Assessment of epidemiology of dengue in Sri Lanka in relation to intervention measures

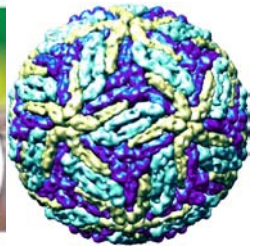
Report of visit to Colombo

During 9 - 15 Oct 2011

Dr S.L. Hoti

Consultant





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Executive Summary

The visit was undertaken as per the TOR and the findings suggest that:

Sri Lanka experienced the largest epidemic of DF/DHF with as many as 70,000 cases and almost 600 deaths during 2009-10. The Health Ministry, Govt. of Sri Lanka undertook intervention measures to contain the dengue epidemic. Establishment of the 'Presidential Task Force for Dengue Control' ensured much needed intersectoral collaboration and coordination. WHO Country Office for Sri Lanka provided the necessary support for implementation of interventions.

Other than community-based control measures mainly targeting larval source reduction, intervention measures included implementation of appropriate guidelines for case management (revised in 2010 based on the regional experience) of severe cases of dengue fever (DF) and dengue haemorrhagic fever (DHF), and vector control activities. Essentially the case management includes the differentiation of DF and DHF based on plasma leakage as the discriminating factor rather than hemorrhage, management of DHF cases which included identification of the beginning and predicting the end the critical (plasma leakage) phase, meticulous monitoring, accurate fluid management in the critical phase, vigilance, early detection and treatment of concealed bleeding and other complications.

As a result of the interventions, the number of cases and deaths has been brought down to about 25,303 and 169 respectively in 2011 (as of December 15, 2011). This is a significant achievement and a silver line in the outbreak control and clinical management of dengue cases. The mortality was mainly among DHF cases belonging to older age groups and hence there is a need to focus upon improving the clinical management practices for reducing the mortality among these groups. The entomological data is fragmented as it is collected by different units of Ministry of Health and hence required to be unified in order to correlate with control measures undertaken and the reduction in number of cases reported.

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Report of assessment of epidemiology of dengue in Sri Lanka in relation to intervention measures

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Introduction

Dengue is an age old disease and its knowledge dates back to 265 AD, described then as 'water poison', clearly for its association with water-associated insects. Global dengue epidemics are known to have occurred regularly over the last three centuries in tropical, sub-tropical and temperate areas around the world. The epidemic of dengue was first recorded in 1635 in the French West Indies, although a disease outbreak compatible with dengue had been reported in China as early as 992 AD[1]. Benzamin Rush[2] was probably describing dengue when he wrote about 'break-bone fever' occurring in Philadelphia in 1780. Most of the cases during the epidemics of that time mimicked clinical dengue fever (DF), although some displayed characteristics of the hemorrhagic form of the disease. In most Central and South American countries, effective disease prevention was achieved by eliminating the principal epidemic mosquito vector, *Aedes aegypti*, during 1950s and 1960s.

Dengue viruses (DENV), the causative agents of dengue, are arthropod-borne viruses (arboviruses) belonging to the genus Flavivirus (family Flaviviridae). There are four genetically related but antigenically distinct serotypes (DENV-1, 2, 3 and 4) within the dengue (DEN) antigenic complex. DENV is a small spherical shaped virion of 40-50 nm in diameter and covered with a lipopolysaccharide envelope. It has small genome consisting of the positive single-strand RNA genome (Fig. 1) of 11 kb in length. Its genome has a single open reading frame that encodes three structural proteins viz., the capsid (C), membrane (M) and envelope (E) glycoproteins and seven non-structural proteins (NS1, NS2A, NS2B, NS3, NS4A, NS4B and NS5) (Fig. 1A). Some of these are involved in receptor binding, haemagglutination of erythrocytes and the induction of neutralizing antibodies. Envelop E glycoprotein elicits protective immune response.

The infection is transmitted by day biting mosquitoes viz., *Aedes* (Stegomyia) spp., primarily *Ae. aegypti* and *Ae. albopictus* (Fig. 1D-E), as vectors for domestic and peridomestic transmission, and

arboreal *Aedes* mosquitoes as vectors for enzootic transmission. These vectors are highly resilient and breed in an array of containers; rather any container that holds some clean water, which can be natural as well as manmade. DENVs are extremely restricted in their natural vertebrate host range that includes

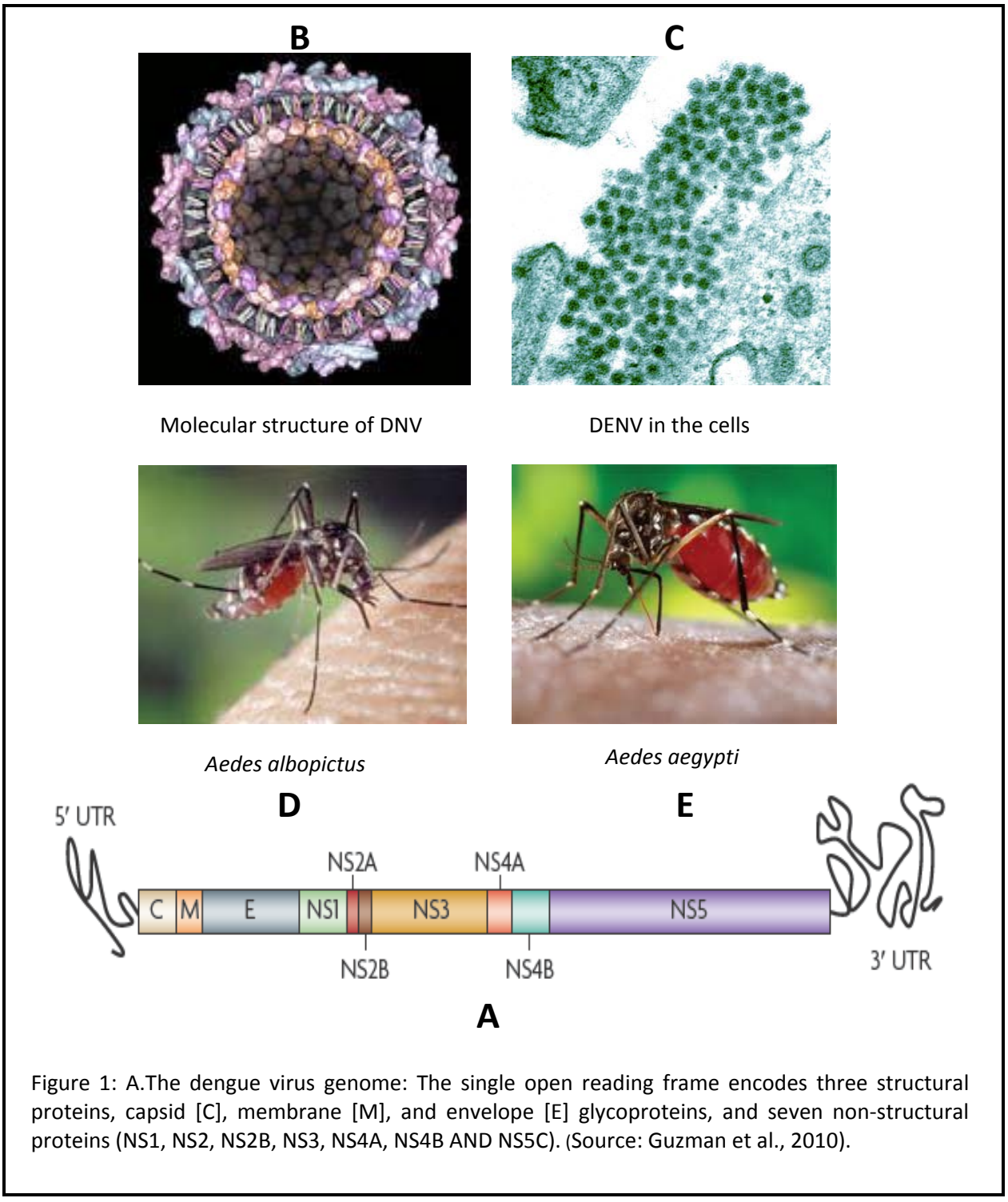


Figure 1: A.The dengue virus genome: The single open reading frame encodes three structural proteins, capsid [C], membrane [M], and envelope [E] glycoproteins, and seven non-structural proteins (NS1, NS2, NS2B, NS3, NS4A, NS4B AND NS5C). (Source: Guzman et al., 2010).

only primates, although some reports suggest for a putative, unconfirmed, extended vertebrate host range[3]. The intrinsic incubation cycle of the virus in the vectors takes place in about 10 days and the infection in mosquito is promoted by the salivary proteins[4].

The clinical presentations of dengue range from mild undifferentiated febrile illness to severe form of dengue shock syndrome (DSS) through DF and dengue haemorrhagic fever (DHF). The hallmark of the severe forms of dengue is vascular permeability and haemorrhage, especially in adults. Recently there are several reports of unusual clinical complications, at times involving CNS.

There was an explosive increase in the geographic distribution of all four DENV serotypes globally after World War II. This is because of several factors; importantly, uncontrolled urbanization, rapid population movement, inadequate water, sewer and waste management, as well as unsustainable vector control programmes. Currently all four DENV serotypes are found in nearly all urban and peri-urban areas throughout the tropical and subtropical regions of the world[5] (Fig. 2).

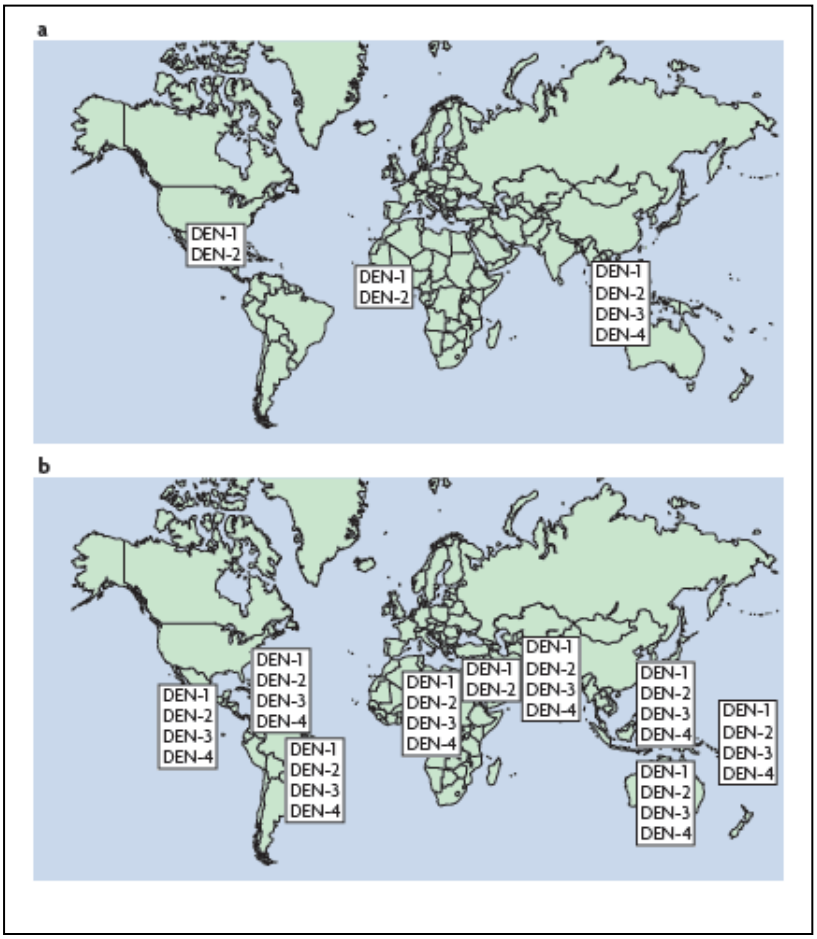


Figure 2: Changing global distribution of DEN serotypes from 1970 (a) to 2004 (b). (Source: Gubler, 1998)

