\) and the only serotype found in the tissues of fatal cases in Venezuela\(^{(15)}\). Interestingly, in French Guiana, the DEN-2 strains isolated during the DHF outbreak and during an outbreak of dengue fever that occurred in 1986 were genetically similar and belonged to the Jamaican genotype which, in turn, has a genome sequence very close to DEN-2 strains from Viet Nam where DHF is highly endemic\(^{(23)}\). These findings illustrate the complexity of the factors responsible for triggering DHF. Studies in Cuba suggested that individual risk factors for DHF include chronic diseases such as bronchial asthma, diabetes mellitus and sickle cell anaemia, and that race seems also to be important since DHF/DSS was more prevalent in white than in black persons\(^{(24)}\).

Overall, the case fatality rate (CFR) of DHF in the Americas is 1.4% (Figure). However, a marked variation has been observed among countries. In 1995, the CFR ranged from 8.3% in Puerto Rico to 0.8% in Venezuela. This variation could be due to several factors such as reporting criteria, viral strain, case management, host genetic factors and possibly other causes.

**Causes of the emergence/re-emergence**

Factors contributing to the emergence/re-emergence of dengue/DHF include the rapid growth and urbanization of populations in Latin America and the Caribbean, increased travel of people which facilitates dissemination of dengue viruses, the circulation of all four dengue serotypes in the Americas thus increasing the risk of DHF in the Region, and the inadequacy of the vector control programmes.

**Vector control**

In 1947, PAHO was entrusted by its Directing Council to organize a hemispheric campaign to eradicate the mosquito *Aedes aegypti*. With the establishment of highly organized, centralized, vertical programmes with excellent supervision and adequate funding, 18 continental countries and several Caribbean island states had, by 1962, successfully achieved eradication. Unfortunately, after 1962, only three new countries eliminated the vector. Even more serious, however, was the fact that the countries that had achieved eradication became reinfested...
with the vector in the 1960s and subsequent decades. Countries still infested (the United States, Venezuela, Cuba and some other Caribbean islands) became sources of reinfestation for those that had eradicated the vector. When the reinfestations occurred, most countries had reduced their surveillance activities to a minimum, did not discover the new infestations until the vector was well established, and did not react with sufficient manpower and funding to eliminate the new infestations. Other reasons for the programme failure include reduced political support for the programmes, resulting in inadequate management and scarcity of trained technical personnel, resistance of *Ae. aegypti* to chlorinated insecticides, and high cost of materials, equipment and wages. There was a progressive dissemination of the vector so that, by 1997, with the exception of Canada, Chile and Bermuda, all countries in the Americas were infested. The practice of water storage in domestic settings due to the problem of water supply and the exponential growth of containers that can hold water (tyres, disposable containers) greatly contribute to the increase of vector densities favouring virus transmission.

*Aedes albopictus*, a secondary vector of dengue in Asia, was first found to be established in the Americas (in Texas, USA) in 1985. Subsequent infestations have been reported from Brazil (1986), Mexico (1993), Dominican Republic (1993), Guatemala (1995), Bolivia (1995, probably eliminated), Cuba (1995), El Salvador (1996) and the Cayman Islands (1997). Although this species is an efficient laboratory vector of dengue, yellow fever and several other arboviruses, and has been found infected with Eastern Equine Encephalitis in Florida, it has not yet been implicated as a vector of any virus in the Americas. Thus, in Brazil where *Aedes albopictus* is now widespread, no specific efforts are made to combat it other than those in place against *Aedes aegypti*.

In 1985, PAHO approved a resolution which, for the first time, gave the countries the alternative of eradication, i.e. control of *Aedes aegypti*. During the next decade, this new control strategy of maintenance of vector populations at levels that did not present a significant public health threat, through the integration of chemical, biological and physical methods, education of the public and participation of the community, was developed and eventually set forth in 1994 in the document “Dengue and Dengue Hemorrhagic Fever in the Americas: Guidelines for Prevention and Control”. However, as dengue and DHF continued to spread and increase, Brazil, in 1995, proposed that the strategy of hemispheric eradication be reconsidered, and the Directing Council of PAHO approved a resolution directing a task force to consider the feasibility, timeliness and appropriateness of drawing up a plan for eradication for the Americas. In 1996, this task force recommended that the plan be written, and the Directing Council directed the countries “to prepare national plans to expand and intensify efforts to combat *Aedes aegypti* with a view to its eventual eradication in the Americas” and that another task force prepare a hemispheric plan. This plan was formulated in 1997, and another resolution was passed.
in September of that year directing the countries to carry out the Hemispheric Plan, with the following five steps:

1. Avoid epidemics of dengue, DHF and urban yellow fever;
2. Avoid outbreaks of dengue;
3. Interrupt transmission of dengue;
4. Eradicate Aedes aegypti, and
5. Establish sustainable surveillance against the re-infestation of areas free of Aedes aegypti.

The anti-Aedes aegypti programmes of the Americas have changed considerably since the days of the eradication campaigns. Most have become decentralized or are in the process of decentralizing, and have suffered much reduction in manpower and funding. In accordance with the Hemispheric Plan, each country will begin at the step that is appropriate to its own epidemiological and entomological situation and progress to the subsequent steps depending on its human and financial resources until eventually eradication is achieved and sustainable surveillance against reinfection is maintained.

References


Control of Dengue/Dengue Haemorrhagic Fever in China

By

Wang Wenjie

Department of Diseases Control
Ministry of Health
44 Houhai Beiyan, Beijing-100725,
The People’s Republic of China

Abstract

Dengue fever, one of the notifiable infectious diseases under the administration of the Law of the People’s Republic of China on the Prevention and Control of Infectious Diseases, has been a priority health problem in China, especially in its southern provinces which are considered to be tropical or subtropical areas. The dengue fever occurrence epidemic in China has lasted almost 20 years, the outbreaks occurring mainly in two or three provinces, i.e. Guangdong, Hainan and Guangxi Zhuang Autonomous Region, and some infection being found in Yunnan province. The main vectors were different in different provinces. In recent years, however, the dengue morbidity has greatly decreased, and no case has been reported to the Ministry of Health since 1996.

Introduction

Since 1940s, there had been no recorded case of dengue fever until the year 1978(1) when a few cases of dengue fever were reported. But since late 1970s and early 1980s, the epidemics of dengue fever drew the attention of the Government at different levels. The DF prevalence had lasted for nearly 20 years; however, for several years now, no DF case has been detected in China. Because of climatic and environmental factors, the occurrence of DF in China had been limited to two or three provinces, i.e. Guangdong, and Hainan provinces and the Guangxi Zhuang Autonomous Region. In addition, among the south-western provinces such as Yunnan, there had been antibody positive, even though no apparent cases were reported.

Historical background

Dengue fever in China started with the importation of two cases between 1949 and 1976 which could not be confirmed by isolation and serological methods, but only clinically. During 1978-1982 and 1985-1986, there were some epidemics and outbreaks in Guangdong province, (at that time, Hainan was a part of Guangdong province). The sequence of events is as follows:

1978: 22122 cases, with 14 deaths, were reported from seven counties/cities. The first case occurred in May, with
Control of Dengue/Dengue Haemorrhagic Fever in China

Symptoms of fever, headache and muscle ache. The virus was type DEN-4, the morbidity was 39.56/100000, fatality 6, and mortality 0.03/100000.

1979: The cases had greatly decreased, all the cases were restricted to Guangdong province and occurred in the second half of the year. Six hundred-and-sixty-seven cases, including 635 from Hainan, were reported without any death, the morbidity rate being 1.17/100000.

1980: The total number of cases was 452 675, with 71 deaths. This included 437 468 cases from Hainan with 64 deaths; the percentage of cases and deaths from Hainan was 96.66 and 90.14% respectively. The morbidity was 8006.14/100000, fatality 0.1%, and the virus was DEN-3.

1981: 29 543 cases, 2 deaths, morbidity 33.51/100000, fatality 0.1; the virus: DEN-3.

1982: Only 19 cases, no death; all cases were from Hainan, Guangdong province. The virus was DEN-3.


1985: 16 385 cases, 28 deaths, Den-2. Occurred from July to December. Morbidity 25.85/100000, fatality 1.70.

1986: 118881 cases, 296 deaths. Morbidity 190.12/100000, fatality 2.5; Virus: DEN-2. The morbidity was higher than in 1985, the second highest after that of 1980; however, the fatality was the highest (2.5), which was more than 10 times that in 1980.

1987: 32830 cases, 79 deaths, morbidity 51.73/100000, fatality 2.4. Virus: DEN-2 (Fig.1).

In 1990, Hainan became a province carved out of Guangdong province. The data was collected and analysed separately.
for 1990-1996, when 7922 cases and three deaths were reported from Guangdong. The average morbidity was 1.67/100000. (Fig.2). The distribution of cases and types of viruses for the years 1990-1996 are given in Table 1.

The occurrence of the cases was concentrated during the period in August-October, the morbidity percentage being 94.05.

The data of 1995 showed that the cases were mostly typical of DF. There were 12 haemorrhagic cases among 758 cases (1.58%).

Table 1. DF Prevalence in Guangdong 1990-1996

<table>
<thead>
<tr>
<th>Type of virus</th>
<th>Cases</th>
<th>Deaths</th>
<th>Morbidity*</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990 D4</td>
<td>374</td>
<td>0</td>
<td>0.60</td>
<td>0</td>
</tr>
<tr>
<td>1991 D4/D1</td>
<td>371</td>
<td>3</td>
<td>0.57</td>
<td>0.003</td>
</tr>
<tr>
<td>1992 –</td>
<td>2</td>
<td>0</td>
<td>0.003</td>
<td>–</td>
</tr>
<tr>
<td>1993 D2</td>
<td>359</td>
<td>0</td>
<td>0.53</td>
<td>–</td>
</tr>
<tr>
<td>1994 –</td>
<td>4</td>
<td>0</td>
<td>0.006</td>
<td>–</td>
</tr>
<tr>
<td>1995 D1</td>
<td>6812</td>
<td>0</td>
<td>9.75</td>
<td>–</td>
</tr>
<tr>
<td>1996</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7922</td>
<td>3</td>
<td>1.67</td>
<td></td>
</tr>
</tbody>
</table>

* per 100,000

Before 1990, Hainan had witnessed five epidemics/outbreaks 1917. The data showed that the DEN-3 virus was responsible for these epidemics, but during 1985-1988 and in 1991 DEN-2 was also

Table 2. DF/DHF in People’s Republic of China 1990-1996
associated\(^2\). The cases were a mix of DF and DHF. *Aedes aegypti* mosquito has been the major vector in the epidemics of DF in Hainan. The geographical and seasonal data show the characteristics were in line when control measures were taken. With a decrease in the density of the *Ae. aegypti* mosquito, the cases of DF/DHF also declined. As described above, the people in Hainan are also sensitive to the dengue viruses, and the prevalence depends on the degree of exposure to the vector.

**Vector surveillance**

The vectors of DF/DHF are *Aedes albopictus* and *Aedes aegypti* mosquitoes. *Aedes albopictus* mosquito is prevalent throughout Guangdong province. *Ae. aegypti* and *Ae. albopictus* mosquitoes together were found in two districts of the province (Zhanjiang and Maoming). The climate of Hainan province, which is an island, is subtropical, and the rainy season lasts several months. The main vector of DF/DHF is *Aedes aegypti* mosquito, which is found mainly in seaside areas.

**Laboratory support**

The laboratory facilities are available in the Institute of Virology, Chinese Academy of Preventive Medicine, and the Beijing Institute of Tropical Medicine. All the activities are administered and supported by the Department of Diseases Control, Ministry of Health.

**Risk factors**

Guangdong and Hainan provinces are subtropical areas. Considering the climate and the environment, *Aedes* mosquitoes breed abundantly in living dwellings in these areas. There is no effective control against these vectors.

During recent years, many areas have come under construction. During this activity, many people are employed temporarily, and the health and hygiene conditions are not ideal. The DF cases mostly occur among this group of people. At the same time, with economic development, tourism is catching up. Some cases were detected among emigrants who had visited other regions in the country or had gone abroad.

Although dengue is listed in the Law of the People's Republic of China on the Prevention and Control of Infectious Diseases as a notifiable infectious disease, the prevalence had been restricted to one or two provinces, and there had been no reporting of its incidence due to lack of knowledge on the part of local health workers. Some cases were misdiagnosed as that of typhoid or influenza. Surveillance network is also not very strong.

**Future strategy**

Surveillance network needs to be strengthened while training activities should be encouraged and supported. Technical teamwork is significant in China.

There is a need to develop some kind of a joint project in several provinces with international collaboration. It can prove to be
a practical way for the control of DF, as happened in 1991 when a research project on the control of dengue fever at community and environmental level was finalized between the Hainan Anti-Epidemic Station and the Research Center of Social Development of Canada. The outcome of the research was promoted in the areas of health education, intervention, etc.

Coordination among the relevant agencies should be continued as control of DF should not be the responsibility of the health department alone. Other agencies, especially those responsible for construction activities, vector control as well as medicine and biomedical production should be actively involved in the programme.

References
<table>
<thead>
<tr>
<th>Years</th>
<th>Cases</th>
<th>Years</th>
<th>Cases</th>
<th>Years</th>
<th>Cases</th>
</tr>
</thead>
</table>

- Cases
- Deaths
Control of Dengue Fever/Dengue Haemorrhagic Fever in Singapore

By Tan Boon Teng
Vector Control & Research Department, Ministry of the Environment, Singapore

Abstract
The control of dengue fever/dengue haemorrhagic fever (DF/DHF) in Singapore is largely through source reduction, health education and law enforcement. Adulticiding is carried out when the house index exceeds 2%, and when there is a reported case or a localized outbreak. Regular Aedes surveillance is conducted in areas identified as dengue-sensitive. The national annual Aedes house index has been kept below 2% since 1979; however, the number of cases has seen an increase since 1986. Data for the first four months of 1997 showed that landed properties, schools, construction sites and vacant premises were the main premises-types breeding Aedes mosquitoes. The commonest habitats indoors were ornamental containers, domestic containers, receptacles exposed to rain, canvas sheets and roof gutters. In the public areas, discarded water-bearing receptacles were the major culprit. The Ministry of the Environment, Singapore, which is responsible for dengue control, is constantly looking for permanent ways of eliminating potential breeding habitats. It is also educating householders, construction contractors, estate managements and schools on measures to prevent mosquito breeding in their premises through the mass media, seminars and exhibitions. Enforcement action is stringently carried out. Research to explore new tools to monitor the Aedes population and forewarn about an outbreak is under way. There is a need to establish a reliable population indicator for Aedes breeding found in the open areas outside of premises, as the present premises indices do not include these.

Introduction
DHF was first reported in Singapore in 1960\(^1\). Since then, it has become endemic. Large epidemics occurred in the years 1966-1968. The largest, with 1187 cases and 27 deaths, occurred in 1973\(^2\). Another epidemic occurred in 1978 with 384 cases and two deaths\(^3\). From 1979 to 1985, the number of cases remained low at less than 300 cases per year with deaths of two or less per year. However, the number of DF/DHF cases started to rise in 1986 and reached a peak in 1992, with 2878 cases reported. The 1992 epidemic was brought under control.
Aedes control strategy

The control of dengue fever/dengue haemorrhagic fever (DF/DHF) in Singapore is the responsibility of the Vector Control & Research Department (VCRD), Ministry of the Environment (ENV). It plans and carries out vector control operations, analyses trends and conducts research on vectors. The Quarantine and Epidemiology Department (QED) investigates and monitors vector-borne diseases.

Control of the vectors, Aedes aegypti and Aedes albopictus, is largely through source reduction, health education and law enforcement. As far as possible, permanent measures to eliminate potential habitats are carried out. Adulticiding with thermal fogging machines and cold foggers using Actellic (a.i. : pirimiphos-methyl) is carried out whenever the Aedes house index exceeds 2%, and when there is a case reported or a localized outbreak. A localized outbreak is defined as two or more cases reported within a 200 m radius.

Vector control operations to disrupt disease transmission are carried out upon notification of suspected DF/DHF cases, without waiting for laboratory confirmation.

Besides the emergency vector control response to cases, there is also a preventive, routine Aedes surveillance programme in areas which are identified as dengue-sensitive based on the history of cases, Aedes population densities, presence of conducive housing types, development and construction activities, and human population density to support transmission in these areas. This routine Aedes surveillance programme in which a dengue-sensitive area is completely surveyed within a 1 - 3 months cycle, has successfully reduced the number of DF/ DHF cases in these sensitive areas.


In the last five years since 1993, DF/DHF has been continually on an upward trend. The number of cases were 946 in 1993, 1239 in 1994, 2008 in 1995, 3128 in 1996, and 1700 as at June 1997. Over 70% of the cases were sporadic ones scattered all over the island. The remaining 30% occurred in localized outbreaks. The morbidity and mortality rates are shown in the table below.

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of DF/DHF cases</th>
<th>Morbidity Rate</th>
<th>No. of Deaths</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1993</td>
<td>946 (152)</td>
<td>32.9</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Control of Dengue Fever/Dengue Haemorrhagic Fever in Singapore

### Aedes situation (1993 – Apr 1997)*

The national annual Aedes House Index (HI) remained low at 1.3% in 1993, 1.07% in 1994, 1.16% in 1995, 0.69% in 1996 and 1.92% in 1997 (up to April 97). However, in some neighbourhoods, the Aedes HI for the estates can reach as high as 10% - 20%.

The main premises types found breeding Aedes mosquitoes were landed properties (HI 2.1%), flats (0.6%), shophouses (1.14%), schools (27.0%), construction sites (8.3%), factories (7.8%) and vacant premises (14.6%). The main breeding habitats in premises were ornamental containers (29.6%), domestic containers (30.4%), receptacles placed in the compound exposed to rain (12.9%), canvas sheets (5.0%) and roof gutters (2.6%). Although breeding found in roof gutters was only 2.6%, there might be many more which were breeding or had the potential to breed but were not detected because of the difficulty in accessing roof gutters.

A large number of Aedes mosquito breedings have also been found outside of premises in the public areas. The majority of such habitats were discarded receptacles (46.3%), closed perimeter drains (9.6%), domestic containers left by residents in the public areas (5.6%) and infrequently-used gully traps (4.8%). The problem of discarded receptacles in public areas breeding Aedes is increasing as manpower for public cleansing work is difficult to come by in manpower-scarce Singapore. Closed perimeter drains are difficult to maintain, and there is now a move towards removing the covers so that these drains can be maintained properly by the Town Councils. The infrequently-used gully traps on the void decks of flats in public housing estates used to be the second highest outdoor habitats. In 1996, the Government embarked on a project to install anti-mosquito valves into these gully traps, and since then, there has been a significant drop in the number of these gully traps breeding Aedes mosquitoes, from 13.2% in 1995 to 7.5% in 1996 and 4.5% in 1997. The project is expected to be completed in early 1998.

### Source reduction

Source reduction is still the main emphasis in the control of DF/DHF. Householders are advised to remove potential habitats as much as they can (e.g. flower pot plates, roof gutters, ground depressions), or else treat these habitats with temephos sand granules or...
insecticide paint. In the case of estate management, construction sites, schools and factories, ENV shows them the types of potential habitats in their premises, and requires them to engage pest control operators to do mosquito control in their premises.

ENV is also constantly looking for permanent measures to eliminate Aedes breeding habitats. Besides retrofitting gully traps with anti-mosquito valves and opening up closed perimeter drains as mentioned in the preceding paragraph, it is also studying the designs of sewers, drainage systems and roof gutters to make them mosquito-proof.

