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Review Article

Dengue: A Continuing Global Threat

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ABSTRACT

Dengue is a significant mosquito-borne infection. An arbovirus named dengue virus is the causative agent. Due to the nature of the mosquito-borne infection, dengue has become a significant public health threat in many developing tropical countries. Dengue had been present throughout tropical regions of the world for more than 50 years. Of several tropical regions, Southeast Asia is accepted as the area with the highest prevalence of this disease. A severe hemorrhagic form of dengue infection has become a leading infectious cause of death for local people in Southeast Asia. Francisco Pinheiro, a former researcher from the Division of Disease Prevention and Control, and the Special Program for Vaccines and Immunization, Pan American Health Organization (DC, USA), said that the highest incidence of dengue could be seen in Southeast Asia, particularly in Vietnam and Thailand, which together account for more than two-thirds of the overall reported cases in Asia. Hence, several groups are now carrying out research and development on dengue infection in this area. At present, due to the efficient mosquito-borne method by which the virus is transported, dengue is not confined within the tropical region, but is sporadically reported from many nontropical countries. It is accepted that it is now a global issue. In South Asia, there have been many reports of dengue epidemiology coming in from India.

INTRODUCTION

Dengue is the most important arthropod-borne viral infection of humans. Worldwide, an estimated 2.5 billion people are at risk of infection, approximately 975 million of whom live in urban areas in tropical and sub-tropical countries in Southeast Asia, the Pacific and the Americas. Dengue, a flavivirus in the family Arboviridae, has four known serotypes (varieties recognized as distinct by the immune system). The most severe form of the disease is dengue hemorrhagic fever, which is characterized by thrombocytopenia, bleeding, and shock. The hemorrhagic form continues to be the leading viral hemorrhagic fever in the world. Pronounced "deng-gee" or "deng-gay."Dengue hemorrhagic fever occurs in many areas where other dengue serotypes are localized. Studies show that infection with and subsequent immunization from one dengue serotype actually increases the odds of developing dengue hemorrhagic fever during infection with a second serotype. This is especially notable in areas where multiple serotypes have overlapping, endemic regions. Essentially, exposure to a mild form of dengue (in some cases, there is no apparent illness) seems to sensitize the immune system to the hemorrhagic form of the disease.

Also known as:

• Break bone fever, named by Dr. Benjamin Rush in Philadelphia, 1780; a reference to the symptom of aching joints.

• Dandy fever.

• Dungeon - from the Spanish duengo

• Seven-day fever.

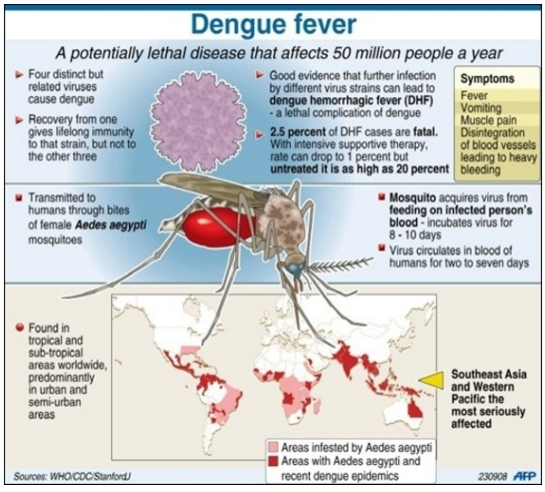

Figure 1:

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HISTORY:-

The origins of the word dengue are not clear, but one theory is that it is derived from the Swahili phrase "Ka-dinga pepo", meaning "cramp-like seizure caused by an evil spirit". The Swahili word "dinga" may possibly have its origin in the Spanish word "dengue" meaning fastidious or careful, which would describe the gait of a person suffering the bone pain of dengue fever. Alternatively, the use of the Spanish word may derive from the similar-sounding Swahili. Slaves in the West Indies who contracted dengue were said to have the posture and gait of a dandy, and the disease was known as "Dandy Fever". The first record of a case of probable dengue fever is in a Chinese medical encyclopedia from the Jin Dynasty (265–420 AD) which referred to a "water poison" associated with flying insects. The primary vector, A. aegypti, spread out of Africa in the 15th to 19th centuries due in part to increased globalization secondary to the slave trade. There have been descriptions of epidemics in the 17th century, but the most plausible early reports of dengue epidemics are from 1779 and 1780, when an epidemic swept across Asia, Africa and North America. From that time until 1940, epidemics were infrequent. In 1906, transmission by the Aedes mosquitoes was confirmed, and in 1907 dengue was the second disease (after yellow fever) that was shown to be caused by a virus. Further investigations by John Burton Cleland and Joseph Franklin Siler completed the basic understanding of dengue transmission.