Global epidemiology of dengue

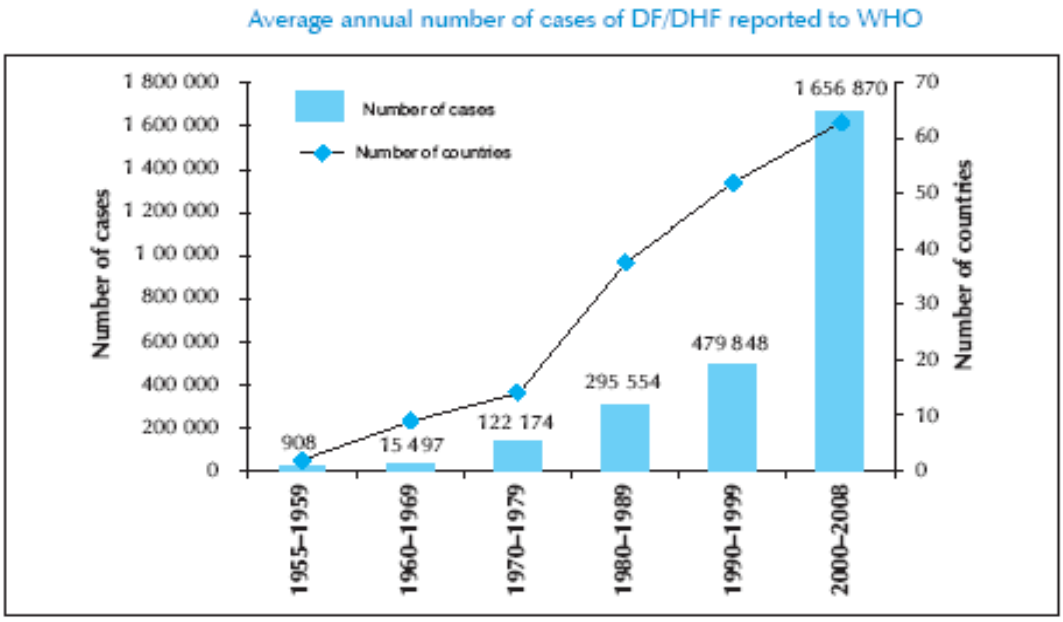
The distribution of the two major vectors is global and as a result nearly a third of the human population is at risk of dengue infection. Currently, dengue fever is the fastest emerging arboviral infection spread by *Aedes* mosquitoes with major public health consequences in over 100 countries in South-East Asia, the Western Pacific, and South and Central America. Up to 2.5 billion people globally live under the threat of dengue fever and its severe forms - DHF or DSS, of whom more than 75% people (~1.8 billion) live in the Asia-Pacific Region. The disease is spreading to new geographical areas in leaps and bounds as a result of the expansion of the distribution of its vectors with increased frequency of outbreaks. The scenario is becoming complicated due to changing disease epidemiology and climate. The global spread of dengue fever within and beyond the usual tropical boundaries threatens a large percentage of the world's population, as human and environmental conditions for persistence and even spread of infection are present in all continents[6].

It is estimated that of the 50 million cases of dengue fever occurring worldwide annually half a million people suffer from DHF and require hospitalization leading to loss of significant numbers of DALYs (1300 per million population)[7] and hence tremendous economic burden. The burden of illness caused by dengue is measured by a set of epidemiological indicators such as the number of clinical cases classified by severity (DF, DHF & DSS), duration of illness episode, quality of life during the illness episode, case-fatality rate and absolute number of deaths during a given period of time. All these epidemiological indicators are combined into a single health indicator, DALYs.

Children less than five years old are mainly affected and the case fatality rate (CFR) ranges from 2.5 - 5.0% among affected cases. However, recently there is shift in age profile of dengue with older children as well as adults being affected by dengue. Every 10 years, the average annual number of cases of DF/DHF reported to WHO continues to grow exponentially. From 2000 to 2008, the average annual number of cases was 1.66 million nearly three-and-a-half times the figure for 1990-1999, which was 0.47 million cases (Fig. 3A).

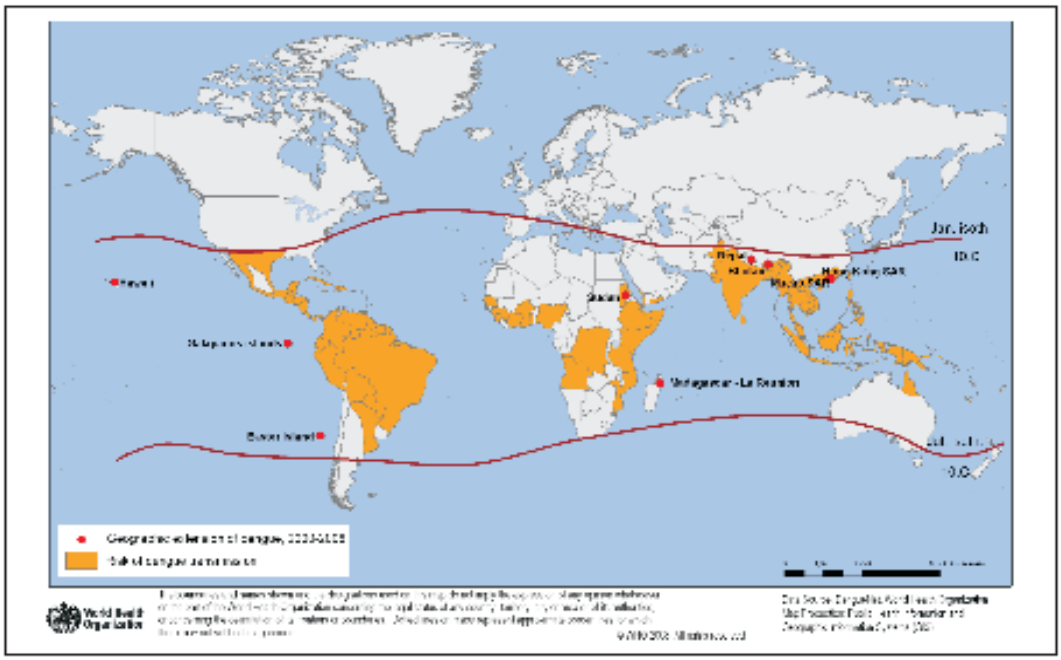
All four dengue viruses are currently circulating in Asia, Africa and the Americas. In 2008, a record 69 countries from the WHO regions of South-East Asia, Western Pacific and the Americas reported dengue activity. Geographical extension of areas with dengue transmission or resurgent dengue activity has been documented in Bhutan, Nepal, Timor-Leste, Hawaii (USA), the Galapagos Islands (Ecuador), Easter Island (Chile), and the Hong Kong and Macao Special Administrative Regions of China between 2001 and 2004 (Fig. 3B). Nine outbreaks of dengue occurred in north Queensland, Australia, in four years from 2005 to 2008[8].

A



Source: www.who.int.

B



Source: Dengue Net, WHO, 2008. www.abc.net.au/rn/backgroundbriefing/documents/20100221_map.pdf

Figure 3: Global burden of DF/DHF

Dengue, especially its severe forms DHF and DSS, has become major international public health concerns over the past three decades concomitant to the spread of different serotypes of the virus[9]. This situation has worsened in the recent past and may continue to do so in the future unless consorted efforts are made to control. Efforts to decrease transmission by vector control have failed, and no effective antiviral treatment is available or foreseeable on the immediate horizon. However, due to early detection and better case management, reported case-fatality rates in many countries have been lower in recent years than in the decades before 2000.

Due to the high disease burden, dengue has become a priority issue for several global organizations other than WHO, including the United Nations Children's Fund (UNICEF), United Nations Environment Programme (UNEP) and the World Bank among others. In May 1993, the Forty-sixth World Health Assembly (46th WHA, 1993) adopted a resolution on dengue prevention and control, which called for strengthening of national and local programmes for prevention and control of dengue. DF, DHF and DSS should be among the foremost health priorities of those WHO Member States where the disease is endemic. The resolution also urged Member States to: (1) develop strategies to contain the spread, and increasing incidence of dengue in a manner sustainable; (2) improve community health education; (3) encourage health promotion; (4) bolster research; (5) expand dengue surveillance; (6) provide guidance on vector control; and (7) prioritize the mobilization of external resources for disease prevention. In response to the WHA resolution, a global strategy for operationalization of DF/DHF vector control was developed. It comprised the following five major components:

1. Selective integrated mosquito control with community and intersectoral participation
2. Active disease surveillance based on strong health information systems
3. Emergency preparedness
4. Capacity-building and training
5. Intensive research on vector control

Epidemiology of dengue in South East Asia

A severe form of haemorrhagic fever, most likely akin to DHF, emerged in some Asian countries following World War II that lead to significant ecological disturbance and demographic changes[10]. The population growth and unplanned urbanization that ensued subsequently resulted in limitations of housing and water supply, and break down of water and waste water management, and solid waste disposal in the region. These changes favoured the geographic expansion of both dengue virus as well as its vectors. From the 1950s through 1970s, cyclical epidemics of dengue were reported from several Asian countries such as India, Philippines and Thailand with increasing magnitude during successive

years (Fig. 4). Increased disease transmission and frequency of epidemics were also the result of circulation of multiple serotypes in Asia.

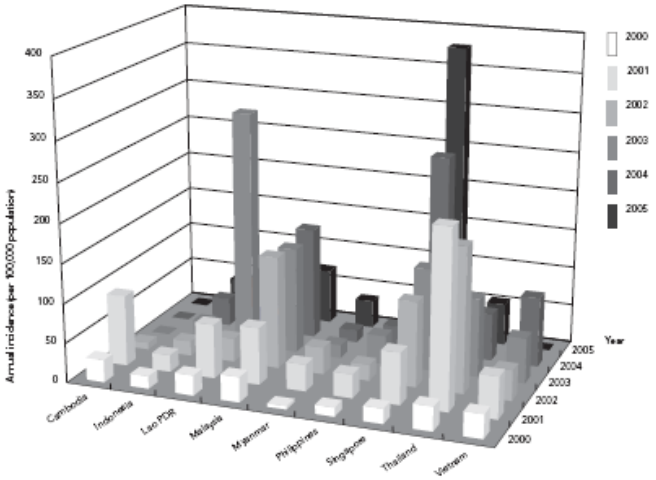
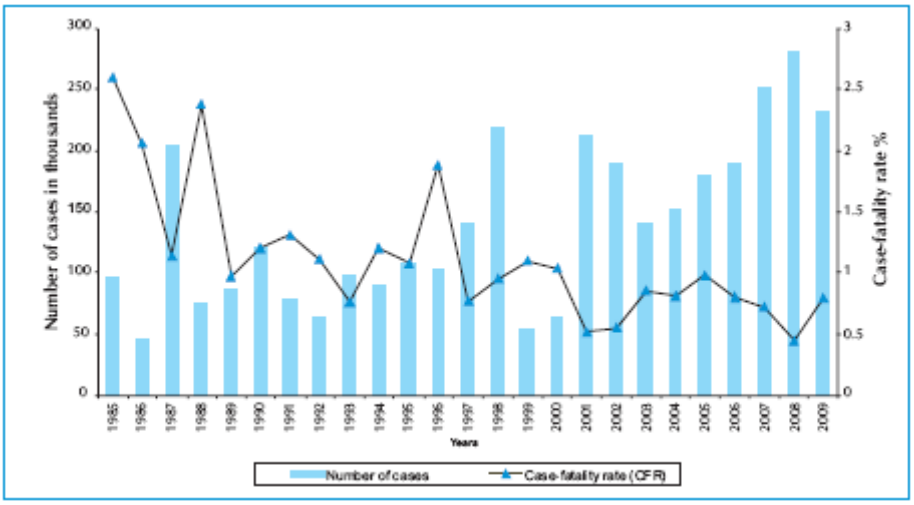


Figure 4: Annual incidence of dengue fever/haemorrhaegic fever in Southeast Asian countries, 2000-2005 (Source: Ooi and Gubler, 2008)

Of the 2.5 billion people around the world living in dengue endemic countries and at risk of contracting DF/DHF, nearly half of them live in 10 countries of the WHO South-East Asia (SEA) Region. This region together with Western Pacific Region bears nearly 75% of the current global disease burden due to dengue. Till 2003, only eight countries in the Region had reported dengue cases. However, by 2009, all Member States, except Democratic Peoples' Republic of Korea reported dengue outbreaks. Korea is the only country in the South-East Asia Region that has no reports of indigenous transmission of dengue. Timor-Leste reported an outbreak in 2004 for the first time. Bhutan also reported its first dengue outbreak in 2004.[10] Similarly, Nepal reported its first indigenous case of dengue in November 2004.[11]

In India and Thailand, the prominent strain of dengue has been DEN 1 which is linked with high morbidity and low mortality. In Indonesia, the number of reported cases started to rise since 2004 and reached a plateau between 2007 and 2009 and is following an endemic pattern. In other countries such as Bangladesh, Myanmar and Maldives also, it is following the endemic pattern. Moreover, there has been an increase in the proportion of severe dengue cases, particularly in Thailand, Indonesia and Myanmar. The trend of dengue cases and case fatality rates reported from countries in the SEA Region are shown in Fig. 5. The case-fatality rate (CFR), however, has registered a declining trend since 1985 and this could be attributed to better case management. DF/DHF is endemic in most countries of SEA Region and detection of four serotypes has now rendered these countries hyper-endemic. However, the endemicity in Bhutan and Nepal is reported to be uncertain.