**Public education**

Public education is an ongoing process through the media, pamphlets and posters, house-to-house visits, talks, seminars and exhibitions. The education programmes are tailored for the different target groups: householders, schools, estate management, construction contractors and architects. In the surveys conducted by ENV over the past few years, it has been shown that people generally have high knowledge of dengue fever and the Aedes mosquitoes. However, this knowledge has not been translated into action in checking and removing stagnant water in their premises. This is especially so when the public generally sees the control of DF/DHF as fully the Government's responsibility.

ENV has also started to highlight to the population that litter thrown into public places can breed the Aedes mosquito which transmits DF/DHF. It is hoped that when people realize that their littering behaviour poses a health hazard to themselves, they will then refrain from littering.

**Enforcement**

The legislation to prohibit the breeding of mosquitoes is the Destruction of Disease-Bearing Insects Act (Cap. 79). The maximum fine under this legislation is S$2000. Enforcement action is taken stringently against anyone who breeds vector mosquitoes in their premises. With effect from 1 October 1997, the compound fine for householders, schools, factories, commercial premises, etc., has been increased from S$50 to S$100 for the first offence, and from S$100 to S$200 for subsequent offences at the same premises. In the case of construction site contractors, the compound fine which is offered for the first offence at a site only has been increased from S$200 to S$500; for subsequent offences at the same site, the contractors will be required to attend court. In addition, if a construction site is constantly unkempt or breeding mosquitoes repeatedly, ENV will serve a stop-work order under the Environmental Public Health Act (Cap. 95) to stop all construction activities until the site is spruced up.
Control of Dengue Fever/Dengue Haemorrhagic Fever in Singapore

and mosquito control measures are properly carried out.

Chemical control
Temephos (sand granules and emulsifiable concentrate) and anti-mosquito oils are the main chemicals used for larviciding. However, wherever possible, the potential habitats will be permanently eliminated. Pirimiphos-methyl is used for adulticiding. Thermal fogging is carried out for adult mosquito control in open areas and in the compounds of landed properties. Because of resistance from the public to thermal fogging within the house, houses are sprayed with water-based mixture of Actellic using an electrical cold fogger. The use of cold fogger for spraying within houses has increased the accessibility into houses to spray up to 70% from below 30% when thermal fogging machines were used.

Research
ENV is currently exploring several new tools to help in the monitoring of the Aedes population and forewarning of an outbreak in a locality. The Geographic Information System (GIS) is being developed to enable us to view the breeding sites in a locality and also the whole of Singapore over time and space. This will enable us to analyse the Aedes population trends spatially and to determine control priority areas. A method to detect and type dengue viruses in adult Aedes mosquitoes using reverse transcriptase polymerase chain reaction (RT-PCR) has been established jointly with the National University of Singapore. Field studies are now being carried out to determine if the proportion of infected mosquitoes in a locality would be a better indicator of an outbreak than the traditional Aedes HI.

As there are many Aedes habitats in open areas, there is a need to look into the possibility of establishing an index for Aedes breeding in open areas, which should be reliable and preferably be easy to determine. An outdoors index, together with the premises indices, would give a more complete picture of the population densities and distribution of both the Aedes vector species and help us to understand more of each of their roles in disease transmission.

Conclusion
There has been a resurgence in DF/DHF in the region in recent years, despite much efforts and resources pouring into dengue control programmes. More research to understand the Aedes mosquitoes and how they manage to overcome our efforts to stamp them out is urgently needed. There is also a need for a greater sharing and exchange of information and ideas amongst the countries.
affected by the disease. This could be done through information technologies (e.g. Internet, electronic mails) which have sped up communications by leaps and bounds. With such exchanges of information and expertise, we could learn from each other’s experience and expertise, with the hope that we will be able to control the disease more effectively in the future.

References


By
Do Quang Ha
Pasteur Institute, Ho Chi Minh City and
Trinh Quan Huan
Department of Hygiene and Prevention,
Ministry of Health, The Socialist Republic of Viet Nam.

Abstract
Dengue haemorrhagic fever (DHF) is showing an increasing trend in Viet Nam ever since its detection in 1959. Both north and south Viet Nam though are equally endemic, but they show seasonal variations. While in north Viet Nam the peak incidence is from June to November and then there is interruption of transmission due to winter, in south Viet Nam the transmission occurs throughout the year.

Realizing the need for making organized efforts for the control of DF/DHF, the Ministry of Health established a National Programme for Dengue Prevention and Control in 1997. The key elements of the programme include: (i) active surveillance; (ii) emergency response; (iii) long-term vector control, and (iv) clinical diagnosis and management. An action plan for the years 1997-1998 covering the whole country has been put into operation.

Dengue Activity in Viet Nam

Since 1963, there has been a steady increase in the incidence of dengue haemorrhagic fever (DHF) in Viet Nam, which is a major public health problem and a leading cause of hospitalization and death in the country.

In north Viet Nam, DHF was identified for the first time in 1959, where a major epidemic occurred in 1969. In the south, DHF first appeared in 1960, where an outbreak occurred in 1963, resulting in 331 hospitalized children with severe haemorrhage, of whom 116 died. Since then the disease has been spreading with continuous increase in the number of cases and deaths (Figure 1). The peak season is from June to November in north Viet Nam while in south Viet Nam DHF cases occur throughout the year. In the north, transmission does not take place during the winter months (Figures 2, 3).
Figure 1. Reported DHF cases and deaths in south Viet Nam, 1963-1996

Figure 2. DHF epidemics in four regions in Viet Nam, 1991-1996
Figure 3. Reported DHF cases in Viet Nam, by month during 1995-1996
During 1991-1996, 386,420 cases were reported with 1388 deaths. In 1996, DHF occurred in 44/53 provinces and cities (Table). Uncontrolled urbanization and poor environmental conditions led to an increase in the incidence of dengue. This highlighted the need for establishing a national programme for dengue control in the country.

### Table. Reported DHF cases by regions in Viet Nam, 1996

<table>
<thead>
<tr>
<th>Region</th>
<th>Morbidity</th>
<th>Lethality</th>
<th>CFR %</th>
<th>By province</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Viet Nam</td>
<td>2,498</td>
<td>1</td>
<td>0.04</td>
<td>15/23</td>
</tr>
<tr>
<td>Central part</td>
<td>22,346</td>
<td>23</td>
<td>0.10</td>
<td>10/10</td>
</tr>
<tr>
<td>Highland</td>
<td>891</td>
<td>2</td>
<td>0.22</td>
<td>2/3</td>
</tr>
<tr>
<td>South Viet Nam</td>
<td>51,957</td>
<td>236</td>
<td>0.45</td>
<td>17/17</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>77,692</strong></td>
<td><strong>262</strong></td>
<td><strong>0.34</strong></td>
<td><strong>44/53</strong></td>
</tr>
</tbody>
</table>

### National programme

In 1997, the Ministry of Health (MoH) developed a programme for active surveillance of DHF in six target provinces in Viet Nam.

The strategy is based on four elements:

1. **Active surveillance**
   - Two components, clinical and serological surveillance, are the most important elements in the control process, especially during the pre-epidemic stage, because if the causal virus can be detected, the dengue transmission can be prevented. During this period, MAC ELISA test is very useful for this purpose.
   - Entomological surveillance is also important, which should be oriented to detect container volumes, which is important to establish the larval number and adult density index.
   - Epidemiological surveillance is a reactive method, but it is also important for recording DHF cases and deaths for further data analysis and interpretation.

2. **Emergency control measures**
   - The goal of emergency vector control is to reduce the number of infected mosquitoes as quickly as possible to prevent transmission. During the pre-epidemic stage when the first case of dengue is detected, insecticides (small spraying can) are used indoors and around the patient's house up to a radius of 25 metres for killing infected mosquitoes. This treatment is a very important part of the programme, because these patients are the tip of an iceberg of dengue in the pre-epidemic stage.
   - In the epidemic stage, if a large outbreak occurs, ULV sprayers will be used with such insecticides as ICON (ICI, UK), K-Othrine (French Co.) or Vectron (Japan).
A community-based source reduction effort is initiated in parallel to the reduction of breeding places of *Aedes* mosquitoes indoors and outdoors.

3. Long-term vector control

This requires close cooperation between the public health staff and the community in the application of biological agents as mesocyclops (*Micronecta*), larvivorous fish (*Poecilia reticulata*) and other initiatives.

4. Clinical diagnosis and management of cases

In recent years, the dengue CFR has decreased from 0.35% to 0.25%. This has demonstrated the need for further improvements in disease management. In the future, more investments would be necessary as micro-hematocrit sets and microscopes for platelet estimation need to be provided to all hospitals.

Short training courses on the diagnosis and treatment of DHF will be organized for all medical personnel working at commune, district and provincial levels in target areas.

Plan of action 1997-1998

1. Objective to be attained by the end of 1998

To reduce the number of DHF cases by 50% from the level during 1992-1996 in six target provinces: Nam Dinh, Thanh Hoa, Khanh Hoa, Ho Chi Minh city, Minh Hai and Can Tho.

2. Target populations and services

It is estimated that there will be on an average six high-risk districts in each province, so the following targets are set forth for the country:

<table>
<thead>
<tr>
<th>Target districts</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target communes (average 8 communes per district)</td>
<td>288</td>
</tr>
<tr>
<td>Target population (average population of a district is 130,000)</td>
<td>4,680,000</td>
</tr>
<tr>
<td>Households</td>
<td>561,600</td>
</tr>
<tr>
<td>Schoolchildren aged 8-13</td>
<td>963,000</td>
</tr>
<tr>
<td>Target services:</td>
<td></td>
</tr>
<tr>
<td>6 Province centres</td>
<td>120 persons</td>
</tr>
<tr>
<td>36 district teams of hygiene and prevention</td>
<td>180 persons</td>
</tr>
<tr>
<td>288 commune health stations</td>
<td>1,440 persons</td>
</tr>
<tr>
<td>Private physicians estimated</td>
<td>288 persons</td>
</tr>
<tr>
<td>Health volunteers</td>
<td>2,880 persons</td>
</tr>
</tbody>
</table>

3. Main operational strategies in target areas

3.1 Training of health workers: according to job, task and responsibility for each level; concise, authoritative guidelines will be produced. These will address technical norms, including job and task description, in relation to DHF control for MoH staff, institute staff, province staff, district staff and commune health staff.

Training courses will be conducted at three levels – from institute to provinces, from provinces to districts, and from districts to communes.

3.2 Stratification of areas: to identify the high-risk districts and to make a rational
choice between mesocyclops, fish or other alternative larval control methods.

3.3 **Information, education and communication (IEC)** on DHF for people at risk to mobilize them for larval control.

3.4 **Intersectoral collaboration at province, district and commune levels.** The intersectoral committees will be established at all levels under the leadership of the People’s Committees. A national intersectoral committee for control and prevention of DHF will be created based on experiences gained after two years of work in these target provinces.

**References**


All country
(1995: 80447/222)

All country
(1996: 74569/254)
Current DF / DHF Prevention and Control Programme in the Philippines

By

MA. Nerissa N. Dominguez
Programme Manager
National Dengue Prevention and Control Programme
Communicable Disease Control Service
Department of Health
Sta. Cruz, Manila, Philippines

Abstract

Dengue haemorrhagic fever was first recorded in the Philippines in 1953(1) and was made a notifiable disease in 1958. Sporadic dengue outbreaks occurred in some areas of the country until the 1980s, and, since then dengue has maintained its endemicity in all regions of the country(2).

In 1993, the National Dengue Prevention and Control Programme was formulated and piloted in two regions of the country, namely, Region 7 in the Visayas and the National Capital Region in Luzon with a five-year medium-term plan. It is envisioned to extend the programme nationwide by 1998. Highlights of the Dengue Prevention and Control Programme include its goal, objectives, strategies, support system, programme policies, guiding principles, programme status and future actions. This programme lays emphasis on an effective integrated vector control approach which is community-based and managed, planned and sustained by the community itself.

The dengue epidemiology in the Philippines describes the pattern of dengue occurrence in the country and how it can contribute to information exchange among endemic countries, not only in Asia but the whole world.

Introduction

The dengue problem in the Philippines has been confronting the country since 1953 when haemorrhagic fever was reported for the first time in this part of Asia. From then on, sporadic cases of dengue have been reported in several parts of the country and control measures were instituted as necessary.
Development of DF / DHF Control Programme

It was in 1993 when the Communicable Disease Control Service, as mandated by Executive Order 119, formulated the National Dengue Prevention and Control Programme for the control of DF/DHF.

Being a low budget programme – US$16 million in 1993; US$1.6 million in 1997 – it was implemented in only two regions of the country, namely, Region 7 and the National Capital Region (NCR) which were high incidence regions.

Programme goal

To reduce the morbidity and mortality rates of dengue infection to a level wherein it will no longer be a public health problem.

Programme objectives

General objectives: To prevent and control the transmission of dengue virus and obtain reduction by 90% by the end of a 15-year period.

Specific objectives

(1) To create a dengue technical working group;
(2) To develop an integrated vector control approach for prevention and control;
(3) To develop capability on diagnosis and management;
(4) To intensify health education/IEC activities, and
(5) To operationalize an effective surveillance system and to develop a dengue epidemic contingency plan for emergency response.

Key programme strategies

(1) Integrated vector control approach – A combination of several approaches directed towards container management and source reduction. This is through a combination of health education, environmental sanitation and community mobilization.

(2) Case diagnosis, management and reporting – Immediate reporting to nearest health authority of cases on suspicion and clinical diagnosis.

(3) Surveillance – Due to administrative constraints, fever surveillance and, to some extent, vector surveillance is only feasible.

Support systems

(1) Training – Training of coordinators and field implementors, including orientation meetings of key leaders of community, is one of the key elements of this new programme.

(2) Health education – Long-term control and prevention is based on properly informed community that understands and practices dengue prevention and control measures at their own capability level. This will facilitate participation of the community and
governmental organizations (GOs), NGOs and POs.

(3) **Laboratory facilities/diagnostic support** – For proper clinical diagnosis of dengue, laboratories are to be supported to be able to do platelet and hematocrit determination.

(4) **Rapid response emergency mosquito control** – This support strategy is in place to immediately contain an incipient outbreak before it spreads to other areas. This approach includes chemical control of the vectors combined with other integrated vector control approaches.

(5) **Epidemic contingency planning** – This includes estimating resources needed during outbreak management so that a ready plan of action can be immediately implemented.

(6) **Research and project development** – Basic and operational research is encouraged for improvement of programme implementation.

**Programme Implementation**

The programme is being implemented in two prioritized regions of the country since 1993. These are: Region 7 composed of four island provinces, and the National Capital Region composed of four districts with eight cities and nine municipalities.

All the regional dengue coordinators, regional entomologists/designates, some sanitary engineers and health education and promotion officers have been trained. Orientation meetings were conducted for key leaders in some selected municipalities and cities in support of a community-based programme.

Information materials in the form of VHS and Beta tapes, leaflets and posters were prepared, translated and reproduced in 16 local/regional dialects. Special information materials like flyers, dengue advisories, dengue alert bulletins and billboards are issued and distributed before the rainy season as a proactive step to prevent the disease. The visual, audio and print media are being utilized for this purpose.

Guidelines and protocols have been issued as standards for programme implementation, e.g. Guidelines for the prevention and control of dengue haemorrhagic fever; Guidelines in the organization of the ‘Little Dengue Brigade’, and Protocol on *Aedes* survey/surveillance.

Laboratory support has been given to pilot areas to enable them to routinely perform platelet and hematocrit determination, while rural health units...
were given paediatric cuffs for standardized tourniquet test.

Hospitals in the pilot areas have been augmented with medicines like IVF and analgesics and plasma expanders as well as chemicals for emergency outbreak control are in place at the regional health office and pilot areas.

Collaboration between GOs and NGOs has been established. A special programme was launched last year which was called “Tepok Lamok Dengue Sapok” (Kill the mosquito, Knock out Dengue) – 4 o’clock Habit, as per an Administrative Order of the President, H.E. Mr Fidel V. Ramos. All government and private agencies and the citizenry are required to observe the 4 o’clock habit, whereby every 4 o’clock in the afternoon, everyone has to search and destroy or eliminate breeding places of mosquitoes in homes, offices and the environment. This 4 o’clock habit can be practised at one’s own convenience if necessary. A memorandum of agreement with several government agencies for this purpose was effected. These agencies include: the Department of Health, Department of Interior and Local Government, Department of Education, Culture and Sports, Department of Environment and Natural Resources, Department of Social Welfare and Development, Department of Public Works and Highways, the Philippine Information Agency, National Disaster Coordinating Council, and the Metro Manila Development Authority.

Nongovernmental agencies and organizations were also asked to collaborate, too. These included religious groups, socio-civic groups like Rotary Club International, Media groups, academia and people’s organizations. This special programme will be a national initiative organized every year to lead the country in its fight against DF/DHF.

Successful NGO collaboration is exemplified by Rotary Club International District 3810 awarded by the Rotary Foundation for Health, Hunger and Humanity Grant (3-H Grant). It is a $500 000 grant awarded for the Philippines and Colombia. It focuses on information campaign and community participation and mobilization to prevent and control epidemic dengue haemorrhagic fever. It is envisioned to be a model programme for Rotary International to expand it globally.

**Historical account of DF / DHF**

In the Philippines dengue haemorrhagic fever was recognized for the first time in 1953, and made a notifiable disease in 1958 and reclassified as DEN/DHF. During 1966, a severe epidemic was recorded in the Metro Manila area with a morbidity rate of 28/100 000 and mortality rate of 0.7/100 000.

Dengue has now become endemic all over the country where it occurs sporadically and sometimes in epidemic form (see Figure).

The country is experiencing a more-than-three-times increase in the average five-year morbidity rate of 12.12 per 100 000 population during 1989-1993$^{(3)}$ as compared to the five-year average of 3.84 per 100 000 in 1984-1988. The five-year average in 1984-1988 was actually double than that of the 1979-1983 average which...
was 1.54 per 100,000. This also shows that DHF cases are on the increase and dengue is becoming one of the major public health problems that should be addressed.

**Age and sex distribution.** The most commonly affected are the under 15-year-olds, with the 0-9 year age group leading both in morbidity and mortality. There is no significant difference in sex distribution, although males are slightly more affected (51% males and 49% females).

**Geographical distribution.** All 16 regions of the country are endemic for dengue. The regions with the highest morbidity and mortality are region Nos. 7, 8, 11, 10, 12, 6, and NCR.

**Seasonal distribution.** The pattern of occurrence in relation to the months of the year is variable, although the increase in incidence usually occurs one-to-two months after the start of the rainy season. Hence, an increase in dengue cases can be expected starting from July or August up to December. There is, therefore, a strong correlation between rainfall and dengue incidence. Dengue is common during the rainy season and is usually at its peak two months following the rainfall.

**Vector.** Two vectors have been identified to be responsible for dengue: *Aedes aegypti* and *Aedes albopictus* (4). *Ae. aegypti* is predominantly urban, while *A. albopictus* is a rural vector. The former breeds in artificial containers, usually domestic containers, while the latter breeds in natural containers.

**Agent.** All four serotypes of dengue virus, namely DENs- 1, 2, 3, and 4, are
present in the Philippines, although the most predominant are DENs- 1, 2 and 3.

**Case fatality rate.** The case fatality rate (CFR) ranges from 1 to 4%.

**References**


Dengue Outbreak in Ludhiana (Punjab), India, 1996

By
Kuldip Singh Gill, D. Bora, M. Bhardwaj, S. Bandyopadhyay, Kaushal Kumar and Rakesh Katyal
National Institute of Communicable Diseases
22 Sham Nath Marg, Delhi-110054.