TRANSMISSION:-

Dengue fever is a common viral infection that is carried and spread by the mosquito. Specifically, the female Aedes aegypti mosquito becomes a vector or carrier of the virus when it bites an infected human. This infected mosquito goes on to bite another human, and the cycle continues.

Incubation period is 5-8 days.

Aedes aegypti :- The yellow fever mosquito, Aedes aegypti is a mosquito that can spread the dengue fever, Chikungunya and yellow fever viruses, and other diseases. The mosquito is a small, dark mosquito of approximately 4 to 7 millimeters with typical white markings on the legs and a marking of the form of a lyre on the thorax. Females are larger than males, and can be distinguished by small palps tipped with silver or white scales.

Aedes aegypti is a day biting mosquito. That means that the mosquito is most active during daylight, for approximately two hours after sunrise and several hours before sunset. The mosquito rests indoors, in closets and other dark places. Outside, they rest where it is cool and shaded. The males of all species of mosquitoes do not bite humans or animals of any species, they live on fruit. The female of Aedes aegypti feed not only on fruit, but also on blood.

Figure 2:

The mosquito originated from Africa, but is now present globally in tropical and sub-tropical regions. The mosquito has a so-called cosmo-tropical distribution annually, and spreads to more temperate regions during the summer. Living near man Aedes aegypti has become largely dependent on and adapted to humans. The insect is very fast in flight unless gorged with blood. Other types of mosquito even fly into your face and can be easily caught or killed, not Aedes aegypti.

Life Cycle of Aedes aegypti :- Aedes aegypti is a so-called holometabolous insect. This means that the insect goes through a complete metamorphosis with an egg, larvae, pupae, and adult stage. The adult life span can range from two weeks to a month depending on environmental conditions. The life cycle of Aedes aegypti can be completed within one-and-a-half to three weeks.

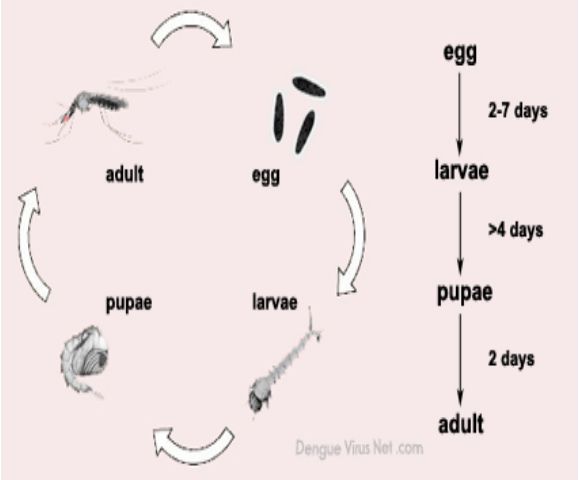


Figure 3:

After taking a blood meal, female Aedes aegypti mosquitos produce on average 100 to 200 eggs per batch. The females can produce up to five batches of eggs during a lifetime. In warm climates eggs may develop in as little as two days, whereas in cooler temperate climates, development can take up to a week. Laid eggs can survive for very long periods in a dry state, often for more than a year. However, they hatch immediately once submerged in water. After hatching of the eggs, the larvae feed on organic particulate matter in the water, such as algae and other microscopic organisms. Males develop faster than females, so males generally pupate earlier. If temperatures are cool, Aedes aegypti can remain in the larval stage for months so long as the water supply is sufficient. After the fourth instar, the larvae enters the pupal stage. Mosquito pupae are mobile and respond to stimuli.