Source: Country reports

Figure 5: Trends in the number of dengue cases and case-fatality rates (CFR) reported from countries in the SEA Region, 1985-2009.

Generally urban areas are much affected by dengue. For example, in Delhi, India, there has been an increase in number of reported cases of DF/ DHF during 2009 as compared to previous year and the number of reported cases started to rise earlier (July/ August) as compared to previous years where it started to show a rising trend in September/ October (Fig. 6). Dengue cases are being reported from Delhi every year since long time. An outbreak of dengue was reported in 1996 with 10 252 cases and 423 deaths following which increased number of cases was reported again in 2003 and 2006. In 2010, cases started rising in second week of July; 60 - 70 cases are being reported daily and till 19th September 2296 cases and 5 deaths have been reported. In comparison, in 2009, 1153 cases were reported with 3 deaths.

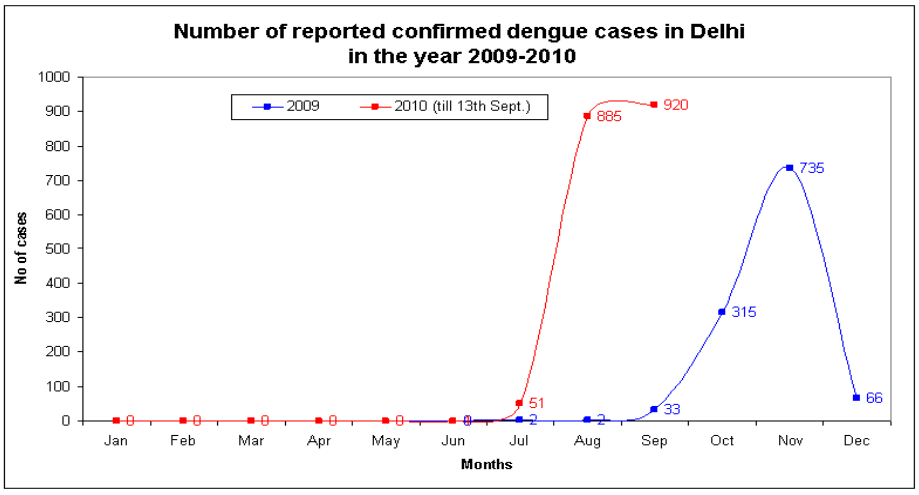


Figure 6: Number of reported confirmed cases of DF/ DHF in Delhi, India 2009-2010

Similarly, in Indonesia, where more than 35% of the country's population lives in urban areas, 150 000 cases were reported in 2007 (the highest on record) and almost the same number reported annually till 2009, and then reduced to almost half in 2010 (i.e. 80 065 cases) (Table 1). Over 25 000 cases reported from both Jakarta and West Java alone. The CFR was approximately 1% during 2009.

In Myanmar in 2007, the states/divisions that reported large number of cases were Ayayarwaddy, Kayin, Magway, Mandalay, Mon, Rakhine, Sagaing, Tanintharyi and Yangon. In 2007 Myanmar reported 15 283 cases and in 2009 there was a sharp rise in cases (24 287) with 181 deaths. The reported CFR in Myanmar during this year was slightly above 1.0%.

In Thailand, dengue is reported from all four regions: Northern, Central, North-Eastern and Southern. In June 2007, outbreaks were reported from Trat province, Bangkok, Chiangrai, Phetchabun, Phitsanulok, Khamkaeng Phet, Nakhon Sawan and Phit Chit. A total of 69,947 cases were reported from this country in 2007. However, there was a steep hike in number of dengue cases during 2008 (89 626), followed by a fall in number in 2009, and another significant hike in 2010. However, the case fatality rate in Thailand was significantly low (below 0.2%) throughout (Table 1).

Table 1: Number of cases of DF/ DHF and Incidence (per 100 000 population) of DF/ DHF in SEA Region, 2000-2010.

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Bangladesh	5,551	2,430	6,132	486	3,913	1048	2200	466	1153	474	76
	3.95	1.70	4.21	0.33	2.60	0.68	1.42	0.30	0.72	0.29	0.05
Bhutan	0	0	0	0	2,579	11	116	86	73	351	16
	0	0	0	0	409.37	1.72	17.58	12.84	10.74	50.14	2.29
DPR Korea	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0
India*	650	3,306	1,926	12,754	4,153	11985	12317	5023	12561	15535	9357
	0.06	0.32	0.18	1.20	0.38	1.10	1.11	0.45	1.10	1.31	0.79
Indonesia	33,443	45,904	40,377	51,934	79,462	95279	106425	157442	155607	156052	80065
	16.31	22.07	19.23	24.38	36.79	43.51	48.16	70.29	68.55	66.83	34.29
Maldives	180	73	27	38	742	1126	2768	1680	1476	774	550
	66.18	26.45	9.64	13.38	257.64	385.62	935.14	560.00	483.93	253.77	180.33
Myanmar	1,884	15,695	16,047	7,907	7,369	17454	11383	15285	14480	24287	11704
	4.04	33.39	33.93	16.61	15.35	36.14	23.37	31.13	29.25	45.48	21.92
Nepal	0	0	0	0	0	0	25	3	6	30	2
	0	0	0	0	0	0	0.09	0.01	0.02	0.10	0.01
Sri Lanka	3,343	4,304	8,931	4,749	15,463	5994	11980	7314	6555	35010	27142
	17.88	22.89	47.25	24.86	79.71	30.58	60.51	36.57	32.61	169.13	131.12
Thailand	18,617	139,327	114,800	62,767	38,367	45,893	42456	62949	89626	25194	57948
	29.88	221.51	180.22	97.31	58.85	69.64	63.84	94.09	133.17	37.00	85.09
Timor Leste	0	0	0	0	434	1128	162	210	186	175	473
	0	0	0	0	45.68	113.94	15.88	19.81	17.06	14.58	39.42
SEAR	**63,668**	**211,039**	**188,240**	**140,635**	**152,482**	**179918**	**189832**	**250458**	**281723**	**257882**	**187333**
	4.20	**13.72**	**12.06**	**8.88**	**9.49**	**11.04**	**11.50**	**14.98**	**16.62**	**14.65**	**10.64**

The reported number of cases and CFR in different countries vary over the years. Reported CFR for the region is around 1%. But in India, Indonesia and Myanmar, focal outbreaks away from the urban areas have also been reported higher CFRs of 3-5% (Fig. 7 and Table 1).

In summary, currently the Indian sub-continent is experiencing a huge problem of DF/DHF. The large scale epidemic of dengue that Pakistan is facing currently is probably unprecedented in the history and appears to have caught the country unaware. The recent emergence of DHF in the Indian subcontinent has been well documented in Sri Lanka also. This country also has also experienced large scale epidemics during the last few years with large number of reported cases and deaths. Dengue fever has emerged as an important public health problem in the country in the early 1980s and all dengue viral serotypes have been found in circulation causing DHF. As described in the foregoing section, the spread of dengue in the island country was phenomenal. It occurred in around Colombo city during 1960s and spread centripetally throughout the country during the next 4 decades, leaving only the southern central forested area free. The magnitude of DF and DHF epidemics in the country has continued to increase.

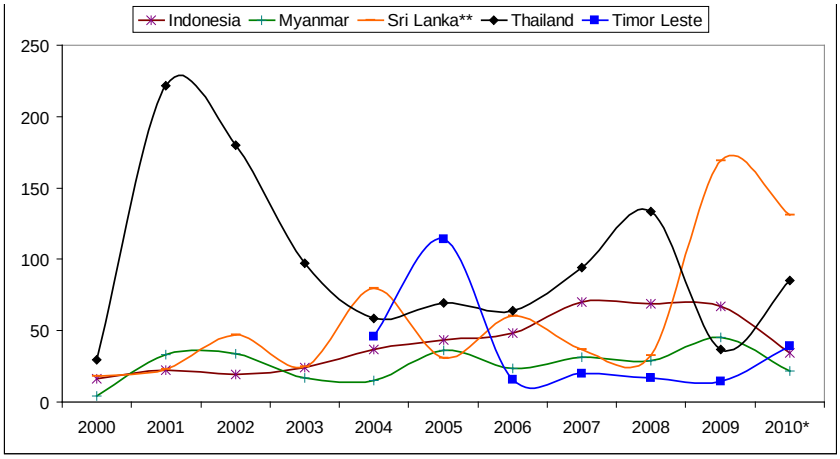


Figure 7: Incidence of reported DF/ DHF (including confirmed/ probable/ suspected cases) per 100,000 population in selected Member States.

Situation of Dengue in Sri Lanka

Geographic and climatic features of Sri Lanka

Also called earlier as Ceylon, Sri Lanka has geographic and climatic features that are conducive for the propagation of vectors of dengue fever and its epidemics. It is an island country located off the southeastern tip of India (7°N 81°E) with an area of 62 705 sq. km of which 870 km² is covered with water. Its terrain is mostly low, flat to rolling plain, with mountains in the south-central interior. One-

fifth of the land is covered with forested areas which include scrub jungles (dry zone) and, tropical and sub-tropical evergreen forests (wet zones) (Fig. 8). Its coastline is 1340 km long and has air and sea route connectivity with India and other neighbouring countries, which have the history of dengue epidemics.

The climate of Sri Lanka includes tropical monsoons: the northeast monsoon (December to March) and the southwest monsoon (June to October). The average yearly temperature for the country ranges from 28 to 30°C. The rainfall pattern is marked by four seasons: from mid-May to October with as high as 2500 mm of rain per month in some areas, October and November, the inter-monsoonal months with periodic spells, December to March with up to 1250 mm of rain northeastern slopes of the mountains and another inter-monsoonal period that occurs from March until mid-May, with light, variable winds and evening thunder showers. Humidity ranges from 60% to almost 90% during different seasons and regions of the country. The land use pattern comprises arable land 14%, permanent crops 15% and permanent pastures 7%. The major crop is rice cultivated on irrigated lands and others cash crops that include tea, rubber, coconut, sugarcane and tobacco.