Abstract
An outbreak of dengue fever/dengue haemorrhagic fever was reported from Ludhiana city in Punjab state, India, during October 1996. The outbreak started in the last week of September and lasted up to the first week of December. The number of cases reported during the outbreak was 720, with 19 deaths. A community survey revealed a very high attack rate of fever cases (4.10%). Serological tests suggested a recent dengue virus infection as seven serum samples out of nine tested were found to be positive. *Aedes* survey carried out in some of the affected localities revealed the presence of *Aedes aegypti*, a vector mosquito. The values of House and Container indices in Ludhiana city during the survey were 32.8% and 29.16% respectively. Breeding of *Aedes* mosquitoes was detected in various types of containers, mostly desert-coolers. To prevent such outbreaks in the state of Punjab and in the region, there is an urgent need for taking appropriate preventive measures and for disease/vector surveillance.

Introduction
Dengue fever is one of the oldest arthropod-borne viral diseases known in India. Outbreaks of dengue fever/dengue haemorrhagic fever (DF/DHF) have been reported from various parts of the country[1,2,3]. Rapid transportation, industrialization, movement of infected human populations/mosquitoes and the changing ecology have facilitated its spread to newer areas[4,5,6]. During 1991-1995, a total of 18 DF/DHF outbreaks were reported from different parts of the country, and the trend shows that the disease is occurring with increased frequency[7]. A widespread outbreak of DF/DHF occurred in Delhi and its surrounding areas during 1996[8]. Similar outbreaks were also reported from the neighbouring state of Haryana[8]. In October 1996, a suspected dengue/DHF outbreak was reported from Ludhiana city of Punjab state. Following the outbreak, a team of specialists from the National Institute of Communicable Diseases (NICD), Delhi, investigated the outbreak and the findings of its investigations are presented in this paper.
Area

Ludhiana is a fast growing city of Punjab situated about 300 km away from Delhi in the north-west. It has a sizeable migratory population. It has 66 municipality wards. The city is roughly divided into new and old parts by a big drain/nullah. Old city is a highly congested area. The city has one civil hospital and a number of private hospitals.

Anti-mosquito measures

In Ludhiana, a city corporation is responsible for all the anti-mosquito activities. The district malaria office is also involved in anti-larval measures by using Malariol and Fenthion. Generally, these measures are directed towards the control of *Aedes quinquefasciatus*.

Methodology

The methodology used in this investigation included collection of institutional data regarding line-listing of cases and clinical details. Blood samples were collected from acute and convalescent cases admitted in different hospitals for laboratory confirmation of the aetiology. Rapid fever survey and entomological collections were carried out in the localities from where suspected dengue/DHF cases or deaths had been reported.

Results and discussions

Epidemiological

(a) Hospital records: Cases of dengue/DHF, based on clinical and laboratory criteria like high fever, headache, body-ache, rash, bleeding manifestations and low platelet count, were admitted in two major hospitals, viz. Dayanand Medical College (DMC) Hospital and the Christian Medical College (CMC) Hospital. The first case was admitted in DMC hospital on 24 September. Up to 18 October, a total of 67 cases were treated in the two hospitals. The proportion of cases by age was: 0-10 years (22.4%), 11-20 years (32.8%), 21-30 years (16.4%) and > 31 years (26.9%). Both sexes were almost equally affected and cases were mostly among young adults and children, the youngest being seven-and-a-half-years old. The symptomatology of admitted cases included fever (100%), headache, body-ache, petechiae (8%), frank haemorrhagic manifestations (5%), rash (3%) and very low platelet count (100%).

(b) Community survey: Among the 2897 persons surveyed for the occurrence of fever cases, with one week recall period in the community, 119 fever cases were detected (attack rate 4.10%). The age-wise analysis of the cases showed that proportions included in the age group were: 0-10 years (21%), 11-20 years (28.6%), 21-30 years (21%) and >31 years (29.4%). Both sexes suffered almost equally. The area-wise attack rate of fever cases from the community showed that Shivaji Nagar area was the worst affected, with an attack rate of 7.9%, Fatehgarh with 1.7%, Khud Mohalla with 1.3% and Indrapuri with 0.6%. The outbreak started in the last week of September 1996 and lasted up to the first week of December 1996 during which period a total of 720 cases (deaths 19) were reported (Figure 1) (Source: Directorate of Health Services, Punjab).
maximum number of cases were reported during the third week of November 1996.

Serological
Nine serum samples collected from acute and convalescent patients were tested by Haemagglutination Inhibition Test\(^{(9)}\), using antigen and antisera received from Centers for Disease Control, USA, and dengue IgM immunoblot commercial kit (Gene Labs, Singapore). Seven of these sera were found to be positive for diagnostic dengue antibodies by HI\(^{(10)}\) and/or IgM immunoblot test. One sample showed low level of antibodies to dengue.

Entomological
The areas surveyed for Aedes mosquito breeding places were Civil Lines, Civil Surgeon’s Office complex, Daya Nand Medical College and Hospital area, Durga Puri colony and Shivaji Nagar colony. In these areas, Aedes survey was carried out in and around those houses from where suspected dengue fever/DHF cases or deaths had been reported. Houses were searched for Aedes mosquito’s larvae in various water collections/containers as per single larva technique and the results are summarized in the table below.

**Table.** *Aedes aegypti* indices in different localities of Ludhiana

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Locality</th>
<th>House Index</th>
<th>Container Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Civil Surgeon’s office complex</td>
<td>44.4</td>
<td>33.3</td>
</tr>
<tr>
<td>2.</td>
<td>Civil Lines residential flats</td>
<td>26.3</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td>Daya Nand</td>
<td>83.3</td>
<td>52.0</td>
</tr>
<tr>
<td>3.</td>
<td>Medical College &amp; Hospital</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Durga Puri colony</td>
<td>27.7</td>
<td>21.7</td>
</tr>
<tr>
<td>5.</td>
<td>Shivaji Nagar colony</td>
<td>23.8</td>
<td>23.5</td>
</tr>
</tbody>
</table>

**Figure 1.** Week-wise distribution of dengue/DHF cases, Ludhiana, 1996
During the survey a total of 73 houses/premises were searched for Aedes breeding and 24 were found positive (House Index 32.8%). Similarly, a total of 120 containers were searched and 35 were found positive (Container Index 29.16%). These indices were found to be higher than the critical index reported for dengue/DHF outbreaks\(^{(17)}\).

The bulk of Aedes breeding sites comprised of desert-coolers. Other containers found positive for Aedes breeding were tin/plastic containers, flower vases, earthen pots, plastic buckets, etc. Adults of Aedes aegypti were also collected from inside rooms and water receptacles, particularly inside earthen pots and desert coolers. The entomological investigation revealed a significantly higher House Index and Container Index for Aedes aegypti mosquito, a proven vector of DF/DHF. The presence of this vector mosquito in Punjab state has already been documented\(^{(12)}\). However, higher larval indices of Aedes aegypti were found during the present investigation, thus indicating that the species is well established in Ludhiana city.

**Conclusion**

The clinical, epidemiological, laboratory and entomological findings of the investigation indicate that the present outbreak in Ludhiana was of DF/DHF. The prevalence of DF/DHF in Ludhiana has been reported for the first time in Punjab state. The last epidemic of dengue outbreak, reported from the northern part of the country, was from Jammu in the year 1974\(^{(14)}\). The current outbreak showed that the disease was now taking root in the plains of Punjab. The occurrence of dengue/DHF outbreak in Ludhiana emphasizes the urgent need for taking appropriate preventive measures and for surveillance of the disease/vector in order to prevent further such outbreaks in other parts of the state and in the region.

**Acknowledgement**

The authors are grateful to Dr K.K. Datta, former Director, NICD, for technical guidance. They are thankful to the Civil Surgeon and District Malaria Officer of Ludhiana district for their help and cooperation during the field investigation and data collection. Thanks are also due to Mr Ravi Kumar, Research Assistant, and Mr N. A. Khan, Technician, for their technical assistance.

**References**


Dengue Control through Schoolchildren in Thailand

By

Dr Yongyuth Wangroongsarb
Vector-Borne Disease Control Programme,
Department of Communicable Disease Control,
Ministry of Public Health
Nonthaburi 11000, Thailand
Fax 66-2-965-9007

Abstract

Dengue haemorrhagic fever (DHF) was first recognized in Thailand in 1949. Although the morbidity from DHF seems to have stabilized over the past few years, the mortality and case fatality rates have been dramatically brought down. However, DHF remains a crucial public health problem, particularly for young children who are the most affected. After several trials on dengue control, a national dengue control programme was started through the schoolchildren approach in 1992.

With a target of reducing DHF morbidity among schoolchildren from 447.8/100 000 to 240/100 000 by 1996, and to 160/100 000 by 2001, the project had achieved the goal of morbidity reduction to 219.2/100 000 pop. by 1996. The project was also evaluated from 96 school samples nationwide during September-November 1994. It was found that 93.7% of the schools sampled had been involved in the project. 62.5% of the provinces and 64.3% of the districts surveyed showed decreasing morbidity rates among both schoolchildren and all other age groups. The majority of both health and education staff had positive attitudes to the objectives and strategies of the project. However, the main constraints were low frequency and non-regularity of the teaching and learning process, lack of consistent supervision from health staff, poor communication and coordination between different organizational personnel and, lastly, insufficiency and irregular and delayed supplies for school support. These weaknesses have been vigorously overcome during the past 2-3 years in order to improve the project implementation.
Introduction

Dengue haemorrhagic fever, a severe form of classical dengue, is one of the tropical diseases transmitted by Aedes mosquito. The disease has worldwide distribution, but is more prevalent in the regions of south-east Asia, western and eastern Pacific islands, the Caribbean and Latin America. It is also stated that DHF is a new, emerging or re-emerging infectious disease, which is threatening people living in many regions. In Thailand, for almost 50 years after the first recognition of the disease in 1949, DHF has spread across the country. It is considered an endemic disease in certain areas. With the availability now of better medical and health care facilities to communities, there has been a sharp decrease in the death and case fatality rates during the past few decades; however, the morbidity rate seems to remain rather stable.

Epidemiological situation

Morbidity and mortality

After DHF was first recognized in 1949 at Bangkok, more than 1500 cases were reported during 1950-1957. Later in 1958, there was an outbreak of DHF in Bangkok and other surrounding provinces. Since then, the number of reported cases has been gradually increasing over time, from 2158 cases in 1958 to 7663 cases in 1965. During 1958-1967, the disease occurrence was confined only to Bangkok and other big cities, but later in 1978, the disease spread across the country in urban areas and then to rural areas with a larger number of cases – 12,547 in 1978 to 80,076 in 1985. In 1987, the cases touched a high of 174,285, which was the largest number ever recorded. Since 1990, the number of the reported cases has been declining every year, approximately 40,000-60,000 cases a year (Fig. 1).

Figure 1. Trend of DHF morbidity and mortality rates in Thailand, 1958-1997
Table 1. Morbidity, mortality and case fatality rates of DHF in Thailand, 1958-1996.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases</th>
<th>Deaths</th>
<th>Morbidity Rate [1/100,000]</th>
<th>Mortality Rate [1/100,000]</th>
<th>CFR (%)</th>
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<td>71.71</td>
<td>0.13</td>
<td>0.19</td>
</tr>
</tbody>
</table>

* data as of Oct 2, 1997
Source: Division of Epidemiology, Ministry of Public Health, Thailand.

In 1958, 300 persons died of DHF (1.23 deaths/100,000). Although the number of deaths due to DHF has fluctuated during the past few decades, the mortality rate seems to be on the decrease during the same period — from 1.19/100 000 in 1959 to 0.19/100 000 in 1996. Similar is the trend in the case fatality rate – down from 13.9% in 1958 to 0.31% in 1996 (Table 1). This seems to be due to improvements in medical care and services as well as better accessibility to medical services and health facilities of people in communities. Nevertheless, the case fatality rate in the past few years seems to be rather stable.

Seasional variation
DF/DHF occurs mostly in the rainy season (from May to October) which coincides with the reopening of schools for new sessions (1,9). The peak of the disease outbreak usually is reached in June and July (see Fig. 2). It is noticed that man-made containers are the most potential Aedes breeding places commonly found in the rainy season, and shortage of water supply at some periods of time had resulted in a significant increase in the number of water containers even though piped water supply was available (10). Moreover, schools and households in villages, with high disease prevalence, had a higher number of water containers that resulted in more vector populations (11).

Age distribution
DHF cases are mostly found in the age group 5-9 years. Annually, the number of cases in the age group of 5-14 years accounts for 70-75% of total reported cases (Fig. 3). The average morbidity rate during the past five years (1987-1991)
Figure 2. Seasonal variation of DHF in Thailand, 1987-1996. 
Reported DHF cases distributed by month, Thailand. 

Figure 3. Age group distribution of DHF cases in Thailand, 1986-1996 
Proportional percentage of DHF cases by specific age-groups. 
among the 5-14-year-old children was extremely high – 447.8 cases/100,000 a year. This number is about 3–4 times higher than that of all age groups (7,9). It has been noticed that the age distribution of the disease has shifted to the higher age group during the past decade, from 0-9 years to 5-14 years (Fig. 3).

Conventional methods of dengue prevention and control

Currently, the dengue programme is an integrated programme which has a community-based prevention and control approach. It is now recognized that without community participation, dengue control is neither achievable nor sustainable (13,14). Several models of dengue control through the community participation approach have been studied during the past decades (15,16). Health volunteers like village health volunteers, village leaders, village councils, monks, teachers, elderly women and other local prime movers in villages were encouraged to participate in the programme. Periodic clean-up campaigns were organized by health personnel to effect vector source reduction and other environmental modifications. Social mobilization by utilizing the mass media, community talks and public relations, and various other strategies were used to initiate and encourage communities to participate in the search, elimination and destruction of the aquatic foci which were potential larval breeding sites. Incentives and rewards were also provided to volunteers and community members to promote their participation and to help them develop health education and health communication. However, these model also did not prove viable due to inconsistency and non-sustainability of their participation in dengue control activities. This could have been due to the reason that the suitability of the community participation approach was dependent on various socioeconomic, cultural and political features in the community. A small and well-organized community, which is culturally and economically more homogenous, is more suitable for community initiative than the rapidly growing, socially complex and multicultural urban communities (17). It is well recognized that dengue control activities must be integrated with other health sectors and the community. Dengue control in primary schools is another development model which uses primary school children as volunteers for vector control in schools and communities. This school-based approach seems to be working successfully in Thailand after five years of programme implementation.

Dengue control through schoolchildren

According to epidemiological analysis, the disease victims are young school children aged below 15 years. They are mostly primary school children (grades 1-6) and secondary schoolchildren (grades 7-9). The peak of the disease usually occurs in June and July, the same period as the schools commence. Actually, the disease is transmitted by Aedes mosquitoes which are day-time biting vectors. Thus, it is argued that the disease transmission might be happening in school areas (5,7,9,16). Several research studies on model development of DHF prevention by the community-based approach focusing on
primary schools had been conducted in several provinces\textsuperscript{(15,19,20)}. In these studies, schoolchildren were educated about dengue, its transmission and prevention. They were initiated and encouraged as health volunteers to participate in vector survey and vector control in their schools while local health workers technically supervised and promptly supported them with supplies. The outcome of this strategic approach, in terms of disease prevention, was satisfactorily successful as compared with other conventional approaches. \textit{Aedes} larval indices were reduced by 60-80\% in comparison with the results obtained from conventional models\textsuperscript{(15,19)}. It was also found that schoolchildren were more effective than village volunteers, particularly in urban communities\textsuperscript{(19)}. These studies substantially encouraged the Ministry of Public Health to revise the control strategies. Finally, in cooperation with the Ministry of Education, the Ministry of Public Health decided to establish a joint project for national dengue campaign in primary schools, which started in 1992.

\section*{Purposes and targets}

The main purpose of the project is to educate schoolchildren about dengue and its transmission as well as about the methods for its prevention. Schoolchildren are also encouraged to participate in vector control activities by eliminating \textit{Aedes} breeding places within their school and household areas\textsuperscript{(18)}.

The target of the joint project is to reduce the DHF morbidity rate among schoolchildren to 240/100 000 by 1996 and 160/100 000 by 2001\textsuperscript{(18)}. Additionally, another target is to reduce the disease transmission by reducing the container index (C.I.) in schools to as low as 10\%\textsuperscript{(9)}.

\section*{Strategies}

According to the project, the interventions to be applied are:

\begin{itemize}
  \item Providing health education to all primary schoolchildren by integrating the “dengue message” into the current curriculum of the national primary education programme.
  \item Producing and publishing manuals and guidelines related to dengue infection and its control for the teaching staff in order to use them as teaching aids.
  \item Producing some additional reading books related to dengue for each level of schoolchildren.
  \item Producing several types of health education materials such as posters, pamphlets and audio-visual aids to support the schools involved in the project for educating schoolchildren.
  \item Organizing both health and education staff at local level in every province and district to carry on the project, orientating them about the project and urging the local health staff to supervise all schools involved in the project.
  \item Distributing and disseminating all health-related materials and other supplies to all schools involved in the project.
\end{itemize}
All primary schoolchildren are expected to participate in vector control by eliminating *Aedes* breeding places within their schools and household areas. Some senior students would be trained and encouraged to act as health volunteers in order to advocate health education in their communities as well.

**Project implementation**

The project has been implemented through the joint management of both health and educational organizations. It is eventually run by a number of joint committees (organizational staff of both departments) from central to peripheral levels. Generally, the committee may be divided into two bodies – a steering committee and a technical coordination and operation committee.

The **steering committee** is an executive committee principally comprised of health professionals and under the chairmanship of the Health Minister. This committee is responsible for administrative and management issues of the joint project, including resource allocation and adjustment\(^\text{(18)}\).

The **technical coordination and operation committee** is responsible for project implementation in terms of technical support, monitoring and supervision, including management of logistics and supplies. The technical committee may be categorized into two levels, central and peripheral levels.

At the **central level**, there are several sub-committees. Most of them are mainly dominated by education professionals. The technical committee and sub-committees are responsible for coordinating the work of both health and education organizational staff to establish a national curriculum for primary education by integrating health information and dengue message into the current curriculum, producing guidelines and manuals for teaching staff and additional reading books for schoolchildren, and preparing health educational aids and materials to supply to all schools involved in the project. In addition, they are also responsible for monitoring and evaluating the project implementation\(^\text{(18)}\).

At the **peripheral level**, from province to district, there are joint committees at each level. These joint committees are a kind of working groups or task forces mainly responsible for project operation. The working groups or committees at either provincial or district levels are, in fact, composed of both local health and education professionals, including some local politicians and other local officers. These committees are carrying out project activities in all schools involved by orientating both local health and education personnel about the dengue control programme, organizing staff from both sectors for the project; technically supervising the schools involved; managing and disseminating supplies to schools, and monitoring and evaluating project activities and outcomes. The work plans or plans of action at provincial and district levels are organized and prepared by the committees at those levels. Work plans at the provincial level are submitted to the steering committee at the central level for approval and budget allocation\(^\text{(18)}\).

According to the plan, monitoring of activities and project evaluations were to be done on a regular basis in order to provide feedback to the Health Ministry.
and other stakeholders about the success and shortcomings of the control programme.

**Responsible and contributing agencies**

Because of the joint nature of the project, the contributing agencies include both health and education department staff. They are categorized into several levels as follows:

**At central level**

*Ministry of Public Health*
- Vector-borne Disease Control Programme
- Department of Communicable Disease Control (Department of CDC)
- Division of School Health, Department of Health
- Division of Epidemiology under the Office of Permanent Secretary

*Ministry of Education*
- Office of the National Primary Education Commission
- Department of Curriculum and Instruction Development
- Department of Teacher Education

**At provincial level**
- Provincial Health Office
- Provincial Primary Education Office

**At district level**
- District Health Office
- District Primary Education Office
- Division of Environmental Health, Municipality
- Division of Education, Municipality

**Budgeting and funding support**

The project has been implemented with financial support from the Central (national government) budget, which has been proposed under a budgetline of the Vector-Borne Disease Control Programme under the CDC Department, Ministry of Public Health. The expenditure for the project during 1992-1997 was about Baht 62.07 million or US$ 2.483 million (25 Baht = 1US$), which was expended mainly for supplies, including chemicals, for school support.