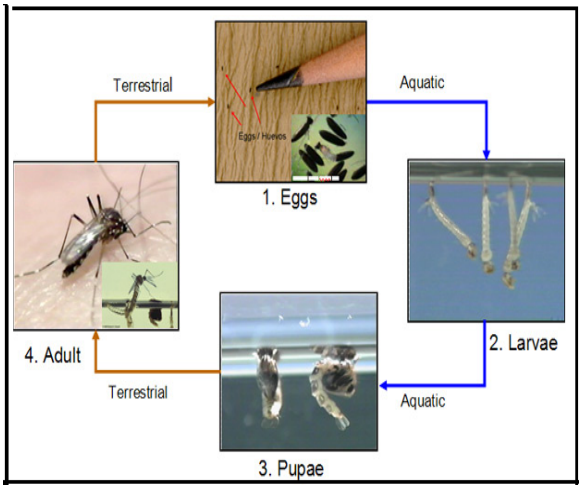


Figure 4:

DENGUE: An Emerging Disease:-

Each year, 100 million people become infected with dengue virus. People first reported the existence of dengue-like disease in 1779 but it was most likely present long before in first appeared in literature. However, the majority of deaths that result from dengue infection result from Dengue Hemorrhagic Fever (DHF) and Dengue Shock Syndrome (DSS). People who develop DHF have a 5% chance of death but if they go on to develop DSS then the mortality rate can rise as high as 40%. The four dengue viruses originated in monkeys and independently jumped to humans in Africa or Southeast Asia between 100 and 800 years ago. Dengue remained a relatively minor, geographically restricted disease until the middle of the 20th century.

Global Dengue: - Today about 2.5 billion people, or 40% of the world's population, live in areas where there is a risk of dengue transmission see WHO/Impact of Dengue. Dengue is endemic in at least 100 countries in Asia, the Pacific, the Americas, Africa, and the Caribbean. The World Health Organization (WHO) estimates that 50 to 100 million infections occur yearly, including 500,000 DHF cases and 22,000 deaths, mostly among children.

Dengue is endemic throughout the tropics and subtropics and is a leading cause of febrile illness among travelers returning from Latin America, the Caribbean, and Southeast Asia, according to an analysis of data collected by the GeoSentinel Surveillance Network. Dengue occurs in >100 countries worldwide (Map 3-01 through 3-03), including Puerto Rico, the US Virgin Islands, and US-affiliated Pacific Islands. Sporadic outbreaks with local transmission have occurred in Florida, Hawaii, and along the Texas–Mexico border. Although the geographic distribution of dengue is similar to that of malaria, dengue is more of a risk in urban and residential areas than is malaria.

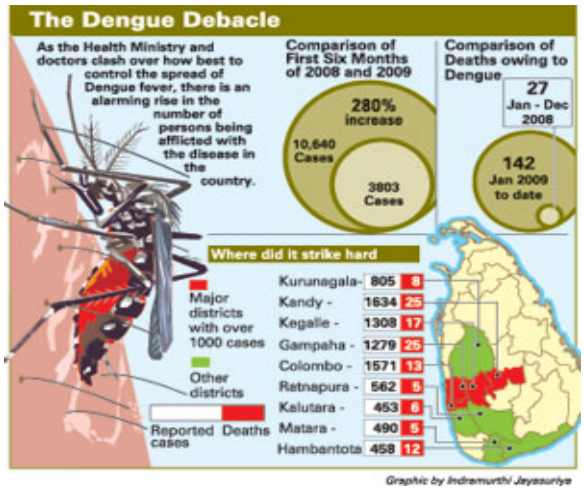


Figure 5:

SIGNS AND SYMPTOMS:-

1. Characterized by sudden onset of high fever, weakness and prostration, severe headaches, retro-orbital pain, joint and muscle pain (myalgia), nausea, vomiting, and rash. The fever rises rapidly to as high as 104 F, and may be accompanied by bradycardia. The petechiae rash appears 3-4 days after the onset of fever, and usually appears on the trunk first, before spreading peripherally. Symptoms usually persist for 7 days, hence one of the common names for the disease: seven-day fever.
2. Symptoms of hemorrhagic dengue are initially indistinguishable from dengue fever, but progress to faintness, shock, and systemic bleeding (gastrointestinal hemorrhage, etc.). The mortality rate for hemorrhagic dengue is 5%.
3. Retro-orbital (behind the eye) pain. The eyes also become reddened Severe joint and muscle pain Nausea and vomiting A flushing or pale pink rash comes over the face and then disappears. The glands (lymph nodes) in the neck and groin are often swollen.
4. In some people, the disease proceeds to a critical phase as fever resolves. During this period, there is leakage of plasma from the blood vessels, typically lasting one to two days. This may result in fluid accumulation in the chest and abdominal cavity as well as depletion of fluid from the circulation and decreased blood supply to vital organs. There may also be organ dysfunction and severe bleeding, typically from the gastrointestinal tract. Shock (dengue shock syndrome) and hemorrhage (dengue hemorrhagic fever) occur in less than 5% of all cases of dengue, however those who have previously been infected with other serotypes of dengue virus ("secondary infection") are at an increased risk. This critical phase, while rare, occurs relatively more commonly in children and young adults.

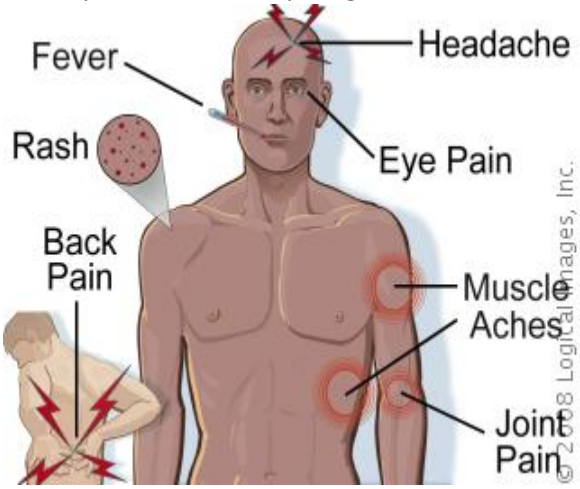


Figure 6:

DIAGNOSIS TEST:-

Serological assays are most commonly used for diagnosis of dengue infection as they are relatively inexpensive and easy to perform compared with culture or nucleic acid-based methods. When a dengue infection occurs in individuals who have experienced a previous dengue infection, a secondary immune response occurs, which generates high levels of IgG through the stimulation of memory B cells from the previous infection as well as an IgM response to the current infection. Because high levels of IgG compete with IgM for antigen binding, an IgM capture assay can be used.

MAC-ELISA- The Armed Forces Research Institute of Medical Sciences (AFRIMS) developed an IgM antibody-capture enzyme-linked immunosorbent assay (MAC-ELISA) for dengue in regions where dengue and Japanese encephalitis virus co-circulate. Dengue-specific IgM in the test serum is detected by first capturing all IgM using human-specific IgM bound to a solid phase. The assay uses a mixture of four dengue antigens. Compared to the haemagglutination inhibition assay as the gold standard, MAC-ELISA shows a sensitivity and specificity of 90% and 98%, respectively, in samples collected after 5 days of fever. In addition to serum, dengue-specific IgM can be detected in whole blood on filter paper and in saliva, but not in urine. More than 50 commercial kits are available with variable sensitivity and specificity. False-positive results due to

dengue-specific IgG and cross reactivity with other flaviviruses is a limitation of the MAC-ELISA, mainly in regions where multiple flaviviruses co-circulate. Some tests also show non-specific reactivity in sera from patients with malaria and leptospirosis.

IgG ELISA-. An ELISA for dengue-specific IgG detection can be used to confirm a dengue infection in paired sera. It is also widely used to classify primary or secondary infections. Some protocols use serum dilutions to titre dengue-specific IgG and others use the ratio of IgM to IgG. The assay uses the same dengue antigens as MAC-ELISA and it correlates with results from the haemagglutination inhibition assay. In general, an IgG ELISA lacks specificity within the flavivirus sero complex groups, however it has been demonstrated that the IgG response to the prM membrane glycoprotein is specific to individual flaviviruses as no cross reactivity was observed in sera collected from individuals infected with dengue or Japanese encephalitis virus.. Finally, dengue-specific IgG was shown to have high specificity in an assay using a recombinant polypeptide located in the N-terminal region of the envelope protein. IgG assays are also useful for sero-epidemiological studies to identify past dengue infection.