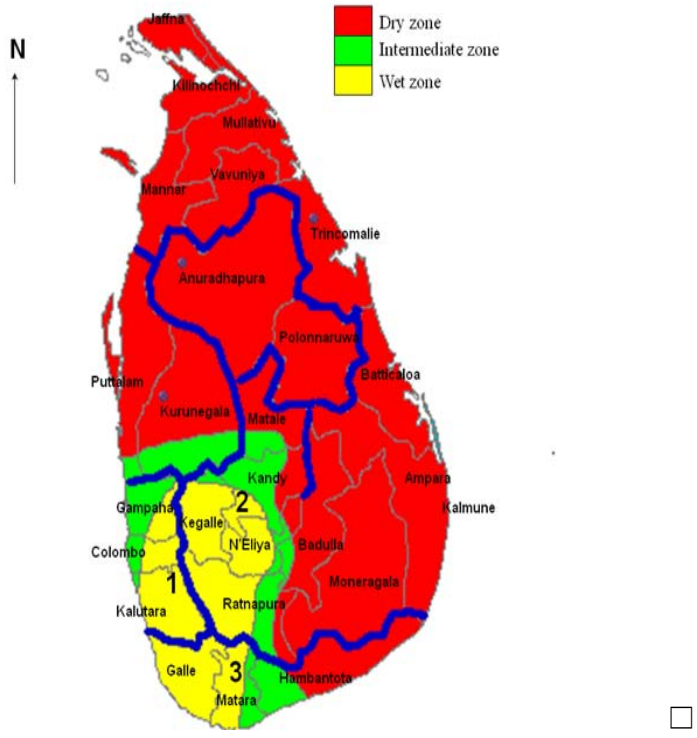


Figure 8: The map of Sri Lanka showing precipitation and irrigation patterns (Source: Wikipedia)

The country is divided into nine provinces, 25 districts and 321 divisional secretary areas. It has a population of about 21 million (density 319/sq. km) of which 21% constitute urban residents. Ethnic

groups mainly include Sinhalese 70% (mainly Buddhists), Sri Lankan Tamils 10% and Sri Lankan Muslims 8%.

Epidemiology of dengue in Sri Lanka

Dengue cases were serologically confirmed in Sri Lanka since 1962. However, cases occurred in epidemic proportions for the first time in Sri Lanka during 1965-66 with sporadic cases of hemorrhagic disease. Initially, the disease was mainly spread in the western costal belt and later found in other suburbs as well. In 1965, there was a dengue outbreak throughout the country with 51 cases and 15 deaths. Since then epidemics were found to have occurred in many parts of the country fairly regularly in 1966, 1967, 1968, 1972, 1973 and 1976, and the number of cases was reaching a peak in 1988. Despite periodic epidemics of DF during 70s through 80s, reporting of DHF/DSS cases never being in significant numbers in spite of circulation of all four dengue viral serotypes and a high prevalence of secondary serological response (e.g. 74% in Colombo) among confirmed cases. The first epidemic of DHF/DSS occurred during 1989-90 and the etiological agent was DENV-3, which was reported to have a genetic change resulting in increased epidemic potential/ virulence. Since then outbreaks with successive ones being larger in dimension than previous ones have occurred (Fig. 9A & B), and currently DF and DHF are endemic to Sri Lanka.

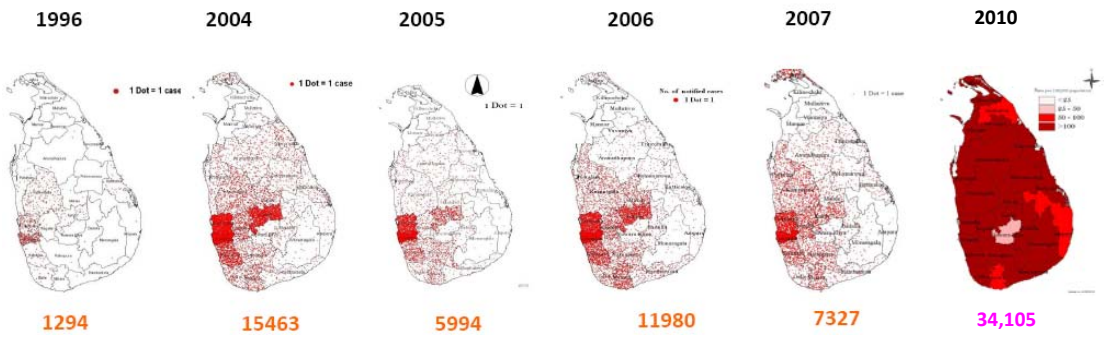


Figure 9A: Temporal and spatial spread of dengue cases in Sri Lanka during 1996 -2007 (Source: Weekly Epidemiological Report, Epidemiology Unit, Ministry of Health, Sri Lanka).

In this millennium, the first large scale epidemic in Sri Lanka was recorded in the year 2002 with 8931 cases and 64 deaths, followed by a relatively low endemicity in 2003 with half the numbers (4749 suspected cases and 32 deaths). However, in 2004 there was a much bigger epidemic with 15 463 suspected cases and 88 deaths reported to the Epidemiology Unit of the Ministry of Health. However, in 2005, only 5211 suspected cases of DF/DHF and 26 deaths were reported (Fig. 10). In 2006, the reported dengue cases and deaths had increased by two folds compared to 2005 figures. As stated elsewhere, during the biannual period 2009-2010, Sri Lanka recorded the largest outbreak with almost 70 000

cases. In 2009 the country reported 35 008 cases and 346 deaths (CFR 1.0%) and in 2010, these figures were 34 105 and 246 (CFR 0.7%) respectively. The case fatality rates ranged from 0.4% to 1.1%. It should be noted that in 1996 the CFR was significantly high (4.2%). Since then it was in decimals till 2009. In 2009, it went up to 1.0% and subsequent to interventions especially on clinical management implemented by the Ministry of Health with the support of WHO, it was brought down to 0.7 in 2010 as explained in later sections.

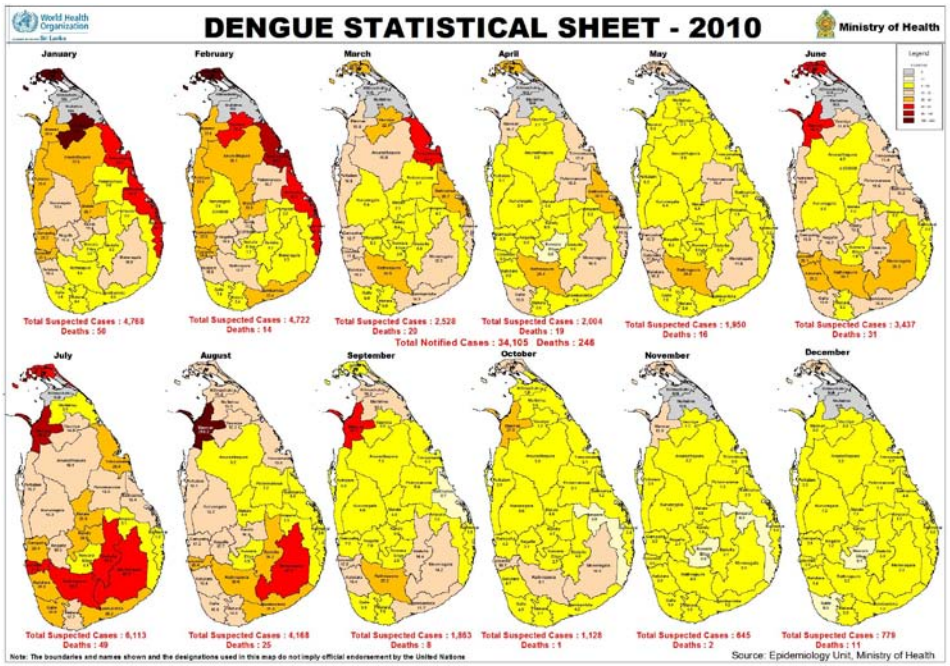


Figure 9B: Temporal and spatial spread of dengue cases in Sri Lanka in 2010 (Source: Epidemiology Unit, Ministry of Health, Sri Lanka).

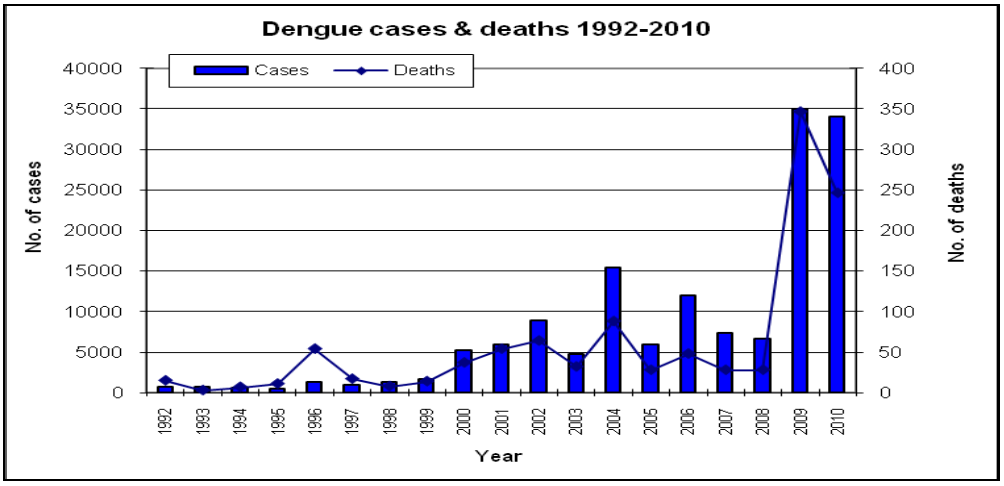


Figure 10: Dengue morbidity & mortality by year 1992-2010 in Sri Lanka

Currently, DF/DHF cases were reported from almost all the districts (Fig. 11). However, in 2004, 72% of cases and 78% of deaths were reported from five cities namely Colombo, Kandy, Gampaha, Kalutara and Kurunegala. Analysis of distribution of cases by province shows that since the beginning of regular outbreaks, Western Province borne the brunt of dengue. In 2007, 61% of reported cases were from the Western Province, while Central and Sabaragamuwa Provinces reported 12% and 10% of cases respectively (Fig.12).

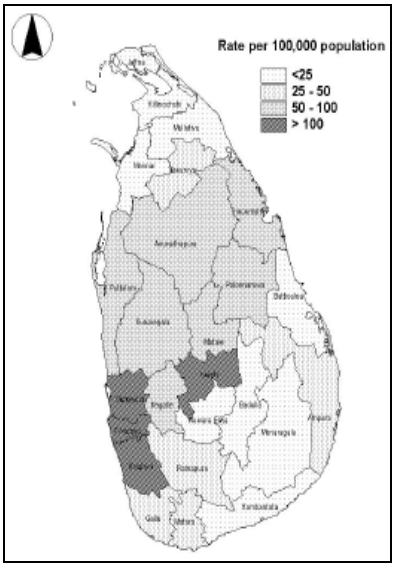


Figure 11: Distribution of confirmed dengue cases by districts 2008 (Source: Weekly Epidemiological Report, Epidemiology Unit, Ministry of Health, Sri Lanka).