**Stakeholders and their concerns**

In this project, there are several levels of stakeholders. At each level, each stakeholder has its own concerns that are different from one another. They are dependent on what roles and responsibilities each stakeholder actually has (Table 2). Besides the CDC department, other stakeholders contributing to the
Dengue Control through Schoolchildren in Thailand

project are the joint committees at both central and peripheral levels as well as the provincial primary education commission and provincial health authorities. At the Central level, the steering committee plays a vital and important role in administration and project management, including resource allocation. Its concerns therefore include justification of resource allocation as well as cost-effectiveness of the project. The technical coordination and operation committees mainly concern themselves with achieving successful organization of the project, effectiveness of its management and consistency and quality of its performance.

At the peripheral level, the provincial joint committees are mainly responsible for technical support and management during project implementation. The success of the project partly depends on their performance. So, their concerns are to ensure effectiveness of resource management and quality assurance of health improvement among school children. The district joint committees are principally operational task forces or working groups that directly contribute to project operation. They deal with day-to-day problems and come up with solutions. Thus, the qualitative attributes of the project are dependent on their enthusiastic involvement and active participation. Their concerns are the outcome of disease control among schoolchildren, technical coordination between staff of both departments and problem-solving during project implementation.

Table 2. Some examples of the stakeholders of the dengue control project and their concerns

<table>
<thead>
<tr>
<th>Stakeholders</th>
<th>Concerns</th>
</tr>
</thead>
</table>

| 1. Department of Communicable Disease Control (CDC), Ministry of Public Health | 1. Goal achievement of the project in terms of morbidity reduction |
| 2. Joint Committees | 2. Attitudes of both organizational staff/personnel |
| A. Central level | 3. Sustainability of such a strategic approach |
| 1. Steering committee | 4. Effectiveness of project management |
| 2. Technical coordination and operation committees | 1. Justification of resource allocation |
| B. Peripheral level | 2. Cost-effectiveness of the project |
| 1. Provincial joint committees | 3. Effectiveness of project management |
| 1. Effectiveness of resource management |
| 2. Quality assurance of health improvement among schoolchildren |
| 2. District joint committees | 1. Effectiveness of disease prevention in the schools |
| 1. Effectiveness of the project in terms of disease control |
| 2. Technical coordination between both organizational staff |
| 3. Problem-solving concerns |
| 3. Provincial health authorities | 1. Effectiveness of health education in the schools |
| 1. Effectiveness of disease prevention in the schools |
| 2. Effectiveness and efficiency of resource reallocation |
| 3. Effective management of logistic supplies |
| 4. Provincial primary education commission | 1. Effectiveness of health education in the schools |
| 1. Effectiveness of resource reallocation |
| 2. The development of knowledge, attitude and practice of those schoolchildren in health care activities |

Finally, the provincial primary education commission and the provincial health authorities are important stakeholders in the project. They have the authority to
organize manpower and allocate financial resources to each school in the areas they are responsible for. They are concerned with ensuring effectiveness of disease control measures and resource reallocation, achievement of the education programme as well as effective management of supplies for school support.

Project evaluation
Since the project was started in 1992, it might be too premature to expect the project to make an impact in terms of disease prevention. From the standpoint of a stakeholder like the CDC Department, its first priority is achievement of project goals in terms of morbidity reduction and sustain-ability of the schoolchildren approach if the outcome is successful.

As part of project evaluation, a cross-sectional survey was conducted during September-November 1994. In this study, 96 schools across the country were sampled and 371 personnel were interviewed. It revealed that 93.7% of the schools sampled were involved in the project. Two-three years after the start of the project, 62.5% of the provinces and 64.3% of the districts surveyed had reported reduced morbidity rates of DHF among both schoolchildren and all other age groups. The majority of health and education staff held a positive attitude to the objectives and strategies of the project as well as its approach. However, 76.7% of the schools involved received programme orientation. Larval control activities were taught by 80% of the teachers and were performed by 94.4% of the students. About two-thirds of the teachers admitted that breeding-site reduction was the most appropriate and effective control measure. However, the main constraints were low frequency and non-regularity of the teaching and learning process, lack of consistent supervision, poor communication and coordination between different organizational staff and health and education personnel and, lastly, insufficient and irregular supplies to schools such as educational materials and chemical larvicides. These shortcomings have been overcome during the past 2-3 years which have helped greatly to improve project implementation.

It is hoped that intersectoral cooperation between the health and education departments, in close collaboration with the community, will be able to reduce the danger of DF/DHF as a major public health problem in Thailand in the near future.

References


Study of the Knowledge and Awareness of Physicians about Dengue Infection, Treatment and its Control in Dhaka

By
Amin Mortayez M. M., Rasheduzzaman Shah,
Mukut Zahangir A., Shamsi Ara Chowdhuri, Dilrose Banu
Institute of Epidemiology, Disease Control & Research
Mohakhali, Dhaka-1212
Bangladesh.

Abstract
The knowledge and awareness test study of physicians in Dhaka about dengue infection, its treatment and control revealed that although DF/DHF was not a major health problem in Bangladesh, the physicians were, to a great extent, conversant with the clinical knowledge but lacked epidemiological comprehensives. A test study brought out the fact that 77.37% of the physicians were aware of the causative agent, 73.16% about diagnostic tools and 61.58% knew about appropriate treatment of dengue fever. About epidemiological comprehensives, the physicians lagged behind. The study highlighted the need for orientation of physicians to the epidemiological aspects of DF/DHF in order to create epidemic preparedness in the country.

Introduction
Dengue fever and dengue haemorrhagic fever has so far not posed any problem in Bangladesh. The first outbreak of dengue fever along with Chikungunya virus was reported in 1954 as "Dhaka fever". DEN-3 virus was isolated as the aetiological agent. Subsequently, a few cases of dengue fever were reported from other parts of Bangladesh. A serological survey of schoolchildren carried out in Dhaka during 1982-83 showed 278 positive cases for DEN-1 infection out of 2,465 schoolchildren examined. Both Aedes aegypti and Aedes albopictus were detected in the old and new parts of the city.

Address for correspondence: Dr Amin Mortayez, M. M., Medical Officer, Institute of Epidemiology, Disease Control & Research (IEDCR), Mohakhali, Dhaka-1212, Bangladesh.
Fax: 88-02-868769 E-mail: paciaiam@bangla.net (Attn. Dr Amin)
Although the density of *Aedes aegypti* was low, the presence of the vectors as well as the dengue virus and the large two-way migration of people to and from the adjoining endemic countries pose a serious threat of DF/DHF outbreak in Bangladesh.

In order to assess the physicians’ preparedness to meet any challenge, a study to test their knowledge about dengue infection, its spread, treatment, prevention and control was organized in Dhaka during September-October 1996. The findings are presented in this paper.

**Methods and materials**

A total of 200 physicians practising paediatrics and medicine were drawn from different sectors of the Dhaka metropolis. Of the total respondents, 63 were drawn from autonomous health care facilities, 56 from government hospitals, 47 were private clinicians and 34 were from semi-autonomous hospitals. Among these, 130 were male and 51 were female specialists. A pre-tested questionnaire was provided for on-the-spot ticking of probable answers.

**Results**

The questions were framed to bring out information on the following aspects of dengue infection and its control.

1. **In-service training on vector-borne or arbovirus diseases**

Only 9.47% of the respondents had formal training on vector-borne viral diseases whereas 90.53% had no such exposure.

2. **Information exchange with others on dengue infection**

When asked if they had learnt about dengue infection from others, only 4.21% replied in the affirmative, 94.74% answered ‘no’ and 1.05% did not respond.

3. **Dengue as a communicable disease**

A total of 76.32% replied ‘yes’ while 9.47% said ‘no’ and 14.21% did not know.

4. **Causative agent of dengue infection**

When asked to name the causative agent of dengue infection, 77.37% confirmed virus aetiology, 11.58% identified it as a bacterial disease while 11.05% did not know.

5. **About the transmission agent**

Replies to the questionnaire are included in Table 1 below.

<table>
<thead>
<tr>
<th>Name of the vector</th>
<th>% Ticked</th>
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</thead>
<tbody>
<tr>
<td>Rodents</td>
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<tr>
<td>Flies</td>
<td>24.74</td>
</tr>
<tr>
<td>Mosquitoes</td>
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</tr>
<tr>
<td>Ticks</td>
<td>10.54</td>
</tr>
<tr>
<td>Not known</td>
<td>12.61</td>
</tr>
</tbody>
</table>

From the above table it is evident that 50% of the respondents replied correctly; the rest either linked it to ticks (10.54%), flies (24.74%) and rodents (2.11%). 12.61% did not know at all.
6. Areas receptive to dengue infection

The results are included in Table 2.

Table 2. Percentage of areas receptive to dengue infection

<table>
<thead>
<tr>
<th>Name of areas</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>17.37</td>
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<tr>
<td>Rural</td>
<td>16.32</td>
</tr>
<tr>
<td>Forest</td>
<td>29.47</td>
</tr>
<tr>
<td>Hilly</td>
<td>18.95</td>
</tr>
<tr>
<td>Everywhere</td>
<td>03.68</td>
</tr>
<tr>
<td>Other combination</td>
<td>04.21</td>
</tr>
<tr>
<td>Not known</td>
<td>10.00</td>
</tr>
</tbody>
</table>

Only 33.69% of the respondents replied correctly that it occurs in both urban and rural areas. Ten per cent did not know about its occurrence.

7. Linkages with spread of dengue infection

When asked about linkages, 30% linked it with water supply and drainage, 22.11% with discarded tins and tyres, 2.63% with latrines, and a good percentage (45.26%) could not specify.

8. Seriousness of dengue infection

When asked if dengue caused epidemics and heavy case fatality in the community, 93.68% said ‘yes’ and 2.63% replied in the negative. 3.69% did not specify.

9. Disease manifestation of dengue infection

The responses on disease manifestation are included in Table 3.

Table 3. Most common set of manifestations of DI

<table>
<thead>
<tr>
<th>Name of the set</th>
<th>% penned</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>61.58</td>
</tr>
<tr>
<td>b</td>
<td>03.68</td>
</tr>
<tr>
<td>c</td>
<td>04.22</td>
</tr>
<tr>
<td>d</td>
<td>14.74</td>
</tr>
<tr>
<td>Not known</td>
<td>15.78</td>
</tr>
</tbody>
</table>

Set (a) : High fever, petechial rash, myalgia, arthralgia
Set (b) : Diarrhoea, hypovolemic shock, lymphadenopathy
Set (c) : Fever, neck rigidity, blurring of vision, malena
Set (d) : High fever, conjunctivitis, hepatosplenomegaly, vomiting

An analysis of the responses indicates that only 61.58% could give correct manifestations.

10. Dengue affection by age groups

Responses to age group affection by dengue fever is given in Table 4.

Table 4. Dengue affection by age group

<table>
<thead>
<tr>
<th>Affected age group</th>
<th>Supporting %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5 years</td>
<td>3.16</td>
</tr>
<tr>
<td>6-15 years</td>
<td>16.32</td>
</tr>
<tr>
<td>16-30 years</td>
<td>10.00</td>
</tr>
<tr>
<td>&gt;30 years</td>
<td>5.79</td>
</tr>
<tr>
<td>All ages</td>
<td>40.00</td>
</tr>
<tr>
<td>Not known</td>
<td>24.73</td>
</tr>
</tbody>
</table>
Physicians were not very clear about age-group affection, so much so that 24.73% showed near ignorance of the subject.

11. Laboratory diagnosis

(a) Availability of facilities: When asked about existence of laboratory facilities for diagnosis of dengue infection in Bangladesh, only 3.16% of the physicians confirmed about the existence and 91.58% said that these facilities did not exist.

(b) Diagnosis: The responses of physicians to different methods of diagnosis of dengue fever are given in Table 5.

<table>
<thead>
<tr>
<th>Method</th>
<th>% supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray</td>
<td>00.00</td>
</tr>
<tr>
<td>Serology</td>
<td>73.16</td>
</tr>
<tr>
<td>Routine blood test</td>
<td>04.74</td>
</tr>
<tr>
<td>Stool routine test</td>
<td>01.05</td>
</tr>
<tr>
<td>Blood + Serology</td>
<td>03.68</td>
</tr>
<tr>
<td>Not known</td>
<td>15.26</td>
</tr>
</tbody>
</table>

12. Treatment of dengue cases

Responses to the question about treatment of dengue fever are included in Table 6.

<table>
<thead>
<tr>
<th>Method</th>
<th>% supported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific antibiotics</td>
<td>00.53</td>
</tr>
<tr>
<td>Only general measures</td>
<td>38.95</td>
</tr>
<tr>
<td>Antibiotics plus general measures</td>
<td>42.63</td>
</tr>
<tr>
<td>Not known</td>
<td>17.89</td>
</tr>
</tbody>
</table>

While 42.63% were in favour of antibiotics plus general measures, 38.95% expressed in favour of antibiotics only. 17.89% did not specify.

13. Control of dengue fever

Responses to various options for control of dengue fever are given in Table 7.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>% checked out</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Using vaccine</td>
<td>04.74</td>
</tr>
<tr>
<td>b. Mass awareness</td>
<td>26.32</td>
</tr>
<tr>
<td>programme</td>
<td></td>
</tr>
<tr>
<td>c. Preventive measures</td>
<td>28.95</td>
</tr>
<tr>
<td>d. Mosquito-impregnated nets</td>
<td>05.26</td>
</tr>
<tr>
<td>Combination of b &amp; c</td>
<td>12.11</td>
</tr>
<tr>
<td>Combination of c &amp; d</td>
<td>10.00</td>
</tr>
<tr>
<td>Not known</td>
<td>12.62</td>
</tr>
</tbody>
</table>

A majority of the physicians were not clear about dengue prevention and control strategies.

14. Anti-dengue vaccines

When asked if anti-dengue vaccines were available, a majority (62.11%) said an
emphatic 'no' while 8.42% said 'yes'. 29.47% of the respondents did not specify.

Results, discussion and conclusions

This study showed that a majority of the physicians had a good clinical knowledge but lacked epidemiological comprehension of dengue fever. Most of them came out with the correct answer with regard to the causative agent of DF (virus:77.37%) and prime diagnostic tools (serology: 73.16%). They also showed a good awareness of the most common disease manifestation (61.58%) and appropriate treatment (general measures: 38.95% and antibiotics plus general measures: 42.63%) despite the fact that only 9.47% of the respondents reported to have had inservice training on arbovirus diseases and 94.74% did not have any kind of information exchange with others on dengue. For clinical assessment of a suspected case, only 16.32% of the physicians were correct in their response to consider 6-15 years age group to be the most vulnerable and affected. On epidemiological comprehension, the physicians were found lacking in the knowledge. There was a positive and constructive thinking on the methods to control this viral disease. A total of 67.38% of the respondents suggested either a mass awareness programme or preventive measures or a combination of both.

The findings on the two different aspects of dengue infection, when summed up, confirmed the earlier impression as far as the knowledge of physicians about DF was concerned. The physicians did have the essential clinical knowledge but lacked information of epidemiological importance on dengue.

References


Use of Geographical Information System to Study the Epidemiology of Dengue Haemorrhagic Fever in Thailand

By

Ratana Sithiprasasna, Kenneth J. Linthicum
Department of Entomology, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand

Kriangkrai Lerdthusnee
National Centre for Genetic Engineering and Biotechnology, Rama VI Road, Bangkok 10400, Thailand

Thomas G. Brewer
Headquarters, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand

Abstract

A Geographical Information System (GIS) was used to study the spatial distribution of dengue haemorrhagic fever (DHF) in Thailand. The National Oceanic and Atmospheric Administration (NOAA) satellite data, with a spatial resolution of 1 km, were used to produce a land cover map and calculate the percentage of forest cover in each province of Thailand. GIS was used as an analysis tool to map the distribution of DHF by creating overlays of epidemiological and digitized province data on a NOAA normalized difference vegetation index image of Thailand. The countrywide GIS database demonstrated that DHF incidence was not correlated to the area of forest cover in the provinces of Thailand. Global Positioning System (GPS) instruments were used to map villages involved in dengue epidemiological studies in Tak province. Differentially processed GPS data with a spatial resolution of approximately 1 metre were incorporated into a GIS for analysis and mapping. Databases associated with a village GIS included village name, house number, demographic data on house occupants, Aedes aegypti populations, Ae. aegypti immature breeding sites and seroepidemiology data on house occupants.

Introduction

Dengue virus infection can result in a wide range of clinical symptoms, including asymptomatic infection, undifferentiated febrile illness, classical dengue fever, dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), which are associated with significant morbidity and mortality. Factors that are involved in the progression of classical dengue fever to DHF and DSS are not well known. Dengue infection occurs after the bite of a competent mosquito vector, primarily Aedes aegypti, that is infected with one of the four dengue virus serotypes. An
analysis of the incidence of DHF cases in Bangkok\(^4\) and experimental studies on the vector efficiency of *Ae. aegypti*\(^5\) suggest that the number of DHF cases is greatly affected by temperature-induced variation in the vectorial capacity of the vector. The spatial distribution of DHF is dependent upon the presence of *Ae. aegypti* or another suitable vector and viremic and susceptible human hosts.

The Geographical Information System (GIS) databases have been recently used to monitor factors affecting disease transmission\(^6\). Recent studies have demonstrated that satellite imagery, digitized land-use maps and global positioning data are promising for predicting changes in habitats of mosquito vectors as they affect disease transmission\(^7\)\(^-\)\(^10\). In this study epidemiological, digital, satellite and Global Positioning System (GPS) data have been incorporated into GIS databases to better understand the spatial distribution of DHF in Thailand.

**Materials and methods**

Digital remote sensing data were produced by the advanced very high resolution radiometer (AVHRR) sensor on polar-orbiting satellites operated by the National Oceanic and Atmospheric Administration (NOAA). The AVHRR records visible, near-infrared and thermal channels of the electromagnetic spectrum. The characteristics of the NOAA AVHRR have been described previously by Linthicum et al\(^8\). The normalized difference vegetation index (NDVI) analysed in this study is a transformation between data from the visible channel and the near-infrared channel. The NDVI data have been shown to be highly correlated with green-leaf biomass and represent the photosynthetic capacity of the area measured. The NDVI data were calculated for NOAA satellite coverages of Thailand for ten dates between December 1992 and April 1993. Data from different dates were then composited by selecting the highest NDVI for each grid cell location. These data have been used as thematic raster base map for displaying DHF incidence by province. The raster map is displayed in a Latitude/Longitude Coordinate system and are georeferenced using the Indian 1975 Datum and Everest 1830 (1975 Definition) Ellipsoid. These data also have been used to calculate forest cover in provinces using unsupervised and supervised classification methods to create vector maps of forest cover\(^11\).

Provincial border boundary data for Thailand were digitized using MapInfo software\(^12\). DHF case data were reported by provincial health offices and published by the Ministry of Health, Thailand\(^13\),\(^14\). The province population data were provided by the Ministry of Interior, Thailand. The DHF incidence was calculated as the number of cases of reported DHF/100 000 population of the province.