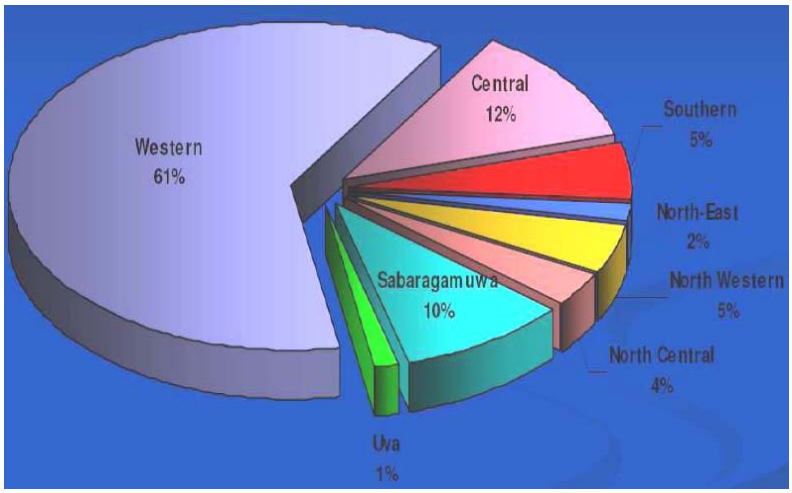
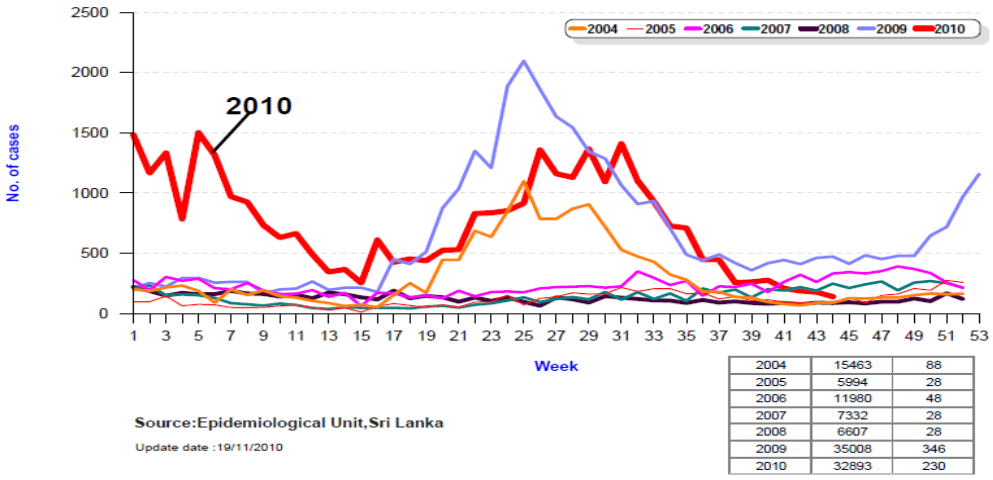


Figure 12: Distribution of dengue cases in Sri Lanka by province, 2007 (Source: Weekly Epidemiological Report, Epidemiology Unit, Ministry of Health, Sri Lanka).

However, in 2010 only 34% of cases were reported from the Western Province despite the fact that there was no marked change in the absolute number of cases compared to the previous year. The reduction in the proportion of cases reported from Western Province was mainly due to increase in cases reported from Northern and Eastern Provinces (Fig. 9B), which were opened up for 'free travel' without restrictions following the end of war in Sri Lanka. The post-conflict period has also witnessed extensive developmental activities in this region. Before 2009/2010, as the result of conflict, accessibility to this region was greatly limited. During this period, no major dengue outbreaks were reported from this region.

Two peaks in the absolute number of cases as well as incidence occur annually in association with monsoon rains, when the density of two mosquito vector species (*Ae. aegypti* & *Ae.albopictus*) is high (Fig. 13). Generally, the first peak occurs in June/July that coincides with the south-western monsoon which commences in late April. The second peak, comparatively a smaller one, usually occurs at the end of the year which is associated with the north-eastern monsoon rains that prevail from October to December.



2004	15463	88
2005	5994	28
2006	11980	48
2007	7332	28
2008	6607	28
2009	35008	346
2010	32893	230

Figure 13: Distribution of notified dengue cases by week 2004-2010

All the age groups were affected with major proportion being below 35 years (Fig. 14). Prior to 2004, pre-school children were found to be mainly affected followed by school children. But during post-2004 period, there was a shift in age profile with older children and young adults being affected more and more. Also there were some significant differences in clinical profile between adults and children, fewer adults developed pleural effusions, ascites or shock[16].

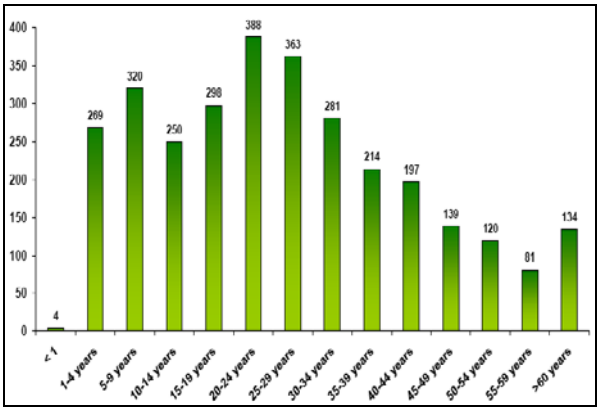


Figure 14: Distribution of dengue in different age groups in Sri Lanka

Dengue serotypes in Sri Lanka

DENV-1 and DENV-2 were isolated during the outbreak of 1965-66 in Sri Lanka. During 1989-2002, DENV-2 was mainly in circulation followed by DENV-3 in Sri Lanka. However, DENV-3 dominated during the large epidemic of 2004. It may be noted that the same serotype was also in circulation in the southern parts of India[13]. The relative proportion of the four dengue serotypes in Sri Lanka during the period from 1989 to 2004 is shown in fig. 15.

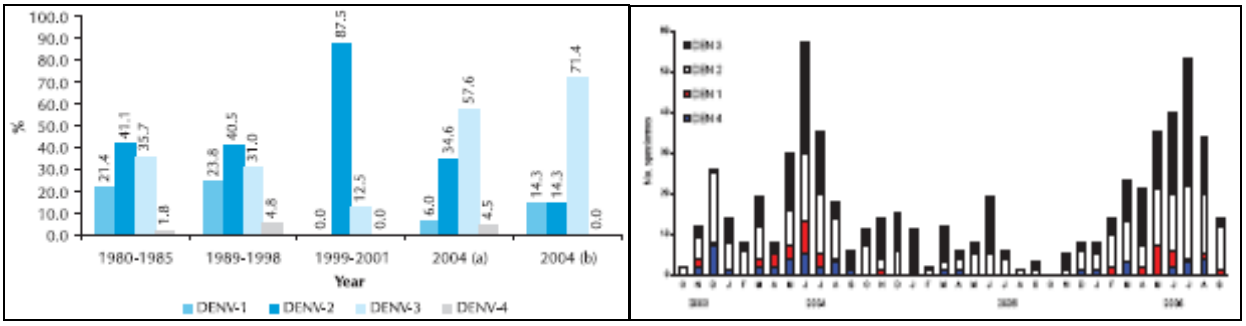


Figure 15: Relative percentages of dengue serotypes in Sri Lanka between 1980 and 2004 (Source: Kularatne et al., 2006; Messer et al., 2002))

A subsequent study on relative abundance of DENV during 2003-2006 also showed that DENV-2 (40%) and DENV-3 (46%) were more common, while DENV-1 and 4 were of rare occurrence (7% each)[12]. Thus, over 30 years of period all four DENV serotypes have been found to be circulating in Sri Lanka. During this period, new genotypes of DENV-1 and new clades of DENV-3 (genotype III) have replaced the older ones (Fig. 16). This is a significant observation as it coincided with the occurrence of large number of dengue cases with increasing emergence of DHF cases and a shift in age groups of cases from children to adults[14].

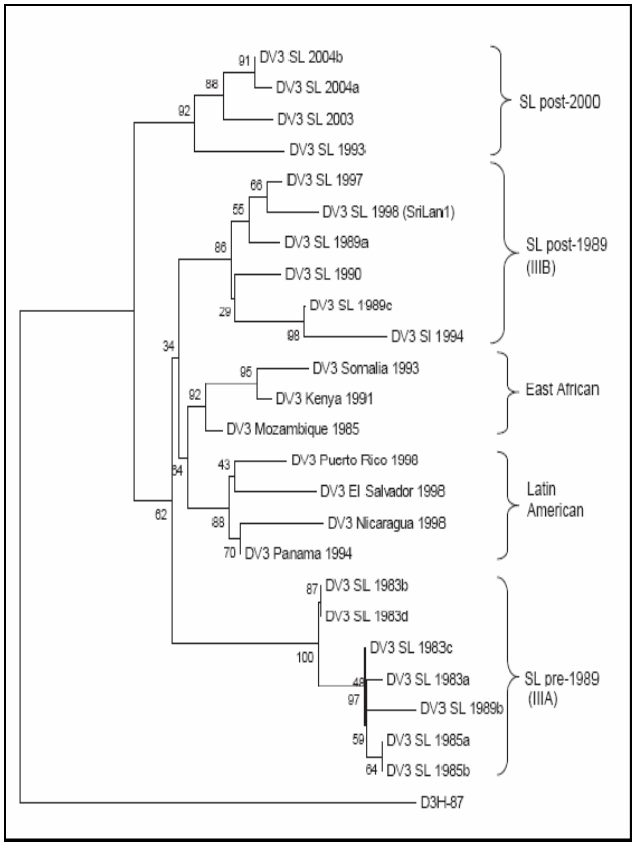


Figure 16: Phylogram of DENV-3 genotype III viruses in Sri Lanka (SL) during 1981-2004 and in other areas. In 1989 and again in 2000, the dominant clade of DENV-3 genotype III was replaced by a new clade of genotype III (Source: Kanakaratne et al., 2009).

Vectors of dengue in Sri Lanka

Both *Aedes aegypti* (Linnaeus) and *Aedes albopictus* (Skuse) (Fig. 1D & E) are prevalent in the country and natural infections have been reported in both vectors. However, tranasovarial transmission has not been reported in Sri Lanka, which is important to maintain the viral cycle during inter-epidemic periods. In this context, it is of interest to point out that there was serological evidence for an epizootic dengue virus infecting toque macaques (*Macaca sinica*) in Polonnaruwa, Sri lanka[15]. *Ae. aegypti* is the primary vector and has been reported to be responsible for major epidemics in Sri Lanka. This is supported by the fact that in 2004 epidemic, most reported cases were from areas where *Ae. aegypti* was frequently encountered. Whereas in areas with *Ae. Albopictus,* only a few cases were reported. *Ae. albopictus* breeds in urban and peri-urban areas and is considered less efficient vector due to its wide range of hosts and aggressive feeding behavior. A seasonal shift was also observed in the density of the two vector species. *Ae aegypti* density was high during and after the Northeast monsoon, whereas *Ae. albopictus* was the dominant species during the onset of the Northeast monsoon. Interestingly, both

species were found to breed at elevations of 1300 m and together in the same container. Water storage tanks are the most preferred breeding sites, while discarded receptacles and tyres serve as important breeding sites of the two vector mosquito species[16] (Table 2). Small discarded containers and plastic sheets were also the main breeding places and most productive for pupal development as they were seldom removed by waste disposal services and people did not commonly use larger water containers. However, in a multi-country study on stegomyia indices viz., Container index (CI), House index (HI) and Breteau index (BI) in Sri Lanka were found to be low compared to that in other dengue endemic countries[17] (Table 3) .

Table 2: Positivity of different types of breeding sites for *Ae. aegypli* and *Ae. albopic* in Kandy and Nuwara-Eliya districts, January 2003 - December 2004 (Source: Kusumawathie and Siyambalagoda, 2005)

Habitat	Number & percentage of habitats positive for		
	Ae. aegypti	*Ae. albopictus*	Total
Water storage containers	126 (62%)	108 (48%)	214 (54%)
Discarded	25 (12%)	53 (23%)	75 (19%)
Tyres	48 (24%)	52 (23%)	93 (23%)
Domestic appliances	4 (1%)	5 (2%)	7 (2%)
Others	1 (1%)	8 (4%)	9 (2%)
Total	204 (100%)	226 (100%)	399 (100%)

Table 3: Vector breeding places and measures of vector production in buildings in a study of risk factors for dengue vector breeding in six Asian sites, 2006-09 (Source: Arunachalam *et al*., 2010).