The position of houses in three villages in Tak province, Thailand, were mapped using a Trimble Geoeplorer GPS instrument as the rover unit. A Trimble Pathfinder Pro XL GPS instrument was run as a base station at our laboratory in Bangkok (13° 45’ 58.878” N Latitude, 100° 32’ 08.504” E Longitude). Both rover and base station units were run simultaneously to allow differential correction of rover data using Trimble software\(^15\). The regression between DHF incidence and per cent
Results and discussion

The distribution of the DHF incidence in 1996 in the provinces of Thailand is shown in Insert A. The relative size of the yellow circle represents the incidence of DHF as indicated in the legend. The darkest green colors on the NOAA/NDVI satellite data-generated base map represent forested areas of Thailand. Approximately 70,000 cases of DHF were reported in 1996. This suggests that there were at least 7,000,000 dengue infections in Thailand during 1996 based upon a conservative ratio of 1 DHF case/100 dengue infections \( (17) \). The DHF incidence ranged from 0 to 220/100,000 population. The highest incidence occurred in Tak province in the central-western part of the country bordering Myanmar. High incidence was also observed in several provinces bordering Laos and Cambodia in eastern Thailand. Lowest incidence of transmission was observed in the northermost and southern-most provinces. It appeared to the authors that most of the DHF occurs in provinces of the central plains and Korat plateau in the east, with the exception of Tak province. Most of these provinces have little forest cover.

The relationship between the DHF incidence and forest cover is shown in Figure 1. There is no correlation between disease incidence and forest cover \( (R^2 = 0.001, F = 0.05, P = 0.83) \). The primary mosquito vector of DHF in Thailand, *Ae. aegypti*, is a species that is closely associated with humans and breeds in artificial containers associated with human habitation, and it is not ecologically linked to forests. Furthermore, most human habitations in Thailand are not associated with forest. For these reasons and from the distribution of DHF illustrated in Insert A, the authors suspected that there might be a negative correlation between forest cover and DHF incidence. Malaria incidence in Thailand, where the mosquito vector is closely linked to forests (*Anopheles virus*), has been strongly correlated with forest cover \( (16) \). The relationship between DHF transmission and ecological variables might be better evaluated by analysing temporal data with GIS.

Figure 2 shows a small portion of the GIS map and database created for one of the three villages that was mapped with a GPS instrument. The GPS data were subjected to differential processing to create a map with a spatial resolution of one metre. These data were then imported into a GIS and a new database created that included village name and house number (portion of data shown), and demographic data on house occupants, adult and immature *Aedes aegypti* populations, *Ae. aegypti* immature breeding sites and seroepidemiology data on house occupants (data not shown). These GIS relational databases are being used as a powerful tool to monitor the status of efforts to control *Ae. aegypti* breeding sites and to evaluate the impact of this control effort on dengue and DHF transmission.
Figure 1. Relationship between per cent forest cover and dengue haemorrhagic fever incidence/100,000 population for the year 1993 for all provinces of Thailand.

Figure 2. Portion of GIS map and database for a village in Tak Province, Thailand.

House locations shown by circle with a spatial resolution of 1 metre.
Historically, maps describing the spatial distribution of DHF and other diseases have been limited to hand-drawn representations on pre-existing maps. GIS, with new advances in image processing and GPS to georeference databases, provides a new and powerful tool to efficiently store, retrieve and interpret DHF databases for epidemiology, ecology and control studies.

References

Insert A

Distribution of dengue haemorrhagic fever incidence/100 000 population for the year 1996 in different provinces of Thailand plotted on provincial boundary layer in a GIS. NOAA/NDVI satellite image showing forest cover in dark green colour used for base map. Water shown in dark black colour.
Hospital-based Retrospective Assessment of Dengue Infection among Filipinos

By

Maria Rosario Z. Capeding and Fem Julia Paladin

Research Institute for Tropical Medicine,
Alabang, Muntinlupa City, Metro Manila, Philippines

Abstract

Dengue infection has increasingly become a significant public health problem in the Philippines. Clinical and laboratory data of confirmed dengue infections in children and adults admitted and referred at a research centre for infectious diseases over an eight-year period (1986-1994) were reviewed. This report highlights the epidemiological pattern of dengue infections among Filipinos.

Introduction

Dengue infections caused by four serologically-related flaviviruses, DEN-1, 2, 3 and 4, are a major cause of morbidity and mortality among children and adults in both industrialized and developing countries, and are significantly occurring in tropical areas of the world. In the Philippines, the disease continues to be a major public health problem since 1954.

Materials and methods

Clinical and laboratory data of confirmed dengue infection in children and adults admitted and referred at the Research Institute for Tropical Medicine (RITM) over an eight-year period (1986-1994) were reviewed. The RITM virology laboratory is the national reference centre for dengue infection in the Philippines. Virological studies include virus isolation using sensitive mosquito cell lines, namely, C6/36 cells derived from Aedes albopictus and TRA-84 SFG from Toxorhynchites amboinensis as well as serodiagnosis by haemagglutination-inhibition (HI) test. The infecting viral serotypes were determined by immunofluorescence method, using dengue-type specific monoclonal antibodies obtained from the Center for Disease Control, Fort Collins, U.S.A.

Results

A total of 283 patients had confirmed dengue infection. Of these, 57 (20%) were confirmed by culture alone, 157 (55%) by
serology alone, and 69 (24%) were diagnosed both by virus isolation and serology.

Only DEN serotypes 1, 2 and 3 were isolated. The most frequent infecting virus was DEN type 2 (52.41%), followed by type 1 (44.35%) and type 3 (30.24%). Of the 226 patients in whom dengue was diagnosed by HI based on the antibody response using the WHO criteria(1), 112 (50%) had definite secondary infection, 59 (26%) presumptive secondary infection, 43 (19%) primary antibody response and 12 (5%) possibly primary or secondary antibody response (Table). Dengue fever (DF) and dengue haemorrhagic fever (DHF) Gr. II were the most common clinical syndromes(1) in the majority of patients with secondary type of antibody response.

### Table. Clinical diagnosis of serologically-confirmed dengue patients

<table>
<thead>
<tr>
<th>Antibody Response</th>
<th>Total No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1o 2 o 1 o or 2o Presumptive 2o</td>
<td></td>
</tr>
<tr>
<td><strong>WHO clinical Classification</strong></td>
<td>1*</td>
</tr>
<tr>
<td>Dengue Fever (DF)</td>
<td>16</td>
</tr>
<tr>
<td>DHF Grade I</td>
<td>12</td>
</tr>
<tr>
<td>II</td>
<td>6</td>
</tr>
<tr>
<td>III</td>
<td>3</td>
</tr>
<tr>
<td>IV</td>
<td>–</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>37 (19%)</td>
</tr>
</tbody>
</table>

* 202 patients with clinical data available

The median age of patients was six years (range eight months to 53 years); 156 (55%) were males and 128 (45%) were females. From 1986 to 1991, a majority or 71 (46%) of the dengue cases occurred among 5-9-year olds; 52 (33%) between 1-4 years; 17 (11%) <1 year and 15 (10%) of the cases occurred among >20-year old people. From 1992 to 1994, 15 (18%) of the cases occurred in 20-years-old people, 25% or 30% between 10-19 years; 19 (23%) in 5-9-year age group; 17(20%) in 1-4 years; and 8 (9%) in <1 year of age.

All patients had symptoms of acute febrile illness. Only 239 patients had clinical data available. Frequent signs and symptoms were: abdominal pain (61%); headache (42%); flushing (40%); hepatomegaly (39%); vomiting and nausea (37%); myalgia (21%) and arthralgia (21%). Common haemorrhagic manifestations were: petechiae (40%); epistaxis (36%); hematemesis or melena (22%); Hermann's rash (17%) and gum bleeding (13%). Twenty-two patients had dengue shock syndrome (DSS), four of whom went into profound shock. Of the 239 patients, eight died, a mortality rate of 3%. Pleural effusion was seen in 8 (3%) of cases. Thrombocytopenia (platelet count 100,000) and hemoconcentration (hematocrit value of >40 volume% or a rise of >20% of the baseline) were noted in only 25% and 67%, respectively.

### Discussion

The data on laboratory-confirmed dengue infections over the last eight years is an underestimate of the epidemiology of the disease in the country and could be due to the absence of an active surveillance system to monitor clinical cases and the inaccessibility to a virology laboratory for diagnostic confirmation.
Prevention and control of dengue infection are dependent on an effective surveillance system. The Center for Disease Control recommends five basic types of useful active dengue surveillance systems\(^2\). During interepidemic periods or lag phase when there are only sporadic dengue cases, the introduction of a new virus serotype serves as a warning of an epidemic transmission. In this review, for example, during the last two years, only DEN types 1 and 2 had been isolated. The reappearance of DEN type 3 or the introduction of type 4 will predict a potential dengue epidemic; therefore, health authorities should intensify surveillance activities and start effective control measures to avert such occurrence. The isolation of DEN type 4 has not been reported in the country; however, it is premature to conclude that this serotype is not present in the country since all four dengue serotypes have been documented in south-east Asia\(^3\). The transmission of this serotype may be of low level and may also vary in geographical distribution.

In this report, a high proportion of dengue cases had secondary type of antibody response which clearly demonstrates the endemicity of dengue in the country. In spite of the secondary type of antibody response observed in most patients where dengue shock syndrome (DSS) is expected more often to occur, only 4% of the patients manifested DSS. Unlike in other south-east Asian countries\(^4\) where secondary infection is associated with DSS, in the Philippines a majority did not progress into DSS. Halstead proposed that DHF was due to a self-destructive host response and some persons were sensitized by their first infection and the course of a second infection with a different serotype may be altered adversely by the immune response\(^5\). Some genetic factors may also determine the clinical outcome in dengue.

During the 1980s, the highest incidence of dengue occurred more frequently in young children. Studies from 1990s showed an increasing proportion of dengue cases among older children and young adults. This latter finding was likewise observed in a 10-year review of dengue patients\(^6\). Multiple dengue serotypes may be transmitted at relatively low rates of infection and previously uninfected adults may become susceptible to the disease.

The clinical and laboratory findings in this study are similar to those reported from studies on Filipino patients\(^7,8,9,10\). A majority had mild haemorrhagic manifestations. Thrombocytopenia and haemoconcentration, which are essential laboratory features in DHF, were observed in only 25% and 67% of patients, respectively. Since the first reported case of dengue fever in the Philippines in 1954, paediatricians have recognized dengue infection as an important clinical problem. The low fatality rate could be due to an early recognition of the disease by parents and a timely and appropriate medical care by physicians.

Acknowledgements

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References


Further Evaluation of Indoor Resting Boxes for *Aedes aegypti* Surveillance

By

**Pattamaporn Kittayapong**

*Department of Biology, Faculty of Science, Mahidol University, Bangkok, Thailand*

**Kenneth J. Linthicum**

*Department of Entomology, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand*

**John D. Edman**

*Department of Entomology, University of Massachusetts, Amherst, Massachusetts, U.S.A.*

**Thomas W, Scott**

*Department of Entomology, University of California, Davis, California, U.S.A.*

**Abstract**

Several types, locations and intervals of artificial resting boxes were evaluated for their ability to attract *Aedes aegypti* males and females resting in houses in Thailand. Overall, 34% of both male and female *Ae. aegypti* captured resting inside houses were collected from the resting boxes. Boxes with black cloth strips covering the entrance attracted the same number of males and females as boxes without strips. There was no significant difference between the mean number of females collected in small resting boxes, with an inside surface area of about one-fifth the surface area of the larger boxes, and the larger boxes. However, significantly, fewer males were collected in the smaller box. The length of time during which the box was placed in the house prior to sampling, either a 15-17-hour interval from evening to the next morning or a 3-4-hour interval in the morning, had no effect on the number of mosquitoes collected. The position where the box was located in the house had more effect on the number of females resting in the box than it did on the number of males. Boxes placed in the dark corners of the house attracted more resting females than those placed in the lighted, open areas, usually in the middle of the house; however, the differences were not significant. The findings further confirm that resting boxes are practical for use in routine sampling of *Ae. aegypti* inside houses. Small boxes can be transported conveniently and are as efficient for collecting females as larger boxes. Boxes can be placed in lighted or dark areas of a house for as little as 3-4 hours to sample the *Ae. aegypti* house population.
Further Evaluation of Indoor Resting Boxes for Aedes aegypti Surveillance

Introduction

The importance of *Aedes aegypti* as a vector has led to the development and use of various methods for sampling mosquito populations to assess the potential risk to humans from dengue and yellow fever viruses\(^1\). Ovitraps are used to sample the gravid female population, and larval collection data are used to calculate House, Container and Breteau indices to assess the degree of infestation. These methods are very labour-intensive and only provide an indirect measure of the *Aedes* population. Day-time human biting collections have been the most common method for sampling adult populations, but this method has significant cost, time and sampling bias limitations\(^2\). Use of hand-held aspirators to collect adults resting in houses has been a significant improvement\(^3,4\).

Attractant resting boxes have been developed and found to be an efficient and rapid method to sample male and teneral, blood-fed and gravid female *Ae. aegypti* resting inside houses in Thailand\(^2\) and Puerto Rico\(^4\). This paper describes further experiments to refine the design and implementation of the attractant resting boxes.

Materials and methods

The resting box design was similar to that used in our previous experiments, with some modification of the dimensions and the front panel as shown in Figure 1\(^2\). The inside surface of the box was covered with black muslin cloth while the outside was covered with black non-reflective paper. The standard box design was 25 cm x 23 cm x 40 cm in size and the top half of the opening of the box was covered by a piece of black cloth.

Twelve houses in Village No. 2, Hua Sam Rong Subdistrict, Plaeng Yao District, Chachoengsao Province, Thailand, were used in each of the four experiments. The experiments were designed to evaluate whether (1) the cover of the box entrance, (2) the size of the box, (3) the time period during which the box was placed in the house, and (4) the position in the house where the box was located had any effect on its efficiency to attract *Ae. aegypti* mosquitoes.

Resting boxes were placed in houses the evening before the first day of collection, except for the experiment that evaluated the length of time during which the boxes were deployed. The location of boxes in each house was rotated daily in all experiments to avoid position effect. Mosquitoes were collected by an electric vacuum aspirator\(^5\). Aspiration normally required about two minutes for each resting box and 10 minutes for the rest of the inside of each house. Collections were conducted for a total of 12 consecutive days. Mosquitoes from each collection were killed by freezing and transferred from the collecting containers to labelled plastic vials. They were then transported on ice to the laboratory at Mahidol University in Bangkok where mosquitoes other than *Ae. aegypti* were removed. Individual *Ae. aegypti* males and females collected from the resting boxes and from inside houses were counted and the number recorded. All data were analysed by ANOVA using SPSS windows Release 6.0.ed\(^6\).
Covering of box entrance. To evaluate whether covering the entrance of the box had an effect on the number of mosquitoes entering the box, boxes with pieces of one-inch-wide black cloth strips covering the box entrance were compared with the standard box design (Figure 1). Two resting boxes, one standard design and one with cloth strips, were placed in each house.

Reduction in the size of box. To evaluate the efficiency of a smaller version of the box to attract mosquitoes, a standard box and a small resting box were placed in each of the 12 houses. The smaller version was 17 cm x 22 cm x 26 cm in size and had an inside surface area that was about one-fifth that of the larger box (Figure 1).

Length of time for placement of box in house. Large boxes were placed in the houses for different time-periods to determine if time had any effect on the number of resting mosquitoes. One group of resting boxes was placed in six houses in the afternoon (1600-1700 hrs) and mosquitoes were aspirated from them at 0800 hrs the next morning. A second group of boxes was placed in six houses in the morning at 0800-0900 hrs and mosquitoes collected from them at 1200-1300 hrs on the same day.

Location of resting box. To determine whether the location of a box in a house had any effect on the number of mosquitoes collected, a large box was placed in a lighted or dark area of a house. A single box was placed in each of the 12 houses. In six houses a box was placed in a dark corner of the house, while in the other six houses boxes were placed in a lighted area, usually in the middle of the house.

Results and discussion

Effect of black cloth strips at the covering of box entrance. A total of 875 male and 439 female Ae. aegypti were collected in 12 houses during the 12 consecutive days of this experiment. Approximately 34% of the males and females were collected in the resting boxes. Although the mean number of both males and females collected/house/day in large boxes was approximately twice that collected in the boxes with black strips of cloth, due to variation in the number of mosquitoes collected the differences were not significant (P = 0.1) (Figure 2). The design of the large box was preferred because it appeared to attract more mosquitoes and because it was easier to make than the box with the strips.

Effect of reducing the size of box. A total of 727 male and 362 female Ae. aegypti were collected from 12 houses during the 12 days of this experiment. Approximately 52% of the males and 49% of the females were collected in the boxes. The mean number of females collected/house/day in the large box (0.69) was greater than that collected in the smaller box (0.54), but the difference was not significant (Figure 3). There were significantly more males collected in the large box (mean number/house/day = 1.6) than in the smaller box (mean number/house/day = 1.0) (P < 0.005). Use of the small box would increase the ease of transporting the boxes; however, the proportion of males collected would be reduced.
Figure 1. Diagram of the 3 resting box designs evaluated for collecting *Ae. aegypti* inside houses in Village No. 2, Hua Sam Rong Subdistrict, Chachoengsao Province, Thailand.

Figure 2. Comparison of the mean number of male and female *Ae. aegypti* (N = 1, 314) collected from large resting boxes vs. black strip boxes vs. the remainder of the house.
Figure 3. Comparison of the mean number of male and female *Ae. aegypti* (N = 1, 089) collected from small resting boxes vs. large boxes vs. the remainder of the house.

Figure 4. Comparison of the mean number of male and female *Ae. aegypti* (N = 1, 023) collected from large boxes placed in house 15-17 hours vs. boxes placed 3-4 hours vs. the remainder of the house.
Effect of length of time of box placement in house. A total of 725 male and 298 female Ae. aegypti were collected from 12 houses during the 12 days of this experiment. Approximately 34% of females and 30% of males were collected in boxes. There were approximately 0.7 females and 1.5 males collected/house/day in the boxes after both the 15-17-hour and 3-4-hour placement periods (Figure 4). These results indicated that placement of the box for just a few hours was sufficient to obtain a representative sample of mosquitoes in a house.

Effect of box location in the house. In this experiment a total of 603 male and 255 female Ae. aegypti mosquitoes were collected from all 12 houses during 12 consecutive days. There were significantly more males than females collected in the boxes (P < 0.05). The mean number of males collected/house/day in boxes placed both in light and dark areas was approximately 1.0 (Figure 5). Although the mean number of females collected/house/day in boxes placed in the dark (0.5) was greater than that in the boxes placed in the light (0.3), the difference was not significantly different (P = 0.06).

Conclusions
Observations from this study confirm the earlier findings that artificial resting boxes are practical for use in routine sampling of Ae. aegypti inside houses\(^2\). Small boxes which can be transported more conveniently are almost as efficient as larger...
Further Evaluation of Indoor Resting Boxes for Aedes aegypti Surveillance

boxes in attracting mosquitoes. Although the smaller box underestimates the population of males, this size box might still be used to prevent or suppress dengue transmission, if impregnated with non-repellent insecticides\(^{(2)}\). Boxes can be placed in lighted or dark areas of a house for as little as 3-4 hours to obtain a representative sample of the \textit{Ae. aegypti} population.

Acknowledgements

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References


Prevalence of *Aedes aegypti* and *Aedes albopictus*—Vectors of Dengue and Dengue haemorrhagic fever in North, North-East and Central India*

By

**N.L. Kalra**
Consultant (Malaria Research Centre), 20 Madhuban, Vikas Marg, Delhi – 110092

**S.M. Kaul**
Joint Director, National Malaria Eradication Programme, 22 Sham Nath Marg, Delhi – 110054

and

**R.M. Rastogi**
Malaria Unit, WHO/SEARO, New Delhi – 110002

**Abstract**

The *Aedes aegypti* mosquito vector was found to be prevalent in the western, northern, Indo-Gangetic and eastern plains, Assam valley and the coastal areas of Orissa state in India. The species was non-existent in the Himalayan region. In north-central highlands, the species showed low-to-moderate prevalence; while in south-central highlands, the mountainous areas were largely free but high populations of the vector were encountered in the valleys. Similarly, the eastern plateau, including the eastern ghats were comparatively free of the vector except large towns in the Mahanadi basin. The Satpura ranges of north Deccan were also found to be free of *Ae. aegypti*.

The elevation, type of relief, terrain, density of population, water storage practices in drought-prone regions and high rainfall leading to formation of secondary foci had direct relationship with the prevalence of the species. Altitudes above 1000 metres were found to be unfavourable for the species.

Being hygroscopic, the species depicted a phenomenon of ‘annual pulsation’. It tends to move to ‘mother foci’ in the central parts of cities which are humid during the dry season and spreads out during the wet season.

*Aedes albopictus* was encountered in the peripheral areas of towns where it replaced the *Ae. aegypti* populations. However, in the eastern plateau, the species penetrated up to the central parts, probably due to lack of intra-species competition from *aegypti* which is very scanty in the region.

The information proved to be of immense value in delimiting areas which were prone to DF/DHF epidemics. The internal dynamics provided useful information for developing control strategies.

*This study was funded by the Indian Council of Medical Research, New Delhi*
Introduction

Dengue epidemics have been known to occur over the last two centuries in tropical and subtropical areas of the world. However, the role of the mosquito *Aedes aegypti* as the vector of this arbovirus has been known only during the past 70 years\(^1\). In 1953-54 a new disease syndrome associated with dengue appeared in the Philippines, which later spread throughout south-east Asia and the Western and South Pacific. Unlike classical dengue which causes only morbidity, this disease entity affected young children and caused severe illness with haemorrhage and shock, resulting in high mortality, and earning a name for itself as dengue haemorrhagic fever/dengue shock syndrome or DHF/DSS.

In India, the association of haemorrhagic manifestations were noticed for the first time in an outbreak in Calcutta in 1963. In this outbreak both the viruses, i.e. dengue and Chikungunya, were found to be circulating together\(^2\). Since then the country has reported several dengue outbreaks in different parts of the country with manifestations of haemorrhagic symptoms in varying degrees. To assess the receptivity of different geographical areas of the country to this infection, an attempt was made to determine the distribution of *Aedes aegypti* in 1968, based upon the museum collection of the National Institute of Communicable Diseases\(^3\). Since this collection was not representative of the whole country, a comprehensive study was launched in 1969 to assess the extent and intensity of the prevalence of *Aedes aegypti*, the suspected vector in the country. This paper highlights the results of five years of inquiry.

Study areas

The study covered ten physiological regions of India, viz. (i) Himalayan region; (ii) Western plains; (iii) Northern plains; (iv) Indo-Gangetic plains; (v) Eastern plains; (vi) Central highlands; (vii) North Deccan; (viii) Eastern plateau; (ix) Coastal plains of Orissa, and (x) Assam valley and the states of Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana, Chandigarh, Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, Orissa, and West Bengal (Fig.1).

Material and methods

In the present study the conventional methods of *Aedes* survey as adopted by the National Institute of Communicable Diseases (NICD) for outbreak studies were followed\(^4\). As the scope of the study was limited to determining the distribution of the species, the information was collected on the following aspects:

(i) Occurrence (as evinced by indigenous breeding), and
(ii) Intensity of infestation (No. of houses found positive per ward)

House (premises) Index:

\[
\frac{\text{No. of houses positive for } Aedes \text{ larvae}}{\text{No. of houses examined}} \times 100
\]
For information collection, 10 to 40 towns, depending on size and population, were selected in each region. Towns/cities were divided into wards/localities and 50 houses selected at random were examined in each ward. Wherever the *aegypti* population reached the peripheral limit, the searches were extended to the adjoining rural areas as well. Each region was surveyed twice corresponding to dry season (March to June) and wet season (July to October).

Searches were carried out in domestic, peridomestic and extra-domestic habitats. Tree holes were the principal habitats examined under extra-domestic situations.

**Observations**

During the period 1969-1973, a total of 203 towns/cities covering ten physiographical regions corresponding to dry and wet seasons were surveyed, except Assam, Kashmir valley and towns in West Bengal which were surveyed during the dry season only. The houses in towns/cities investigated during dry and wet seasons for *Aedes aegypti* and *Aedes albopictus* are included in Inserts B and C. An analysis of the data indicated the following patterns of distribution.

**1. Himalayan region**

A total of 20 towns spread over south Kashmir Himalayas, Punjab Himalayas, Kumaon hills and eastern Himalayas were...
Prevalence of Aedes aegypti and Aedes albopictus–Vectors of Dengue and DHF in India

investigated. The majority of the areas investigated had an elevation above 500 metres. The region was found to be completely free of *Aedes aegypti*. *Aedes albopictus* was found to be the predominant species in Punjab Himalayas, while in south Kashmir Himalayas and Kumaon hills, its prevalence was scanty.

2. Western plains

The area includes the arid zone of moving sand dunes commonly known as “Thar desert” situated between the Indus plain dunes on the west and Rajasthan upland in the south-east. The area is very thinly populated due to extreme scarcity of water.

The *Aedes aegypti* population seems to be fully entrenched in the area and shows perennial prevalence. In Sikar, it was found to infiltrate into rural areas during the wet season. Water scarcity and the resulting water storage practices were determined as the main factor for the high build-up of *Aedes* population.

*Aedes albopictus* was encountered both during dry and wet seasons in the peripheral areas of towns/cities.

3. Northern plains

The region includes the plains of Punjab and Haryana. Major rivers in the Punjab region are Sutlej and Beas, which have long mountainous courses and provide a large network of canals for irrigation purposes. The south-western parts of Haryana face an acute shortage of water. The whole area is densely populated and is one of the richest wheat-growing areas of the country.

The *Aedes aegypti* population depicted low-to-moderate rates of positivity, except in water-scarce areas of Haryana (Ambala, Panipat, Rewari and Rohtak), where a large population builds up particularly during the wet season.

4. Indo-Gangetic plains

The Indo-Gangetic plains comprise Ganga-Jamuna *doab* (which literally means area lying between two rivers), Rohilkhand plains and Avadh plains. Of the *doabs* of India, the Ganga-Jamuna *doab* is by far the largest and most fertile and densely populated area. The elevation and character of the flood plains change within the *doabs*. On the east are the low-lying Rohilkhand and Avadh plains. These plains are seamed with deserted rivers. The Ramganga and Sarda rivers meander through the Rohilkhand plains and lower reaches of Gomti and Ghaghra flow through the Avadh plains. On the north, these plains are bordered by the narrow waterless sandy belts of Bhabar and the swampy belt of alluvial soil (Terai), supporting vast expanses of marshy land with luxuriant growth of vegetation.

The *Aedes aegypti* population seems to have achieved ecological stability in the Ganga-Jamuna *doab* areas. Most of the towns were found to be positive both during dry and wet seasons, indicating a perennial prevalence of the species. Proximity of the towns near the two great rivers, which provide riverine routes for the dispersal of the species and high density of human population, seems to have
provided a foothold to the species in this region.

Both in Rohilkhand and Avadh plains, the *Aedes aegypti* population were detected in wet season only, except in some large towns (e.g. Lucknow and Jaunpur) or towns which are situated on the bank of the river Ganga (e.g. aranasi). A gradual decline in the incidence of the species could be observed as one proceeded towards the swampy and marshy Terai and Bhabar regions in the north.

The *Aedes albopictus* populations were more pronounced in the Rohilkhand and Avadh plains than in Ganga-Jamuna doab. This may be due to the abundance of natural vegetation cover provided by the forested areas in the region.

5. Eastern plains

The eastern plains are further divided into north Bihar plains, south Bihar Plains, north Bengal plains and Bengal basin. The Ganga flows along the southern border of the north Bihar plains, receiving on its left bank three of the major Himalayan rivers - Ghaghra, Gandak and Kosi. A long line of marshy stretch extends from east of Chhapra to Khagaria. North Bengal plains extend from the foot of the eastern Himalayas to the northern limits of the Bengal basin. The region is drained by tributaries of the Ganga and the Brahmaputra. South of Duars, the plains are more flattish and get waterlogged. The Bengal basin embraces most of the alluvial plains of West Bengal and includes the great Ganga delta.

The *Aedes aegypti* populations showed a definite relationship with the terrain. These were found to be quite stable both in the south Bihar plains and the Bengal basin. Both the regions are vulnerable to repeated introduction of the species through the Ganga, which has a lot of riverine traffic. Both in north Bihar and north Bengal plains the species was either absent or had a scanty prevalence. This may be due to the terrain features which support extensive vegetation and lack navigational facilities in its river system.

*Aedes albopictus* was found in negligible numbers in peripheral areas of large towns.

6. Central highlands

The Central highlands is a wide belt of hilly country bordered on the west by the Aravalli range and on the south by the Satpura range. This physiographical region separates the Great Plains from peninsular plateaus. It is further divided into two divisions, namely, north-central highland, which includes the Aravalli range, east Rajasthan uplands, Madhya Bharat *pathar* and Bundelkhand uplands. The Aravalli range extends south-west for a distance of 800 km, in which Abu Hills (1722 m) is the highest peak. East Rajasthan uplands lie on the east of Aravalli, ranging in height from 250 to 500 metres. Madhya Bharat *pathar* is...
The south-central highlands include the Malwa plateau, which is built of lava with rolling surface and flat-topped forested hills with a number of flowing rivers. East of the Malwa plateau is a series of plateaus at different levels collectively known as Vindhyan scarplands. On the south it is bordered by the Vindhya range. Skirting the roots of the Vindhya range and sandwiched between Vindhya and Satpura extends the Narmada valley from east to west.

*Aedes aegypti* depicts differential patterns of prevalence in the north-central and south-central highlands. In north-central highlands the species is fairly widespread particularly in the east Rajasthan uplands and Malwa plateau. Water scarcity and the resultant water storage practices seem to be the single most important factor promoting the stability of the species. It is less common in Madhya Bharat *pathar* because of the hilly and forested nature of the region.

South-central highlands are comparatively free of *A. aegypti* except in large towns situated in the Narmada valley (Jabalpur and Sagar), which showed year-round prevalence of the species. In other large towns of the region, the species was detected during the wet season only.

*Aedes albopictus* also depicted a similar pattern of distribution. It was much more pronounced in north-central highlands and was scanty in south-central highlands. The species was always encountered in peripheral areas.

7. North Deccan

North Deccan is part of the peninsular plateau which is one of the largest physiographical divisions of India. North Deccan comprises the Satpura range and the Maharashtra plateau. The Satpura broadens out considerably in the central part bordered on the north by the Mahadeo hills and on the south by the Gwalgarh hills.

*Ae. aegypti* was found to be completely absent in this region. This may be due to the hilly nature of the terrain, which has been observed to be inhospitable for the species in India. However, *Ae. albopictus* was the common species encountered in the region during the wet season.

8. Eastern plateau

The Eastern plateau has a much more diversified topography than the Deccan plateau. It comprises the Chhota Nagpur plateau, Garhjat hills, the Mahanadi basin and the Dandakarnya area. The Chhota Nagpur plateau consists of perfect basin surrounded by hills rising from 600 to 1000 m. Dandakarnya is also a forested and hilly area.

The Eastern *ghats* are essentially a coastal range. This range exhibits its true mountain character between the Godavari and the Mahanadi.

*Aedes aegypti* are commonly unstable in this area. Low densities of the species were encountered in the industrial towns of Dhanbad and Jamshedpur in the Chhota Nagpur plateau. In other towns the species
seemed to infiltrate during the wet season from the adjoining south Bihar plains.

In the eastern plateau, the species was found restricted to towns situated in the Mahanadi basin only where it perhaps got introduced from the coastal plains. The eastern ghats were found to be free of *Aedes aegypti* population.

*Aedes albopictus* was the dominant species in the region, particularly in the eastern plateau. The species was found to invade practically entire towns during the wet season.

9. Coastal plains of Orissa

The eastern coastal plains of Orissa are much drier and wider than their counterpart in the west. These are also known as Utkal plains and include the Mahanadi delta.

Out of the ten towns surveyed in the region, five towns situated on the coast were found positive for *Aedes aegypti* both during dry and wet seasons. In the other five towns which had proximity to the hilly terrain of the eastern ghat and Gharjat hills were found negative for the species. *Aedes albopictus* continued to be the dominant species in this region and was encountered in both dry and wet seasons.

10. Assam valley

The valley, occupied by the middle course of the Brahmaputra, stretches for nearly 600 kms. The valley is linked with the Ganga plains by the plains of north Bihar. The upper Assam valley, because of its marshy nature, is sparsely populated, while the lower Assam valley is densely populated. The areas receive heavy rainfall from south-western monsoons.

The survey was carried out only during the dry season and it was observed that *Aedes aegypti* was endemic in the entire valley. House indices were observed to be quite high.

*Aedes albopictus* was the dominant species in the peripheral areas of towns and was detected in high densities.

Conclusions

The studies carried out in north and north-east India indicated that *Aedes aegypti* was endemic in the western plains (Thar desert), northern plains (Punjab and Haryana), Indo-Gangetic plains, eastern plains (Bihar and Bengal basin), Assam valley and the coastal areas of Orissa. The species was found to be completely non-existent in the Himalayan region. In north-central high-lands, the species showed a low-to-moderate prevalence, but in south-central highlands, the mountainous areas were largely free but high populations were recorded in the Narmada valley. The eastern plateau, including the eastern ghats, were comparatively free except some prevalence in the towns situated in the Mahanadi basin. The Satpura ranges of north Deccan were also found to be free of *Ae. Aegypti*.

The *Aedes aegypti* population in this region depicted a terrain-bound phenomenon as determined by Kalra et al (3).
The elevation, type of relief, terrain, population density and water storage practices were found to have a direct relationship with the prevalence of the species. The species depicted a high prevalence in areas up to an elevation of 500 metres. These included plains, coastal areas and river valleys.

In areas with the elevation ranging from 500 to 1000 metres, which included mountainous areas and plateaus, the species was found to be scanty. Elevation higher than 1000 metres seems to be the least attractive to it.

In the plains, the species was found to be widespread in densely populated towns while the rural areas were found to be completely free. Introduction of the species into rural areas is a recent phenomenon associated with rural water supply schemes.

The *Aedes aegypti* population depicted a phenomenon of ‘annual pulsation’. The population showed a definite reduction during the dry season and expansion during the wet season due, respectively, to the drying up and availability of breeding sites.

Both drought conditions and high rainfall were found to encourage a high build-up of *Ae. aegypti* population. In the former case, water storage practices due to water scarcity, and in the latter case, abundant availability of secondary foci in domestic and peridomestic areas promoted growth of high vector populations.

A complete absence of breeding was observed in extra-domestic habitats, including tree holes, in this region. This showed continued dependence of the species on man for food and shelter and complete absence of any sign of ecological adaptation towards feral situation which increases its epidemiological potential.

*Aedes albopictus* was encountered in the peripheral areas of towns where it replaced the *aegypti* population. However, in the eastern plateaus, the species was found to be endemic which had penetrated into the central parts of towns/cities. This may be partly due to the absence of intra-species competition from *Ae. Aegypti*, which is very scanty in this region.

**Utility of the information collected**

The data collected under the inquiry helped in delimiting the areas prone to *Aedes*-borne epidemics. The information was also supplied to concerned state governments to enable them to take preventive measures against dengue outbreaks. The dengue outbreaks in Ajmer (1969)\(^5\), and Gwalior (1970)\(^6\) are classical examples. The information broadly holds good even today.

Besides, the data provided useful information on the bio-ecology of the species for planning future studies.
Acknowledgement

The authors gratefully thank the Director, National Institute of Communicable Diseases, Delhi, and Dr B.L. Wattal, former chief of the Division of Medical Entomology and Vector Control, for their guidance and support in the conduct of these studies. Thanks are also due to Messrs H.V. Aggarwal, John Koshy and M.K. Dutta, Research Assistants, and to other staff for their valuable contributions in the field.

Reference


Districtwise House Indices for *Aedes aegypti* during dry and wet seasons
House Indices for *Aedes albopictus* during dry and wet seasons
Breeding of *Aedes aegypti* and its Impact on Dengue/DHF in Rural Areas

By Rakesh Katyal, Kaushal Kumar and Kuldip Singh Gill

National Institute of Communicable Diseases
22 Sham Nath Marg, Delhi -110054.

Abstract

A survey was undertaken to ascertain the *Aedes* indices in Ashawati and Tauri villages of Faridabad and Gurgaon districts of Haryana state, India, during September 1996. The House Index, Container Index and Breteau Index recorded in Tauru village were 33.3, 21.0 and 40.0, while in Ashawati village these indices were 13.6, 2.8 and 10.3 respectively.

Introduction

During 1996, there was an outbreak of dengue/DHF in several localities of Delhi and cases were also reported from urban and rural areas of the adjoining districts of Faridabad and Gurgaon in Haryana state. Dengue/DHF was earlier considered to be confined to urban areas (1,2), but this infection has now also been reported from rural areas of the states of Maharashtra, Karnataka and Tamil Nadu (3,4,5). *Aedes aegypti* has now made successful inroads into rural areas as well (6).

Consequent upon the reporting of suspected cases of dengue/DHF from Ashawati in Faridabad district and a suspected death due to dengue from Tauru in Gurgaon district, a rapid entomological survey for *Aedes aegypti* mosquito was carried out in these villages to find out whether the cases were imported or it was an indigenous transmission. The findings of the study are presented in this paper.

Study area

Ashawati is a typical rural village which is situated some 35 km away from the district headquarters. Houses were a mix of mudplastered walls with thatched roofs and brickwalled with cemented plaster. The village is surrounded by agricultural fields and the main occupation of the residents was agriculture. Many of the villagers worked in factories located in Faridabad.
Tauru village falls under Gurgaon district and is approximately 50 km from the district headquarters. It is a semi-urbanized village with cemented houses. The main occupation of the villagers was agriculture but many of them were working in government and semi-government offices. In both villages people stored water in various types of containers due to shortage of piped water supply. Desert-coolers were also in use in a few houses.

Methodology

The survey for *Aedes aegypti* mosquito breeding was carried out in the villages using the single larva technique. The larvae were collected for species identification and water was removed to destroy the foci of breeding.

Results and discussion

The House, Container and Breteau Indices and various containers found positive during the *Aedes* survey are given in Tables 1 & 2.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of container</th>
<th>Ashawati</th>
<th>Tauru</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. searched</td>
<td>No.found positive</td>
<td>No. searched</td>
</tr>
<tr>
<td>1</td>
<td>Drum</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>2</td>
<td>Earthen pot</td>
<td>78</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Desert cooler</td>
<td>2</td>
<td>–</td>
</tr>
<tr>
<td>4</td>
<td>Cement tank</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Money-plant bottle</td>
<td>7</td>
<td>–</td>
</tr>
<tr>
<td>6</td>
<td>Bucket</td>
<td>5</td>
<td>–</td>
</tr>
<tr>
<td>7</td>
<td>Tyre</td>
<td>7</td>
<td>–</td>
</tr>
</tbody>
</table>

Results of the survey revealed that the House, Container and Breteau Indices in Tauru were very high, i.e. 33.3, 21.0 and 40.0, while these indices in Ashawati were 10.3, 2.8 and 10.3 respectively. Containers commonly found positive for *Aedes* breeding in Ashawati village were earthen pots and cement tanks whereas in Tauru village these were metal drums and earthen pots.

During the entomological investigations carried out in Ajmer (7) it had been observed that the *Aedes* breeding index in the inner and outer peripheral zones of the town was very low, i.e. 1.6% and 0.5% respectively, but the population affected with dengue exceeded 15%. On the other hand, in the central zone of the city where most of the offices, schools, markets and cinema halls were located, the *Aedes* breeding index was 43.7% and more than 40% of the population was affected with dengue fever. People living on the periphery of Ajmer city were found to be visiting the central parts during the day time and were exposed to *Aedes* bites. Hence the population residing on the periphery of Ajmer town acquired infection...
from the central part where the *Aedes* breeding index was high.