Parameter	Site					
	India (n^b = 20)	Indonesia (n = 12)	Myanmar (n = 20)	Philippines (n = 12)	Sri Lanka (n = 20)	Thailand (n = 12)
Container index[c]	5.4	10.7	7.1	12.9	11.1	7.6
House index[d]	19.4	33.1	36.3	16.6	9.1	30.2
Breteau index[e]	28.1	55.3	65.9	24.1	11.3	48.8
Total no. of water containers	10 511	5420	18 510	2319	2063	7804
Per cent of all containers located indoors	83.4	51.5	37.5	42.8	7.1	62.2
Per cent of all containers filled with tap water	95.0	77.6	81.6	86.4	53.6	67.0
Most frequent container types (% of all containers)	Plastic pot (45.4)	Bucket (26.0)	Flower vase (48.7)	Drum/barrel (38.7)	Tin/bottle (27.1)	Ceramic jar (50)
	Metal container (21.5)	Cement tank (25.7)	Cement tank (14.3)	Ceramic jar (32.5)	Bowl (16.2)	Cement tank (13.7)
	Drum/barrel (10.5)	Tin/bottle (6.4)	Drum (12.4)	Coconut (16.17)	Plant axil (11.7)	Bucket (9.9)
Total no. of pupae in all containers	1652	2324	2155	1478	543	453
Most productive container types (% of all pupae)	Cement tank (39.9)	Cement tank (42.8)	Spiritual flower bowl (51.7)	Drum/barrel (49.2)	Bowl (41.6)	Bucket/bowl (38.9)
	Drum/barrel (14.0)	Drum/barrel (13.8)	Cement tank (19.5)	Coconut (18.8)	Tin/bottle (38.6)	Tyres (14.6)
	Grinding stone (13.4)	Flower vase (12.5)	Flower vase (7.2)	Ceramic jar (9.8)	Cement tank (5.7)	Tins/bottles (10.8)

[a] Data collected through entomological survey, wet season only.
[b] *n* is the number of clusters studied.
[c] Per cent of water containers positive for immature forms of *Aedes*.
[d] Per cent of inspected houses with at least one container positive for immature forms of *Aedes*.
[e] Number of containers positive for immature forms of *Aedes* per 100 inspected houses.

Ae. aegypti was the most predominant blood-sucking species in urban centres which correlated well with the findings of the larval surveys. Indoor biting rates of *Ae. aegypti* were six times higher than that of outdoors whereas the opposite was true for *Ae. albopictus*. The former species was found resting commonly indoors. Both the species were found to be highly resistant to 4% DDT and completely susceptible to 5% malathion.

Clinical profile of dengue cases in Sri Lanka

In general, clinical manifestations of DF in Sri Lanka are similar to that presented in other Asian countries, which include high fever, myalgia, headache (mostly frontal), vomiting and loss of appetite. While in DHF/DSS, the symptoms of acute condition begin as in DF and then develop into a severe permeability syndrome that may lead to shock and death in some people. The mean duration of fever was 7 days (range 1-19 days) and the degree of fever varied from low to high grade fever. Generalized erythematous skin flush is prominent in fair skinned patients and islands of pallid areas may be seen mainly on limbs. Some patients present a macular erythematous rash rather than a flush. The flush usually lasts beyond febrile period and its fading is associated with pruritus and mild desquamation[18]. Unusual complications such as myocarditis, effusions, encephalopathy, acute renal and liver failures, and diarrhea have also been observed in some cases[19] (Fig. 17).

In Sri Lanka, there are a few well conducted studies dealing with the details of clinical presentations. These studies have lead to the understanding of reasons for shift in the age profile of the patients from children to adults, and the variations in the clinical profile between the two groups. In recent years, there is an increase in the dengue morbidity and mortality among adults. There was no relationship observed between platelet counts and bleeding manifestations in children unlike in adults[19].

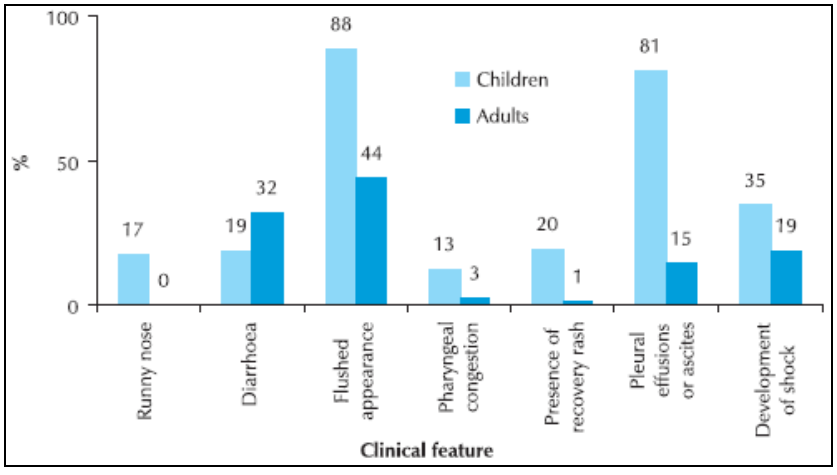


Figure 17: Differences in clinical findings (%) between hospitalized children and adults with dengue (Source: Kularatne et al., 2006)

Table 4: Differences between a) clinical signs and symptom, and b) laboratory and radiological findings in DF and DHF cases (Source: Lucas et al., 2000).

(a)

Symptom/ Sign	DF	DHF	Non–DF
Fever	34	143	177
Vomiting	28	118	149
Abdominal pain	15	62	52
Myalgia	05	22	19
Headache	06	23	23
Loss of appetite	03	13	18
Drowsiness	02	09	25
Coryza	01	04	44
Loose motions	03	12	28
GIT bleeding	15	61	101
Facial flushing	09	39	44
Rashes	12	48	38
Hepatomegaly (tender)	19	82	35
Hepatomegaly (non–tender)	09	28	34
Positive Hess's test	09	38	22

(b)

Lab/X-ray findings	DF	DHF	Non–DF
Raised haematocrit (>40%)	09	143	53
Platelet count			
<100,000/ cu mm	00	69	02
100,000–150,000/ cu mm	01	74	44
Raised SGPT	07	63	44
Pleural effusion	00	22	00

SGPT- Serum alanine aminotransferase

The CFR due to dengue in Sri Lanka is similar to that of other Asian countries and varies from 0.5% - 3.5%[9]. Another study has brought out differences between the DF and DHF cases with respect to clinical signs and symptoms, laboratory and radiological findings (Table 4A & B), which will be useful for case differentiation and appropriate treatment[19].

Intervention measures

As early as in 1996, following the great epidemic of that time, a multi-disciplinary 'Dengue Taskforce' was established by then Her Excellency the President of Sri Lanka to plan and monitor activities for community-based larval source reduction aimed at controlling the *Aedes* mosquito. Accordingly, a 'Plan of Action for Prevention and Control of Dengue' in the country was drawn by the taskforce. The objectives under this plan were: a) to reduce morbidity and mortality due to DF/DHF, b) to forecast and prevent dengue epidemics, and c) to strengthen liaison with civil society groups, NGOs, media and other relevant stakeholders for social mobilization in dengue control. During this period, a "National Dengue Control Unit" was also established at the Ministry of Health.

The current strategy, as per the 'National Plan of Action for Prevention and Control of Dengue Fever 2005-2009' comprises the following components:

1. Current control strategies of dengue fever/dengue haemorrhagic fever

In Sri Lanka, the following strategies are carried out to control DF/DHF.

- Surveillance

  - Disease surveillance
  - Vector surveillance
  - Laboratory surveillance (serological)
- Management of DF/DHF cases
- Vector Control
- Social mobilization
- Emergency response

1.1 Surveillance

The Advisory Committee on Communicable Diseases is the technical committee in the Ministry of Health where policy decisions on the control of all communicable diseases are made. This committee comprises of professors of medicine, paediatrics and community medicine, virologist of the Medical Research Institute, all Deputy Director Generals of the Ministry of Health and heads of specialized campaigns for disease control. This committee is chaired by the Director General of Health Services and the Secretary is the Chief Epidemiologist. This committee meets quarterly and the country situation of all communicable diseases is reviewed in order to take necessary preventive and control measures.

1.1.1 Disease Surveillance (Passive)

DF/DHF is a notifiable disease in Sri Lanka since 1996. All medical officers treating cases of DF/DHF or suspected DF/DHF should notify such cases to the Medical Officer of Health (MOH) of the area of patient's residence. The information is reported to the Epidemiology Unit of the Ministry of Health weekly in the Weekly Return of Communicable Diseases sent from each MOH areas. At the Epidemiology Unit these data are entered into a computer-based information system and necessary guidance is given to the respective MOH regarding control DF/DHF. In the event of notification of unusually large number of cases, all other relevant agencies are alerted and action is taken to prevent further spread.

1.1.2 Laboratory surveillance

The objective is to provide early and precise information to public health officers on various aspects of disease incidence i.e. time, location and virus serotype, and to clinicians serology and virus isolation data for confirmation of the diagnosis of DF/DHF. Active surveillance is carried out at present at selected sentinel stations in and around the city of Colombo by the Virology Department of the Medical Research Institute (MRI).

1.1.3 Vector Surveillance

The main purpose of this is to obtain information on larval and adult vector densities which can be used to control the Aedes mosquitoes. The high risk areas are covered by the Entomology Department of the MRI in the city of Colombo and its suburbs. The other high-risk areas are covered by the entomological teams of the Anti Malaria Campaign (AMC) and Anti Filarial Campaign of the provincial and regional levels. These vector surveillance reports are forwarded to the AMC to coordinate the vector control activities. Monthly meetings are held at the Head Office of AMC to monitor and evaluate the surveillance and vector control activities.

1.2 Vector Control

As a long-term control measure, larval source reduction activities are carried out through environmental management such as regular solid waste disposal and container removal programmes by the municipal council staff and field health staff. Further, these officers conduct clean up campaigns with the assistance of the public and non-governmental organizations (NGOs). Similar activities are carried out in high risk areas by the field staff in MOH office with the support of the community and other organizations.

1.3 Social Mobilization

In respect of the Ministry of Health, the Health Education Bureau (HEB) takes the lead in providing technical guidance for social mobilization focusing in health issues in DF/DHF control activities in collaboration with the Epidemiology Unit and other special units in the Ministry of Health. Efforts to ensure proper disposal of refuse and source reduction are the main emphasis of social mobilization. The electronic and print media play an important role in getting the public support during an outbreak situation.

1.4 Presidential Task Force for Dengue Control

One of the landmark initiatives was establishment of a second multi disciplinary 'Presidential Task Force (PTF) for Dengue Control' on May 25, 2010 under the leadership of H.E. the President of Sri Lanka to plan and monitor activities for community-based larval source reduction aimed at controlling the *Aedes* mosquito.

Eight key ministries whose contribution is vital to control Dengue were brought under the umbrella of PTF for Dengue Control. They are Ministries of Health, Education, Local Government and Provincial Councils, Environment, Public Administration, Media, Disaster Management and Defense.

The Terms of Reference (ToR) of the PTF (Fig. 18) are mainly to target at reducing the number of dengue cases and deaths by conducting well planned and coordinated dengue control activities at provincial, district and divisional levels. To achieve this, the structure of the PTF is extended down to the village level. Each Ministry has developed its own action plan for dengue control. Committees have been established at provincial, district and divisional levels to coordinate, implement and monitor these action plans.

Main responsibilities of each sector are:

i. Ministry of Health – improving case management and minimizing deaths due to dengue, surveillance of cases and death audits and provision of technical information to all sectors;
ii. Ministry of Education – maintaining educational institutions as 'zero mosquito breeding places', developing a sustainable behaviour change among student population to create mosquito free environment;
iii. Ministry of Local Government and Provincial councils – preparing and empowering bylaws for proper waste management and keeping the townships and villages clean;
iv. Ministry of Disaster Management – active participation of staff at all levels in dengue control activities;
v. Ministry of Public Administration – ensuring that public and private institutions are free of dengue breeding places;
vi. Ministry of Environment – management of garbage in an environmental friendly manner and reducing production/consumption of non-biodegradable materials;
vii. Ministry of Defense – ensuring that all the institutions/shelters under ministry are free of mosquito breeding sites;
viii. Ministry of Media – education of the general public on prevention and control of dengue in a responsible manner.