In the present study it was clear that *Aedes aegypti* had established itself in these villages of Haryana state and there was frequent movement of their populations to the nearby towns and to Delhi. Therefore, there was a possibility that the people there may have acquired infection while visiting the towns, and the high *Aedes* densities might have triggered the indigenous transmission. Therefore, it will be worthwhile to monitor *Aedes* indices in villages bordering big towns while planning control strategies for dengue/DHF outbreaks.

**References**


Dengue Vector Control in Viet Nam Using *Mesocyclops* Through Community Participation

By

 Vu Sinh Nam  
The National Institute of Hygiene and Epidemiology, 1 Yersin, Hanoi, Viet Nam

Ron Marchand  
The Medical Commeetee, Nederland-Viet Nam, Amsterdam, Netherlands

Tran Van Tien  
The National Institute of Hygiene and Epidemiology, 1 Yersin, Hanoi, Viet Nam  
and  
Nguyen Van Binh  
The Preventive Health Center, Hatay province, Viet Nam

Abstract

In Tanminh commune (Thuongtin district, Hatay province), a community-based vector control programme was implemented. Using local communication network and with the participation of health volunteers and schoolchildren under the direction of local authority, and in consultation with health staff, campaigns for the elimination of discarded containers and release of *Mesocyclops* proved to be highly effective for vector control and for the improvement of people's knowledge of dengue fever/dengue haemorrhagic fever (DF/DHF).

Introduction

Dengue fever/dengue haemorrhagic fever (DF/DHF) was first recorded in Viet Nam in 1959. Since then, it has become endemic in the whole country. According to epidemiological surveillance, during the period 1979-1995 the morbidity rate of the disease varied from 41.02 to 462.24 and the mortality rate varied from 0.16 to 2.70 per 100 000 inhabitants. Two species of mosquitoes, *Aedes aegypti* and *Aedes albopictus*, were found in Viet Nam. The main vector for the transmission of dengue viruses is *Aedes aegypti*. As elsewhere in other countries around the world, for many years, dengue vector control in Viet Nam was based predominantly on ultra-low-volume (ULV) insecticide spraying to kill infected mosquitoes during epidemics (Gratz, 1991)\(^1\). Meanwhile, the dengue surveillance system remained inadequate; therefore, spraying usually was too late to prevent epidemic transmission (Gubler, 1994)\(^2\). Reiter (1992)\(^3\) has proved low...
effectiveness of insecticide spraying and quick return of vector population thereafter. The most effective method of controlling *Aedes aegypti* mosquitoes is source reduction to eliminate the mosquito larvae from habitats in and around homes where most of the transmission occurs. *Aedes aegypti* breeds and develops in artificial water containers and its life is closely associated with human activities. In order to control these mosquitoes successfully, it is important to gain community participation. The use of the new measure of low-cost, easy application with high, sustainable effectiveness such as *Mesocyclops*, a biological agent to control *Aedes aegypti* larvae, is encouraging for high-risk areas of dengue fever(4,5). In Viet Nam, with the support of the Medical Committee Nederland-Vietnam, such a model has been applied and discussed.

**Materials and methods**

The study has been conducted in Tanminh commune (Thuongtin district, Hatay province, 25 km west of Hanoi city) since August 1995. This commune consisted of four hamlets with 1,600 households, where epidemics had occurred during the years 1988-1992. The control area of Tienphong commune, 1 km away from Tanminh, with a similar natural, social and DF/DHF situation, was selected.

Two training courses had been held for project field staff on DF/DHF vector control measures using *Mesocyclops*, community participation and field organizing skills. Knowledge, attitude and practice (KAP) studies of the community were carried out once before the implementation and another after an interval of 18 months following pre-printed questionnaires of the National Institute of Hygiene and Epidemiology (NIHE).

Community participation in eliminating discarded water containers and releasing *Mesocyclops* in other breeding sites was mobilized through monthly activities of local communication network (videos, loudspeakers, posters, affiches), home visits by health volunteers, schoolchildren and by the leadership of local authority and health staff.

Effectiveness of the methods was assessed by the results of KAP surveys, by monthly vector surveillance (using indoor resting mosquito collection by two trained persons in 30 houses and larval survey), by number of DF/DHF patients, serological surveillance, by survival and development of *Mesocyclops* population, and by community acceptance.

**Results and discussion**

**Aedes aegypti** breeding sites and training field workers

In Tanminh, as well as in other rural communes of north Viet Nam, most of the people are agriculturists. Due to lack of piped water, people collect water from wells and rainwater from rooftops and store it in tanks and jars for daily cooking and washing. Results of investigation of water containers and *Aedes aegypti* breeding sites are given in Table 1. There were six kinds of water containers in Tanminh. Breeding sites of *Aedes aegypti* concentrated in cement tanks, jars and
Dengue Vector Control in Viet Nam using Mesocyclops through Community Participation

discarded containers, of which cement tanks and jars accounted for 66.2%. Although 45.2% of the cement tanks had fishes, the percentage of tanks infected with *Aedes aegypti* larvae was the highest.

**Table 1.** Breeding sites of *Aedes aegypti* identified for *Mesocyclops* releases and community participation, Tanminh, 1995

<table>
<thead>
<tr>
<th>Containers</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cement tanks</td>
<td>1742</td>
<td>36.2</td>
<td>24</td>
<td>33.8</td>
<td>787</td>
<td>99.6</td>
</tr>
<tr>
<td>2 Jars</td>
<td>796</td>
<td>19.6</td>
<td>23</td>
<td>32.4</td>
<td>2</td>
<td>0.3</td>
</tr>
<tr>
<td>3 Wells</td>
<td>819</td>
<td>20.1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>4 Metal tanks</td>
<td>4</td>
<td>0.1</td>
<td>1</td>
<td>1.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5 Discarded containers</td>
<td>935</td>
<td>23.0</td>
<td>22</td>
<td>31.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6 Aquarium</td>
<td>45</td>
<td>1.1</td>
<td>1</td>
<td>1.4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>4071</td>
<td>71</td>
<td>790</td>
<td>100</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A total of 214 persons, including local authority leaders, health volunteers, teachers and field staff were trained on DF/DHF, its vector, larval sites and methods of prevention by using biological predators *Mesocyclops* and eliminating discarded containers. A total of 321 householders were inter-viewed for their knowledge of DF/DHF and measures of prevention; 31.2% of them knew about DF/DHF and 38.9% understood that the disease was transmitted by mosquitoes.

**Activities for community**

**education**

Community education to improve the inhabitants’ perception was conducted through local communication network, home visits by health volunteers, school activities and through community meetings. From September 1995 until April 1997, there were 30 DF/DHF videotape shows held, 383 broadcasts made on loudspeaker, 2,000 posters distributed, 40 banners drawn, and 16 health volunteers made visits to every house at least once a month, giving direct communication for 24,768 times/people, average 3.7 times per person. Fifty-eight primary school teachers were provided with information about DF/DHF, 526 pupils participated in competitions on DF/DHF and its prevention, and among them 16 won prizes and became their school’s propagandists. The results of post-treatment interviews showed that the proportion of the householders’ understanding regarding the transmission mode of DF/DHF had increased from 38.9% to 82.2% after eight months and up to 95.3% after 18-month treatment.

**Releasing Mesocyclops and eliminating discarded containers**

There were three species of *Mesocyclops* predacious to *Aedes aegypti* larvae collected from ponds and water containers in Tanminh. These were *M. woutersi, M. ruttneri* and *M. thermocyclopoides*. These species of *Mesocyclops* were available in the commune in water containers such as cement cisterns, wells and ponds. Health volunteers collected them from these containers and released them into other
containers without *Mesocyclops*. Up to April 1997, *Mesocyclops* were persisting in 1467 cement cisterns (84.21% baseline count), 274 jars (34.4%), 953 wells (116.4%), 65 aquariums and four discarded water containers. No *Aedes aegypti* larvae were detected in water containers having *Mesocyclops*. While releasing *Mesocyclops*, volunteers instructed householders how to maintain and to inoculate *Mesocyclops*. The Commune People Committee had organized a launching ceremony for the campaign. According to the reports of volunteers, in October 1996, the number of *Aedes* larvae-infested water containers had been reduced by 21.7 times (*P < 1x 10^-7*) compared with the data of September 1995, and no infested containers were detected in April 1997 (15 months post-treatment). The relationship between the number of containers having *Mesocyclops* and the number of *Aedes* larval-infested containers showed in Figures 1 and 2 proved clearly the role of biological agent *Mesocyclops* in controlling *Aedes aegypti* larvae in the field trial.

Elimination of discarded containers, the breeding sites of *Aedes aegypti*, was carried out together with the release of *Mesocyclops* and community education, conducted by health volunteers and schoolchildren. During the first year of the project, health volunteers went to every house to detect and to persuade and instruct how to treat about 2900 discarded containers. The quantity of discarded containers in October 1996 had been reduced 5.1 times as compared with the baseline data. Pupils of 12 classes from the primary school were involved in this activity under the supervision of its principal and health volunteers. However, discarded containers were not treated fully. Breeding sites were still detected in discarded containers, in some clay pots and cisterns, but most of them were found in discarded water containers. During the second year, besides education and release of *Mesocyclops*, the volunteers emphasized on support to householders and pupils in detecting and managing discarded containers to eliminate all *Aedes aegypti* in the study area.

**Vector surveillance**

The results of vector surveillance showed that the *Aedes aegypti* population decreased significantly as compared with control and with its baseline data. Post-treatment data showed that the average density index of adult *Aedes aegypti* mosquito (Fig. 3) was 0.05 per house, 11.8 times (91.5%) lower than the pre-treatment phase (0.59 per house), and was 7.2 times lower than the control phase (86.1%, *P = 0.00014*). Similarly, the larvae House Index (Fig. 4) had declined 2.8 times (64.5%) as compared with pre-treatment and 4.5 times (77.6%, *P < 1 x 10^-5*) compared with the control. The larvae container index (Fig. 5) had been reduced 3.2 times (68.8%) and 3.6 times (72.5%) respectively as compared with the pre-treatment and the control village. These results proved that releasing *Mesocyclops* and eliminating discarded containers were highly effective in rural areas of Viet Nam. The networking of volunteers, primary school pupils and health staff and close direction of local authority were substantial factors appropriate for the mobilization of community participation in the realization of DF/DHF vector control in rural areas of Viet Nam.
Figure 1. Number of cement tanks affected with *Ae. Aegypti* larvae and number of cement tanks having *Mesocyclops* in Tanminh, Hatay, 1995-1997

Figure 2. Number of jars infected with *Ae. Aegypti* larvae and number of jars having *Mesocyclops* in Tanminh, Hatay, 1995-1997
Figure 3. Density Index of *Ae. Aegypti* in the field of community participation and using Mesocyclops in Tanminh, Hatay, 1995-1997

Figure 4. House Index of *Ae. Aegypti* in the field of using Mesocyclops and community participation in Tan minh, Hatay, 1995-1997
Serological surveillance

There was no clinical dengue case reported in both treated and control communes, but the result of the serological surveillance indicated clearly that the number of dengue-infected schoolchildren was reduced significantly in the treated commune as compared with the control commune. The first finger-bleed was taken on 15 May 1996 with a total of 200 blood samples from schoolchildren aged 11-13 years. The samples were tested with ELISA to identify recent dengue infection. Five out of 100 samples from the treated village were positive with dengue, whereas two of the 100 samples from the untreated village were found positive. The second bleed was undertaken on 16 January 1997 (at the end of dengue season) for 150 children who were negative with dengue fever from the previous examination. Results with HI test showed the difference in changing dengue antibody response between the treated and untreated communes (Table 2).

Table 2. Result of serological surveillance of dengue fever

<table>
<thead>
<tr>
<th>Name of commune</th>
<th>First bleed (ELISA test)</th>
<th>Second bleed (HI test)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. of samples</td>
<td>No. of Positives</td>
</tr>
<tr>
<td>Tan minh (treated)</td>
<td>100</td>
<td>5</td>
</tr>
<tr>
<td>Tien Phong (untreated)</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>200</td>
<td>7</td>
</tr>
</tbody>
</table>
Discussions and conclusions

Community-based vector control is an emerging new strategy for the prevention of dengue fever and other mosquito-borne diseases in Viet Nam.

The findings of Riviere et al. (1987)\(^{(6)}\) showed that *M. aspericornis* survived up to 17% of the inoculated tree holes and 48% of the wells after five years of inoculation, and *Aedes* breeding had been reduced by 91-200% for at least 6-12 months and for up to five years. The result of Lardeux's experiments (1992)\(^{(7)}\) in Tuherahera village, Tikihau atoll, yielded mixed results; five months post-inoculation, *M. aspericornis* was present in 100% of the covered wells, 3.4% and 12.5% of the covered and open rainwater tanks, and in 8.7% of the 200-litre drums. When they survived, copepods proved effective biocontrol agents of *Aedes* larvae. Similarly, in Queensland, Australia, out of the seven species evaluated in laboratory, all but *M. notius* were found to be effective predators of both *Aedes aegypti* and *Anopheles farati*, but not of *Cx. quinquefasciatus* (Kay, 1996)\(^{(8)}\). The results in Thailand were mixed, but in the Americas there was some success. This work was carried out by Gerry Marten and Macro Suarez in the USA, Mexico, Honduras, Puerto Rico and Colombia. Of the six species of cyclopoids tested in tyres around New Orleans as control agents of *Ae. aegypti*, *Ae. albopictus* and *Ae. triseriatus*, *D. navus*, *M. longisetus* and *M. albidus* reduced the larval population by 99%. In Honduras (Marten et al. 1989)\(^{(10)}\), *M. longisetus*, and *Macrocylops albidus* survived well in outdoor concrete tanks, 200-litre drums, tyres and vases with live plants during the 20-30-week test period and gave excellent control of *Ae. aegypti*. As found with other community-based projects in Puerto Rico, Anguila and Brazil, householders readily accept cyclopods and often are willing to take extra precautions to ensure that these biological control agents are not discarded when cleaning the containers (Marten et al. 1994)\(^{(9)}\). In Viet Nam, use of *Mesocyclops* and community participation for dengue vector control were tested with a great amount of success in the field. In a village-scale trial, *Mesocyclops* was introduced into wells, large cement tanks, ceramic jars and other domestic containers that served as *Aedes aegypti* breeding sites in Phanboi village (400 houses), Haihung province, in February 1993. The use of *Mesocyclops* was complemented by community participation that eliminated unused and discarded containers that collected rainwater that could not be treated effectively with *Mesocyclops*. *Ae. aegypti* disappeared from the treated village in August 1994 and has not reappeared so far. Extended field trials now carried out in Tauminh commune further support the effectiveness of the measure and its cost-effectiveness. This method is low-cost as *Mesocyclops* are available locally, have a high predacious capacity, are easy to be inoculated and released, and can survive for a long time. *Mesocyclops* are especially appropriate for large containers like cement cisterns, wells, steel tanks and clay pots (of big size). Discarded containers, mostly of small size which infrequently contain little water, are not appropriate for *Mesocyclops*; therefore, the solution is to eliminate them. In combination with the community recycling it, *Mesocyclops* is an
Dengue Vector Control in Viet Nam using Mesocyclops through Community Participation

A simple and inexpensive method of Ae. aegypti control that should be effective for many communities in Viet Nam and elsewhere.

Acknowledgements
The authors acknowledge the support of Prof. Hoang Thuy Nguyen (former Director, National Institute of Hygiene and Epidemiology, Hanoi), Prof. Hoang Thuy Long (Director, National Institute of Hygiene and Epidemiology), Prof. Tuong Uyen Ninh and Dr Jenet W. Reid (Smithsonian Institution, USA), Dr Maria Holynski (Museum & Institute of Zoology, Poland) and Dr Gerry Marten (the New Orleans Mosquito Control) who collaborated in identifying Mesocyclops species. Field staff who assisted in the study were Nguyen Thi Yen, Tran Vu Phong, Nguyen Tu Bin, Phan Vu Diem Hang, Dang Nhu Nguyen, Nguyen Xuan Tac, Nguyen Xuan Tai and Le Ngoc Han. Financial support for the project was provided by the Medical Committee Nederland-Vietnam.

References
Trials with Aerosol Spray to Control Aedes aegypti-Biting during DF/DHF Epidemic

By

M.A. Ansari
Malaria Research Centre, Indian Council of Medical Research, 20 Madhuban, Delhi-110092 (INDIA)

Abstract

Hexit Mos kit aerosol application @ 16 ml per 10 seconds sprayed in rooms against Aedes aegypti at 0700 hrs prevented 95.8±4.2% vector to land on human volunteers for 9.65±1.3 hours. Spraying also prevented 87.9±4.1% Aedes aegypti to enter sprayed rooms for 8.25±0.7 hours. Hexit Mos kit aerosol can be used by communities for protection of infants and other vulnerable groups staying at home against Aedes bites.

Introduction

During the 1996 outbreak of DF/DHF in Delhi(1), among the control strategies suggested, stress was laid on the need to promote equity among communities through sharing of responsibilities and self-reliance. To this end, control strategies which are simple, non-toxic and can be handled by people themselves assume greater significance and people need to be empowered with knowledge and skill. To achieve these objectives, commonly-available commercial aerosol as a tool for personal protection against mosquitoes was evaluated with encouraging results. For protection against bites of Aedes aegypti, Hexit Mos kit aerosol was evaluated and the results are incorporated in this paper.

Material and methods

A commercial product Hexit Mos kit aerosol was used in this study. Aerosol comprises 0.02% ww deltamethrin, 0.133% ww allethrin as active ingredient, and 99.85% ww other ingredients.

Aerosol was released @ 16 ml in 10 seconds in rooms of about 3.5x3.5x3.5 m. at 0700 hrs before the forenoon biting peak. Cylindrical cages (12 cm long and 80 cm diameter) made of 20 mesh galvanized wire screen were used in the study to expose mosquitoes. Batches of laboratory-reared ten Aedes aegypti females were exposed at an interval of one hour after aerosol application. A control was held without exposure to the aerosol. Mortality was recorded by holding
Exposed adults in the same cage for 24 hours in the laboratory at 28°C±2°C and 80% RH. Field experiments were conducted in Sadiq Nagar - a residential colony in south Delhi where Aedes indices were predetermined and estimated as 16.75 MHD and 8.81 Container Index. Field observations on landing of mosquitoes after aerosol release were made from 7 a.m. to 6 p.m. in October 1996. During this period the mean temperature varied from 22.2-26.1°C and relative humidity ranged from 57 to 66%.

Results and discussion

Fig. 1 gives the results of Hexit Mos kit spray on the mortality of Aedes aegypti caged in cylindrical wire meshes. The results revealed 100% knock down of mosquitoes for three hours, i.e. three successive batches of Aedes aegypti exposed for one hour died. Thereafter, there was a decline in the mortality up to 6 hours. Corrected mortality after 24 hours is given in Fig.1.

Table 1 and Fig 2 give the results of field evaluations. It was revealed that one release of aerosol spraying @ 16 ml in 10 seconds prevented the entry of Aedes aegypti into the rooms, i.e. 87.9±4.1 mosquitoes were prevented from entry for a period of 12 hours. As a direct consequence of this, the landing rate of Aedes aegypti was reduced by 95.8±4.2.