Subsequently, similar committees were formed at the provincial, regional and divisional levels to organize the necessary resources and to implement various dengue control activities.

1.5 Emergency Response

In November 1996, a National Consultative Meeting was held to identify strategies to strengthen outbreaks response to new emerging and re-emerging infectious diseases. At this meeting a draft action plan was formulated on epidemic preparedness and control of DF/DHF. At present, activities are carried out by the district team headed by the Regional Director of Health Services. Emergency responses are coordinated at the national level by the Epidemiology Unit.

1.6 Integration of Disease Surveillance

Following the Integrated Disease Surveillance and Response Workshop held in January 2004 in Sri Lanka, a plan of action was developed for integration and strengthening of disease surveillance activities, where the following recommendations have been made to enhance DF/DHF surveillance:

i. Development of case definitions for DF/DHF
ii. Expansion of the surveillance system to include outpatients and community level case finding using suitable mechanisms
iii. Strengthening of laboratory surveillance
iv. Inclusion of private sector (institutions as well as private practitioners) into the mainstream/ ambit of the surveillance system
v. Strengthening of epidemic preparedness and response at all levels
vi. Consolidation of notification through managerial and supervisory inputs at all levels of the health system
vii. Establishment of the position of Regional Epidemiology Units/ Information Units in the mainstream of the surveillance system
viii. Flow and analysis of data from periphery to centre in a phased manner and the feed back in the reversed direction

1.7 Establishment of sub-committees of technical experts

At the consultative meeting of technical experts held at the BMICH on August 14, 2004 with the Hon. Minister of Healthcare & Nutrition at chair, it was decided to form sub-committees to address key issues with regard to dengue control and prevention in Sri Lanka.

Subsequently, six sub-committees comprising of experts have been formulated to address key issues in different fields regarding future control and prevention of dengue in the country. These sub-committees include renowned experts from universities and other government ministries, in addition to distinguished personalities who have retired from the universities and government service. The six sub-committees are as follows.

i. Clinical Management
ii. Vector control
iii. Virology and Vaccine Development
iv. Social Mobilization
v. Legislative Enactments
vi. Co-ordination of Research on DF/DHF

The National Plan of Action for dengue control has been developed based on the comprehensive plan of action prepared by these sub-committees.

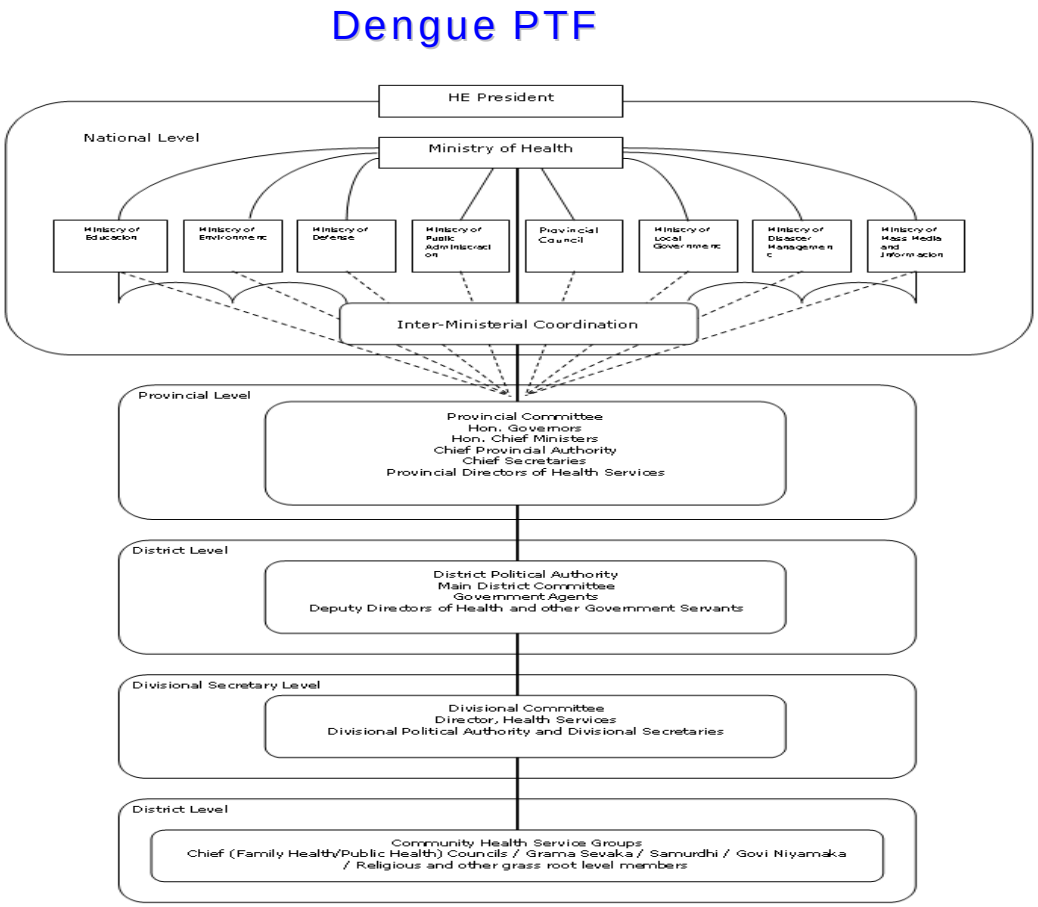


Figure18: The flow chart showing various activities of Presidential Task Force implemented during 2010.

Figure 19: Inauguration of Presidential Task Force on 25 May, 2010.

2. Proposed framework for the control and prevention of dengue fever and dengue haemorrhagic fever

The following framework has been proposed to be carried out in Sri Lanka through integrated approach to reduce morbidity and mortality due to DF/DHF.

2.1 Proper clinical management of DF/DHF cases

The subcommittee on clinical management has developed new guidelines on proper clinical management of DF/DHF cases. The committee comprised of several consultant physicians and pediatricians attached to government hospitals.

The guidelines are in the process of being finalized and will be disseminated to relevant authorities as given in the proposed plan of action. It includes:

i. Management of patients / suspected patients at OPD
ii. Admission criteria to inwards of the hospitals
iii. Clinical management
iv. Discharge criteria for inward patients

Essentially, the case management includes the differentiation of DF and DHF based on plasma leakage as the discriminating factor rather than hemorrhage, management of DHF cases which included identification of the beginning and predicting the end the critical (plasma leakage) phase, meticulous monitoring, accurate fluid management in the critical phase, vigilance, early detection and treatment of concealed bleeding and other complications.

2.2 Strengthening of surveillance

2.2.1. Disease surveillance

In addition to the routine notification data, active surveillance of all cases with fever and hemorrhages at sentinel hospitals is suggested. The sentinel hospitals need to be selected based on disease incidence and vector indices in order to detect epidemics early. Active laboratory surveillance is carried out at present at selected sentinel hospitals by the MRI. This needs to be expanded to other high-risk areas also.

Since at present there is no routine system of recording and disseminating information on DF/DHF from OPD of government hospitals, general practitioners and private hospitals, it has been suggested to develop a health information system for DF/DHF.

2.2.2. Vector surveillance

The main purpose of this is to obtain information which can be used to detect epidemics early and improve the effectiveness of vector control activities. Currently vector surveillance (larval and adult) is carried out in an ad hoc manner in the absence of specific criteria. Therefore, necessary criteria have to be developed to identify high risk areas to be targeted for entomological activities based on vector surveillance data.

There is a need to coordinate activities of all units engaged in vector control by the National Dengue Control Unit. Adequate staff and facilities should be made available for an effective vector surveillance system. Coordination of surveillance activities should be strengthened for best possible monitoring.

2.2.3. Laboratory surveillance

The main objective of active laboratory surveillance is to provide early and precise information on confirmation of diagnosis, magnitude of the disease and viral sero-type. Active surveillance is carried out at present at selected sentinel stations by the Virology Department of the MRI. It is proposed to expand the laboratory surveillance to health facilities in all high risk areas in order to forecast outbreaks and case confirmation.

2.2.4. Health information system for DF/DHF

The information on disease surveillance, vector surveillance and laboratory surveillance should be appropriately coordinated at district, provincial and central level into a common data system. There should be an identified mechanism for flow of information and feed back on action. This DF/DHF information system should be an integral part of the overall communicable disease surveillance system.

2.3 Integrated vector control activities

Source reduction by elimination of breeding places, and chemical and biological control of the vector mosquito must be carried out on a planned basis, complemented by vector surveillance indices. Surveillance of vectors should be an essential routine step in the planning of control measures and their monitoring and evaluation. Surveys are also necessary for studying the ecology and distribution of vectors as well as to determine the risk of outbreaks.

Since vector density has a positive correlation with rainfall, it is necessary to forecast future outbreaks in relation to the rainfall and other climatic factors. Incorporation of rainfall and

entomological data could help to predict future outbreaks and map out high-risk areas for preventive measures.

2.4 Social mobilization

One of the components identified for sustainable prevention and control of DF/DHF is social mobilization. Along with social mobilization, active community participation, inter-sectoral coordination, health education and legislative support are cited as other components for sustainable prevention and control measures.

In Sri Lanka, health education activities are handled at the national level by the Health Education Bureau. At provincial and regional levels, the health education activities are carried out by the respective field and hospital health staff. There should be a coordinated effort to develop and implement an effective media plan targeting awareness creation on dengue, proper disposal of refuse and waste, and source reduction measures through sustained community action.

2.5 Establishment of National Dengue Control Unit

In the absence of a national programme for dengue, the Minister of Health has taken steps to appoint a Director/Dengue Control, to coordinate and mandate the dengue control programme in the country. Necessary infrastructure, logistics and funds should be identified for this unit by the Ministry of Health to facilitate effective and efficient planning, implementation, monitoring and evaluation of prevention and control measures by this unit.

3. Plan of Action for Prevention and Control of Dengue in Sri Lanka

Objectives:

i. To reduce morbidity and mortality due to DF/DHF
ii. To forecast and prevent dengue epidemics
iii. To strengthen liaison with civil society groups, NGOO, media and other relevant stakeholders for social mobilization in dengue control
iv. To identify and mobilize resources to carry out research on dengue
v. To develop and sustain an effective dengue prevention and control programme

For more details please refer to the document entitled the 'National Plan of Action for Prevention and Control of Dengue Fever 2005-2009' published by the Epidemiology Unit, Ministry of Health, Sri Lanka. The proactive role played by the governmental agencies and health officials, aggressive social mobilization that included use of print and electronic media, and punitive measures (annexure) for containing vector breeding appear to have contributed to the reduction in number of

cases, while appropriate management of severe cases has lead to the reduction in CFR which is detailed as below.

Success of intervention measures

In 2009, medical facilities were overloaded with dengue patients and the case management was not effective in reducing the case fatality rate. In addition to controlling dengue, the need to review the existing clinical management practices was well felt. Towards improving the DHF clinical management and reducing the CFR, at the initiative of WHO Country Office Sri Lanka, help of a leading clinician from Thailand, Dr Siripen Kalyanarooj who has long standing experience in managing the DHF cases, was sought. Dr Siripen visited Sri Lanka and carried out death audits and observed existing clinical practices, which revealed certain deficiencies in the case management. She emphasized the need for revising the clinical management guidelines. The guidelines were revised in 2010 based on best available evidence and experience of physicians. Dr Siripen had the opportunity to demonstrate the effectiveness of revised guidelines by saving a child in moribund stage with DHF managed at the children hospital in Colombo. The clinical management guidelines were expeditiously implemented in all hospitals and activities towards reduction of vector breeding sources was undertaken more intensely during 2009. Many of these activities received support from WHO Country Office including that for diagnostics.

The intervention measures currently implemented in Sri Lanka are two-pronged dealing specifically with the morbidity and mortality. The key elements of the morbidity and mortality control are as follows.