Aedes aegypti is a domestic mosquito and predominantly bites during daytime with two peaks, one before forenoon and the other at late afternoon. Aerosols can be used as a supplementary method to ward off Aedes mosquitoes and thus ensure protection of vulnerable groups, i.e. infants and women staying at home, from acquiring dengue infection.
**Figure 1.** Percentage knockdown and corrected mortality after holding females in cylindrical cage kept in Hexit Mos Kit sprayed rooms

**Figure 2.** Landings/Entries of *Aedes aegypti* on human volunteers/room in Hexit Mos Kit sprayed and unsprayed rooms
**Acknowledgment**

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**Table 1: Field evaluation of Hexit Mos Kit aerosol against *Aedes aegypti* (7a.m. - 6 p.m.)**

<table>
<thead>
<tr>
<th>Repli-cate</th>
<th>Entered in Rooms</th>
<th>Landed on human volunteers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>25</td>
</tr>
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<td>3</td>
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<td>19</td>
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</tr>
<tr>
<td>20</td>
<td>4</td>
<td>24</td>
</tr>
</tbody>
</table>

E Experimental
C Control
P Protection
PT Protection time
Figure 1. Percentage knockdown and corrected mortality after holding females in cylindrical cage kept in Hexit Mos Kit sprayed rooms.

Figure 2. Landings/Entries of Aedes aegypti on human volunteers/room in Hexit Mos Kit sprayed and unsprayed rooms.
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References


Status of Dengue Control in Cambodia, 1997

By
Ngan Chantha
Dengue Programme Manager
Ministry of Health, Phnom Penh, Cambodia

Abstract
Since 1962, Cambodia has been facing regular dengue fever outbreaks which affect children in areas with concentrated populations, especially in Phnom Penh and Battambang. Identified areas at risk extend out from the south (Kampot & Kampong, Som provinces) to the north-west (Battambang and Banteay Meanchey provinces), encompassing 16 provinces. Epidemics were reported in 1983, 1985, 1987 and 1990, which were also peak years for dengue in Thailand. In comparison to neighbouring countries, the case fatality rate in Cambodia has been very high, ranging from 3.6 to 15%. However, improvement in health services has brought about a noticeable decrease in mortality due to DF/DHF.

Introduction
The most severe outbreak of DF/DHF occurred in 1995 with more than 10 200 cases and 420 deaths, which corresponds to an attack rate of approximately 104/100 000 population. The 300 per cent-increase in the number of cases in Battambang province between April and May 1995 confirmed the epidemic situation, which spread rapidly to other provinces. As in the past, the four main areas affected were: Battambang (2538 cases); Phnom Penh (2127 cases); Kandal (1767), and Banteay Meanchey (1054 cases).

A simultaneous large-scale intervention played an important role in breaking down the number of cases. This intervention included the following activities: (1) mass-media campaign; (2) massive clean-up operations; (3) Temephos application in water containers, and (4) insecticide ULV spraying.

Current situation
In 1996, the overall incidence remained low. There were 1433 cases recorded, with a case fatality rate of 5%. However, amongst cases from Phnom Penh city, the fatality was maintained at 1%. Three provinces were particularly affected: Banteay Meanchey, where interventions could not be carried out properly due to security reasons; and Stung Treng and Kampot provinces, which did not have a
high incidence in 1995 and, therefore, had a greater non-immune population.

The disease trend has been similar during 1997. Battambang is being given particular attention since the incidence was very low in 1996. An important intervention is presently being applied there in order to interrupt the transmission to the extent possible.

Development of DF/DHF control programme

The dengue fever control programme aims at capacity-building from national down to khum levels through four components: (1) Epidemiological surveillance; (2) Clinical management; (3) Vector control, and (4) Health education.

Programme structure

As defined by the Ministry of Health, the Dengue Fever Control Programme (DFCP) is not a vertical programme but is integrated in the existing health structure, expecting the participation of various departments of the Ministry. For a better operational response, the DFCP follows the structure of the malaria programme by sharing its personnel for dengue prevention and entomological surveys. For clinical management and epidemiology, the programme collaborates with the personnel of referral hospitals. Health education activities are carried out in cooperation with the Department of Health Education and Hygiene.

The programme structure is composed of a National Dengue Fever Control Committee, a programme management team, and four sub-committees: Epidemiology, Entomology, Clinical Management and Health Education.

The Committee participates in decision-making, initiates activities, monitors progress and gives advice in exchange of ideas and experiences. The Committee ensures coordination of activities to be implemented by the programme management and/or the sub-committees.

The sub-committees include experts in their respective fields. They give advice on measures to be taken as well as assist the programme management in their implementation. They also participate in training and supervision.

A yearly draft plan of action is developed by the DFCP in collaboration with the sub-committees. Activities to be implemented are identified according to the objectives of the project.

Training and supervision activities from national to provincial/referral levels are implemented by the Programme and/or the sub-committee members in their respective areas of responsibility, in collaboration with provincial/referral health authorities.

Provincial/referral health authorities have the responsibility of training and supervision at the district and khum levels.
Strategy
The strategy of the programme is two-fold. One, to improve early detection of outbreaks, and two, awareness-raising and education of communities to participate in the reduction of mosquito breeding sites. Trends of incidence and vector surveillance allow the programme to define three types of situations: low endemic, high endemic, and epidemic, and activities to be carried out are outlined by each of the programme components.

Surveillance system
Epidemiological surveillance is based on data from three sources: (1) Recording of dengue fever morbidity and mortality from all levels: health centres, district and provincial hospitals; (2) Measurement of the vector density in selected areas, and (3) Results of a sentinel system based on serological case confirmation.

Health information system: This system carries information from health centres to referral hospitals and to the national level through two ways. The weekly alert system gives information on suspected dengue cases at the time of admission to a health facility, while monthly reports bring information of confirmed cases at the time of discharge from hospital.

Vector surveillance: Provincial entomological teams in four provinces perform monthly surveys to determine the density of the *Aedes* mosquito in selected *khums* representative of the considered area. In four other less-affected provinces, surveys are carried out by provincial entomology teams in collaboration with personnel from the National Entomology Section of the Malaria Centre. The results of these entomological surveys constitute a database which is used to determine the cut-off curves defining the situation in each of the provinces surveyed. This allows decision-making for specific activities to be carried out according to the situation as defined in the operational strategy.

Laboratory: Confirmation of suspected cases which do not show evidence of clinical diagnosis and are mainly characterized by high fever, is a way of measuring dengue transmission, especially when the incidence of clinically-diagnosed cases is very low. Such a measurement can therefore be incorporated into the alert system to support data on vector density and incidence.

Health Education
Health education is a major tool in initiating community-based activities aimed at reducing dengue transmission as well as early treatment of sick children. The knowledge, attitude and practice (KAP) surveys carried out in 1993 and 1995 showed a high degree of awareness among Cambodians with regard to dengue fever and its prevention. These efforts to inform communities are being continued in order to reach the largest audience, especially among mothers and children. However, information dissemination is not a guarantee of community participation for health prevention unless there is a strong commitment of all key players in the community.
The health education strategy is to have a multi-sectorial approach involving several ministries of the Royal Government of Cambodia. As a first step, the ministries involved are: Ministry of Rural Development; Ministry of Women Affairs; Ministry of Health; Ministry of Education, Youth and Sports, and Ministry of Information. The purpose of such a strategy is to use various pre-existing channels to disseminate dengue prevention message with a view to making the strongest impact on the population. Information, education and communication is geared towards all levels of these ministries, going down to communities. The targeted educators of communities are teachers, health workers, community-based workers, clinicians and nurses, newspaper and media personnel and dengue prevention teams.

Health education is carried out in two ways: (1) mass-media campaigns, echoed by clean-up activities initiated by key players in the community, and (2) by integrating dengue fever prevention into pre-existing community-based health and non-health programmes (e.g. sanitation and water distribution improvement programmes). Involving schoolchildren is a key determinant in prevention activities. In addition to the aforementioned activities, the Health Education Unit develops educational materials and messages, including media production.

Clinical management

The clinical management strategy addresses the following three elements: (1) early referral of patients for prompt treatment, reducing the risk of death; (2) prompt and correct diagnosis, and (3) well-managed fluid therapy.

Diagnosis and clinical management are improved through inservice training of health personnel. The clinical protocol is given to all practitioners and is explained and referred to during such training. Inservice training and supervision are carried out from national down to the referral level and on to health centres.

Vector control

An important role of the provincial/municipal entomological teams is to determine high-risk areas that need to be treated when indices show a noticeable increase. Regular measurement of vector indices enables the entomology section to determine the acceptable level which must be maintained throughout the dengue season. In the event that results from entomological surveys show vector indices to be above this threshold, larvicide application (Abate) and insecticide spraying (malathion 90%) are undertaken in priority zones. This operation is coupled with intensified health education activities.

References


Overview of epidemics

During the last 50 years, the four dengue viruses have caused epidemics in the islands of French Polynesia. In 1944, Tahiti was affected by an outbreak due to the first identified dengue virus, DEN-1. The next epidemic took place in 1964, caused by DEN-3, following the opening of the international airport. Dengue fever has become endemic in the country with successive epidemics due to different serotypes: DEN-3 in 1969; DEN-2 in 1971; DEN-1 in 1975; DEN-4 in 1979, and DEN-1 in 1988. During these epidemics, fatal cases and cases with shock syndrome or haemorrhagic manifestations have relatively been rare. Only one serotype of virus is transmitted during and between epidemics, except at the beginning of epidemics when the old endemic virus and the new one introduced are both present in overlapping circulation during a few months.

In 1990, a new epidemic due to DEN-3 was responsible for more serious cases, with about 250 hospitalizations and 11 deaths. *Aedes aegypti* is the quasi-exclusive vector.

1996-1997 Epidemic

The first case of DEN-2 was detected by the clinical and virological surveillance system in August 1996. This system has got together 18 physicians of private clinics and public hospitals and the virological laboratory of the Institute de Recherches Medicales, Louis Malarde. The virological identification was made quickly by Reverse Transcriptase Polymerase Chain Reaction (RT-PCR).

Until November 1996, the epidemiological surveillance was settled on virological diagnosis by RT-PCR or cell cultures and serology. Afterwards, a weekly surveillance of suspected clinical cases was concurrently added, with the participation of 40% of all the physicians in the country. The hospitalizations were also reported.
The peak of this epidemic occurred in January 1997, with 2131 suspected cases, 564 confirmed cases and 219 hospitalizations during the month. Between August 1996 and April 1997, the total suspected cases was estimated at about 13 000. With symptomatic cases, 30% to 60% of the susceptible population has been estimated as infected. Six children were hospitalized: two for shock syndrome, one for haemorrhage and three for viral encephalitis. A 22-year-old man died with staphyllospecticaemia due to post-viral aplasy. The transmission is still on, but is at a low level.

Control activities

The preceding epidemic of DEN-2 took place in 1971 and the serotype disappeared in 1976. In 1996, all the young people under 20 years, more than half the total population, were susceptible to the disease. So, as soon as the first case of DEN-2 was confirmed by the laboratory, a countrywide strategy was defined by the Dengue Control Committee and applied with two main objectives:

To minimize the impact of the new epidemic in order to avoid socio-economic perturbations, and

To develop the efficiency of health services in the management of serious cases by information and sensitization of medical staff and the community.

An intensive health education campaign was supported by the media and the teaching profession in schools. An educational file was elaborated for this purpose. On the ground, ULV and aerosol sprays, with permethrin and malathion insecticides, were used in urban areas where Aedes aegypti densities are known to be high. In other areas, insecticides were used in and around such places as schools, clinics, hospitals, assembly rooms, etc. Vector control teams visited dwellings and gathering places to search for mosquito breeding sites and to promote appropriate individual and community actions.

The administrations, municipalities, schools, religious groups, environmental associations and youth and women associations actively participated to fight the epidemic and to destroy Aedes aegypti breeding sites. Messages to families and physicians were broadly spread to recognize the first symptoms of the disease and to provide appropriate care.

References

1. Laigret J, Pare F and Rosen L. Dengue Type 4 - French Polynisie. MMWR, 4 May 1979 : 194-201

Since 1983, dengue fever and dengue haemorrhagic fever (DF/DHF) cases have been occurring in big and crowded cities, mostly in five provinces (Vientiane Municipality, Borikhamvay, Khammouane, Savannakhet and Champassak) in Laos.

The total number of cases and deaths is given in the table below. The first and second outbreak were limited only to Vientiane; the third large outbreak extended to all the aforementioned five provinces in 1987. There were 9699 cases with 295 deaths, mostly children under 15 years.

The main vectors (Aedes aegypti and Aedes albopictus) were collected in all five cities. Space spraying of insecticide (Malathion 95%) and use of larvicide (Temephos 1%) were the main measures used for vector control, which was integrated with health education, promotion of personal protection and reduction of Aedes breeding. This was also supported by legislation.

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Cities affected</th>
<th>Cases</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>-</td>
<td>204</td>
<td>5</td>
</tr>
<tr>
<td>1985</td>
<td>-</td>
<td>1774</td>
<td>11</td>
</tr>
<tr>
<td>1987</td>
<td>6</td>
<td>9699</td>
<td>295</td>
</tr>
<tr>
<td>1988</td>
<td>1</td>
<td>180</td>
<td>1</td>
</tr>
<tr>
<td>1989</td>
<td>1</td>
<td>68</td>
<td>-</td>
</tr>
<tr>
<td>1990</td>
<td>3</td>
<td>99</td>
<td>3</td>
</tr>
<tr>
<td>1991</td>
<td>4</td>
<td>132</td>
<td>4</td>
</tr>
<tr>
<td>1992</td>
<td>2</td>
<td>86</td>
<td>1</td>
</tr>
<tr>
<td>1993</td>
<td>3</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>1994</td>
<td>4</td>
<td>1870</td>
<td>17</td>
</tr>
<tr>
<td>1995</td>
<td>6</td>
<td>3345</td>
<td>23</td>
</tr>
<tr>
<td>1996</td>
<td>9</td>
<td>2563</td>
<td>23</td>
</tr>
</tbody>
</table>

The case diagnosis was done by clinical symptoms and some of them were confirmed by serological methods (HI) and two serotypes (DEN-1 and 2) were found circulating.
Surveillance and control system

After the large outbreak in 1987, the Dengue Control Committee, led by the local governor, was established at the provincial level, especially in the five provinces, in order to ensure within the framework of dengue control full compliance of the public with the control measures promoted by health authorities. The purpose of the legislation was to support and provide all facilities for surveillance, survey and control activities.

At national level, the Institute of Malariology, Parasitology and Entomology (IMPE) is expected to provide and strengthen technical and equipment support. The provincial Vector Control Units routinely conduct larval surveys and do monitoring of cases by collaborating with hospitals. If any suspected patient or outbreak is found, proper disease control measures are undertaken in consultation with the Dengue Control Committee and IMPE.

Vector control strategies in Lao PDR

In order to avoid DF/DHF outbreaks, the following integrated measures are taken:

1. Monthly surveillance; vector surveys of larvae and adult mosquitoes as the main activity of IMPE and Vector Control Units in provinces forecast impending outbreaks by relating vector indices with other epidemiological information. Control action can then be taken in time to prevent any large outbreak.

2. Activate the community for environmental management, destruction or elimination of unwanted natural and artificial containers (old tyres, other containers which can breed mosquitoes, etc.), covering the water containers that are considered useful, and essential and weekly cleaning. Large water containers which need to be left open to be properly treated by larvicide (1g:10 litres of water).

3. Promote personal protection measures (use of mosquito coil, repellent, mosquito net, insecticide-impregnated mosquito net, aerosols, etc.).

4. Especially under epidemic conditions, space spraying becomes a major vector control activity to achieve rapid knock down and eventual mortality of the adult Aedes vectors. ULV, cold generators, Leco, Fontan and Malathion 95% were used in Laos.

5. Community education is also essential, especially for parents. They must take an active part in preventive actions and seek early medical care for their sick children to prevent any serious outcome.

6. The legislative measure was also carried out (e.g. establishment of Dengue Control Committees at the provincial level).

References

Historical Account of Dengue Haemorrhagic Fever in Sri Lanka

By
Tissa Vitarana, W S Jayakuru, and Nalini Withane

Ministry of Science, Technology and Human Resources Development, No. 320, Jayah Mawath
Colombo 10

Sri Lanka is an island situated 34 kilometres south of India. It has an area of 65,610 sq km and a population of 18.3 million, 22% of whom live in urban areas and the rest in rural areas. Clinical dengue-like illness has been recorded in Sri Lanka since the beginning of the century, and it was serologically confirmed in 1962. Following a Chikungunya outbreak in 1965, there was an island-wide epidemic of dengue associated with DEN types 1 and 2, with 51 cases of DHF and 15 deaths in the period 1965-1968. From 1969 up to 1988, multiple dengue serotypes circulated in urban areas with endemic DF, but there were only occasional cases of DHF.

From 1989 onwards, DHF has become endemic in Sri Lanka and there have been 203 hospitalized clinical cases of DHF, of whom 37% were serologically confirmed and 20 deaths, giving a case fatality rate (CFR) of 9.8% (Figure). There was a sharp rise in 1990 with 1350 suspected DHF cases, of whom 363 were serologically confirmed, and there were 54 deaths (CFR 4.0%).

During the period 1991-1995, between 440 and 1048 cases were reported each year with a CFR of about 4%. However, in 1996, there was an epidemic with 1298 clinically-diagnosed cases of DHF hospitalized and 54 deaths (CFR 4.2%). Because of deficiencies in reporting it is likely that the actual number of cases was more.

In 1989, the DHF cases initially occurred mainly in and around Colombo, but they progressively spread to other towns and reached outbreak proportions in several provincial capitals, e.g. Kurunegala, Galle, Kandy and Batticola in 1996.

The age distribution pattern shows a preponderance in children under 15 years (65%), with a peak in the 5-9-year age group. It is noteworthy that there has been a significant number of cases in the 15-29-year age group, especially between 15-19 years. The sex distribution does not show any significant male-to-female difference.
There is a close correlation of the occurrence of DF/DHF with the rainfall and the peak levels are reached with the south-west monsoon (May to July) and the north-east monsoon (October to December). Entomological studies conducted by the Medical Research Institute (MRI) indicate that over 90% of the breeding of *Aedes aegypti* and *Aedes albopictus* occurs in small outdoor containers like tins, coconut shells, bottles, plastic containers, rubber tyres, etc. Indoor water storage is not widely practised in Sri Lanka.

The main serotypes associated with DHF since 1989 have been DEN-2 and 3.

**References**

Use of Dengue Blot IgG Test as an Epidemiological Tool for Assessing Incidence of DHF in Communities

By

Faisal Yatim
Communicable Diseases Research Centre
National Institute of Health Research and Development
Ministry of Health, Jakarta, Indonesia

During 1990, the Blot IgG test for DHF serology, which was developed by Dr M. Jane D. Cardosa and marketed by M/s Diagnostic Biotechnology Ltd., Singapore, was further modified and standardized by Dupen Diagnostics Division. A field evaluation of this test kit was undertaken by the National Institute of Health Research and Development in collaboration with the DHF Control Programme. This paper presents the sensitivity and specificity of this kit.

One thousand specimens of acute and convalescent DHF cases were collected from four provincial health laboratories. The specimens were obtained from clinically suspected DHF patients who had been hospitalized in district hospitals. Sera samples were divided into two, and each set was tested by IgG blot for comparison with haemaglutinin test (HI). The results of the trials are summarized in Table.

<table>
<thead>
<tr>
<th></th>
<th>Positive</th>
<th>Negative</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hi Test</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>713</td>
<td>98</td>
<td>811</td>
</tr>
<tr>
<td>Negative</td>
<td>39</td>
<td>225</td>
<td>364</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>752</td>
<td>323</td>
<td>1175</td>
</tr>
</tbody>
</table>

Sensitivity: 713/752 = 94.8%
Specificity: 225/323 = 69.66%

From the results, it is apparent that the Blot test captured only the IgG antibodies which reflects that the patients had previous dengue infection, and hence can assay the incidence in the community. However, for detection of recent infection, it must be combined with Blot IgM. Addition of Blot IgM will not, however, make this test cost-effective.

References