1. **Morbidity Control**
    a. Vector surveillance and control mainly through source reduction
    b. Social mobilization

2. **Mortality Control**
    a. Early detection of DHF cases and management as per the case definition and classification according to the revised guidelines published in 2010 (Guidelines on management of Dengue Fever and Dengue Hemorrhagic Fever in Adults, and Guidelines on management of Dengue Fever and Dengue Hemorrhagic Fever in Children and Adolescents, can access at www.epid.gov.lk). These guidelines played a major role in the case management and CFR reduction since 2010.
    b. Regular monitoring of haematocrit and full blood count in dengue patients. Monitoring of these indicators is vey vital for diagnosis as well as fluid management.

c. Prompt case definition/ classification guided fluid management using crystalloids (normal saline and/or Hartmann's solution) or colloids (appropriate boluses of Dextran 40 or 6% Tetrastarch) to prevent shock and fluid overload.

The outcome of these intervention measures was quite visible since 2010. Since January 2011 there is a perceptible change in the CFR. The CFR has been brought down by about 70%, which is a significant accomplishment that leads to the saving of several precious lives. In 2011, there was a sharp decline in the number of cases compared to previous years, and up to December 15, 2011, only 25 303 cases of dengue and 169 deaths were reported. The deaths due to dengue reported in 2011 were mostly among elderly people (70%) than in children, possibly due to co-morbidities such as diabetes and other conditions associated with reduced immunity (personal communication with Dr. Hsitha Tissera, Epidemiology Unit).

The experience in controlling the dengue and its vectors during the last 50 years has been that it is a formidable task and the vector as well as virus is invading new areas relentlessly. Presently it appears that reducing the morbidity, which causes unnecessary hospitalization and economic burden, apart from severe discomfort to the affected individual, and bringing down the CFR are the only possible options. Towards this end, the gains of Sri Lankan medical fraternity are very significant despite the limited resources in the country. If the experience gained by the physicians in Sri Lanka is utilized for refining the DHF case management practices and are replicated in other dengue affected areas/ countries it will be possible to prevent morbidity and mortality due to dengue.

South-South Cooperation for dengue control in Pakistan

Recognizing the success of controlling DF/DHF by Sri Lanka, the Govt. of Punjab State of Pakistan sought the help of Sri Lankan Health Ministry for tackling the morbidity and mortality in the current large dengue epidemic in that country. Public health specialists, clinicians, virologists and other health personnel were deputed to Lahore, Pakistan, and these experts imparted training in the differentiation of DF and DHF based on plasma leakage as the discriminating factor rather than hemorrhage, management of DHF cases which included identification of the beginning and predicting the end the critical (plasma leakage) phase, meticulous monitoring, accurate fluid management in the critical phase, vigilance, early detection and treatment of concealed bleeding and other complications (Fig. 20). The clinicians in the dengue affected areas in Punjab readily accepted the guidelines and implemented which lead to saving of scores of lives of severe cases of DHF in Pakistan. This is a shining example of the way the South-South cooperation can help in facing the challenges of diseases affecting the third world countries.

Figure 20: Sri Lankan clinicians in Pakistan for imparting training on clinical management of dengue cases.

Risk factors and possible resurgence of dengue in Sri Lanka

There is a possibility of dengue resurgence in the island country and hence the need to consolidate the gains achieved and sustains the control efforts effectively. The possible risk factors for resurgence are i) changing rainfall pattern, ii) abundance of various vector breeding habitats; mainly disposed containers such as cups, bottles, plastic containers, plastic sheets, roof gutters etc, iii) existence of natural habitats such as tree holes: large land mass of Sri Lanka being covered with vegetation, and iv) human behaviors with reference to waste water and solid disposal management.

Currently all these risk factors are being managed effectively and DHF cases are intensively treated through intelligent management, thus keeping the morbidity and mortality due to dengue under check. But, it is crucial to maintain the level of these efforts; backed by appropriate surveillance measures, which will go a long way in preventing the future dengue epidemics in the country. Any slackness in these measures will defeat the success gained so far.

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Annexure - I

Taking the fight back to dengue

From what could be gathered, the state is confronting the dengue menace head-on and the Dengue Control Week is registering some remarkable victories against the dreaded disease. For instance, on the first day of inspections, in the metropolis and its environs, more than 3,000 dengue mosquito breeding sites were detected and destroyed by the authorities. More such detections are being made and further successes are being registered in the fight against dengue.

This is as it should be. There is no choice but to adopt a no-holds-barred approach to bringing the disease under control and we are happy that the health authorities, led by Minister Maithreepala Sirisena are putting their best foot forward in this crucial undertaking. A proactive involvement in the eradication of this disease on the part of the state and other relevant parties is what is required and we hope this activity would be perpetuated and not discontinued when it is found that the worst is seemingly over.

A pattern of sorts could now be discerned in the outbreak of dengue in this country. Come the monsoon showers and an outbreak of dengue could be expected. The showers are increasing in intensity and this could be one reason why the disease is proving to be rampant and somewhat unmanageable. The rains are so torrential and heavy currently, that taking timely precautions against the outbreak and spread of diseases is proving very difficult. Therefore, we cannot afford to be taken unawares by the rains. The conditions on the ground should be such always that the possibility of the outbreak of disease should be nil or minimal.

This is the reason why the basic material conditions that bring about dengue and other diseases should be removed permanently. We should be also always vigilant about these conditions re-manifesting themselves once they are dislodged. Accordingly, the current dengue eradication programme should be carried out on a permanent basis. The state and the public, in other words, should be proactively involved in dengue-eradication and cease being reactive to the outbreak of the disease. Right now, we are mainly reactive to dengue and this is an approach which is not at all

advisable.

Accordingly, public awareness of dengue and other diseases should be always high. Only a sustained public education programme could ensure this state of vigilance. The public should be fully aware of the conditions that could help in breeding dengue and other preventable ailments. Besides, all relevant sections should be encouraged into eliminating these conditions by themselves, rather than be habituated into reacting to health crises or be dependent on state agencies to do the eliminating for them. For instance, residents should be sufficiently knowledgeable to destroy the conditions that give rise to these illnesses. By now, for instance, the public should see for themselves that various kinds of junk and disposables that help in the breeding of dengue must be destroyed and their respective premises kept clean and habitable.

However, all resistance to these illness eradication efforts should also be neutralized by the authorities. We are compelled to say this because of the news that some dengue-control personnel have been attacked by intransigent members of the public. This lawless trend must be arrested by the state and the offenders brought to justice.

We have here the evidence that not all sections of the public could be described as civic-conscious and responsible. It is this lack of conscientiousness which is as dreadful as dengue itself. With persons of this kind for whom correction is anathema, it is small wonder that dreaded diseases are on the rise once again.

We call for the stringent application of the law. Offenders must be fined and all those who resist inspection must be prosecuted and brought to book. With dengue claiming more and more lives, it should be plain to see that dengue must be tackled on a very urgent basis. Nothing could be left to chance.

Dengue cases declining in Sri Lanka

Latest figures released by the Epidemiology Unit of Sri Lanka's Health Ministry show that the dengue cases are on the decline during the past month.

According to the statistics released on Tuesday, in the first two weeks of September only 585 cases of dengue have been reported.

Sri Lanka recorded the highest number of dengue cases of this year in July with 4,774 patients. However, the number has declined 22% compared to the reported cases in July 2010.

Report of Activities during the Visit to Colombo

9 – 15 Oct 2011

The visit was undertaken during 9 - 15 October 2011. Visits to different Ministry of Health institutes and offices were made and information gathered as per the TOR which is as follows:

a. Review the epidemiological data on dengue in Sri Lanka and to postulate possible factors contributing to resurgence
b. Correlate the intervention methods implemented with the epidemiological data
c. Record and report the success story of bringing down the case fatality rate
d. Prepare a document for publication, and submit a report to WHO

08.10.2011:

1. Departure (18.00 hrs) from Pondicherry and arrival (21.00 hrs) in Chennai, India

08.10.2011:

1. Departure (18.00 hrs) from Chennai and arrival (21.00 hrs) in Colombo, Sri Lanka

10.10.2011

1. Meeting with Dr Supriya Warusavithana, National Professional Officer and Dr Navaratnasingam Janakan, National Consultant, WHO Country Office, Sri Lanka in Colombo:
   Discussed regarding the work plan as per the TOR.

2. Visit to Epidemiology Unit, Ministry of Health, Govt. of Sri Lanka:
   Held discussions with Dr Pabha Palihavadan, Chief Epidemiologist and Dr Hasitha A. Tissera, Consultant Epidemiologist, MoH along with Drs Supriya and Janakan. Explained the plan of visit keeping the TOR as the base.

   Discussed with Dr Hasitha regarding the work plan of the assignment. He explained the dengue control activities in detail including the historical perspective, especially the clinical management of cases. Awareness of people and a very strong and well planned clinical management with trained physicians playing a major role in the cut down of dengue case fatality rate. Especially, fluid management using Dextran 40 and whole blood infusion instead of platelet helped to reduce the CFR.

3. Briefing with Dr Firdosi Rustom Mehta, WHO Representative to Sri Lanka in presence of Dr Supriya, Dr Jankan and Dr Hasitha Tissera:

   Dr Mehta felt that there is a need to bring the success story of reducing the case fatality rate due to dengue achieved by adhering to the guidelines developed (especially on fluid management practice)

with the help of Dr Siripen Kalyanarooj (Thailand), and the actions implemented as per the Taskforce set up for dengue control under the initiative of H.E. the President of Sri Lanka.

11.10.2011: *Holiday (Poya = Poornima, Full moon day).*

1. Worked with Dr Hasitha, reviewed the epidemiological data on dengue in Sri Lanka, trends of different types of cases and the type of trends (year-wise DF/DHF and CFR) for the preparation of the report.
2. Held discussion with Dr F. R. Mehta, WR, about the structure of the proposed report/manuscript. Dr Mehta suggested that the lead authorship should be from MoH, Sri Lanka.

12.10.2011:

1. Meeting with Dr Paba Palihavadana, Chief Epidemiologist, MoH, Sri Lanka:
   Discussed regarding the preparation of the report and the proposed manuscript. Also discussed about the authorship of the manuscript.
2. Meeting with Dr P.G. Mahipal, Additional Secretary, MoH, Sri Lanka:
   Apprised him about the TOR of the visit and preparation of the report and issues related manuscript preparation for publication.

13.10.2011:

1. Meeting with Dr Sunethra Gunasena, Consultant Virologist, Department of Virology, Medical Research Institute, Colombo:
   This department is involved in the surveillance (passive), diagnostic services, training and research on viral diseases. For dengue HI, IgM ELISA and nested PCR assays are employed for diagnosis of suspected cases. Also discussed about the dengue epidemics in Sri Lanka, diagnostics used and sero/genotypes of dengue virus over the years.
2. Meeting with Ms. Apeksha, Research Officer, Department of Entomology, Medical Research Institute:
   Each province of Sri Lanka has a trained entomologist and district units are manned by entomological assistants. Vector surveillance is carried out for dengue by these units. Dengue control is mainly through source reduction and social mobilization. Data on dengue vector surveillance is available with Entomology Units, Dengue Control Unit, Medical Research Institute, Anti Malaria Campaign and Anti Filariasis Campaign.

14.10.2011:

1. Met Dr Ranjith Batuwanthudawe, Consultant Epidemiologist, Director, Dengue Control Unit and Dr Risintha Premaratne, Consultant Epidemiologist, Deputy Director, Anti Malaria Campaign and discussed about the entomological surveillance and dengue control aspects.

2. Met Dr Sunil Settinayake, Director, Anti Filariasis Campaign and discussed regarding the entomological aspects of dengue.
3. Held discussions with Dr Kolitha Sellahewa, Consultant Physician, Epidemiology Unit on the clinical management of dengue cases and preparation of manuscript.
4. Met Dr Supriya Waruswithana and debriefed about the visit and assignment.

15.10.2011:

Returned to India (late afternoon)