Neutralization assays-. The plaque reduction neutralization technique (PRNT) and the micro-neutralization assay are used to define the infecting serotypes following a primary infection. These tests are mainly for research and vaccine studies.

Antigen detection - Dengue antigens can be detected in tissues such as liver, spleen and lymph nodes as well as tissues from fatal cases (slides from paraffin-embedded, fresh or frozen tissues) using an enzyme and a colorimetric substrate with antibodies that target dengue-specific antigens.

TREATMENT:-

According to World Health Organization dengue has increased 30 folds worldwide in the last 50 years. About 3 billion population of the world is vulnerable to dengue fever. It is present in about 112 countries of the world. Every year about 350 million people are infected with dengue virus resulting in deaths of 25,000 people. Unfortunately, no medicine for treatment is available. Many countries are making Herculean efforts to develop anti-dengue vaccine; many are at the stage of animal trial and some have reached to human level tests. It is expected that vaccine will be launched in 2014 or 2015. In the mean time, we have to look for other methods of treatment:

Because dengue fever is caused by a virus, there is no specific medicine or antibiotic to treat it. For typical dengue, the treatment is concerned with relief of the symptoms and signs. Rest and fluid intake for hydration is important. Pain relievers such as aspirin and nonsteroidal anti-inflammatory drugs (NSAIDs) should only be taken under a doctor's supervision because of the possibility of worsening bleeding complications. Acetaminophen (Tylenol) and codeine may be given for severe headache and for joint and muscle pain (myalgia).

Allopathic Treatment: Dengue fever has four type according to intensity, body resistance, type of virus and number of attack; Benign Dengue which is almost asymptomatic; Dengue fever(DF); Dengue Hemorrhage Fever(DHF) and Dengue Shock Syndrome (DSS):

1. Aspirin - Aspirin, Brufen and non-steroidal anti-inflammatory drugs should be avoided as these drugs may worsen the bleeding tendency associated with some of these infections. Patients may receive paracetamol preparations to deal with these symptoms if dengue is suspected. Doctors should be very careful when prescribing medicines. Any medicines that decrease platelets should be avoided. Antipyretic medicine is not must effective in case of DHF. Vomiting, nausea, anorexia is accompanied by high grade fever and pains in DHF. Vomiting leads to dehydration so ORS (oral rehydration salt) and fruit juices must be given to the patient. Patient must be monitored and treated carefully if need glucose drip should be applied.

Homeopathic Treatment: 1. In Homoeopathy, more than 20 medicines which can be taken based on different symptoms of fever in different stages. Homeopathic Remedy Eupatorium Perfoliatum 200c in the Wet dose to treat many patients presenting Dengue and the majority have confirmed that they experienced perceptible relief in about an hour after their first dose, when their throbbing headache left them. They also reported that their excruciating body and joint pains left them within 2-3 hours. Eupatorium Perfoliatum 200c can be purchased from any Homeopathic Pharmacy in your country in the Liquid Dilution in Alcohol. Eupatorium Perfoliatum

200 is used in the Wet dose taken every 2 hours for the first day and every 3 hours thereafter till the patient is cured.

- Dr Tajammal Hussain Bukhari told an effective dengue control prescription from homeopathy. Bryonia, Rhustox, Ipecoc, China, Eupaturrium 30 Crotalis 200 are given once in a day. Sri Lankan homeopathic doctors prescribe Blancha Tincture, it increases platelets count.

Figure 7:

Ayurvedic Treatment : 1) Mix 360 mg of Shunthi Churna with 125 mg of Hinguleshwar and now take this mixture at least 4 times daily, you may take with tea or hot water. If case the temperature of the patient rises beyond 104°F (40°C), then you may apply cold pad, on the forehead till the temperature subsides.

2) Another ayurvedic medicine used for treatment of dengue fever is tulsi (holy basil). Medicinal properties of tulsi are very useful in ayurvedic therapy. The leaves of tulsi are used to produce soothing effect on the nervous system. Tulsi leaves strengthen the stomach and induce copious perspiration.

3) use of papaya leaves in management of dengue fever especially in increasing platelet count in dengue patients with low platelet count and those who develop hemorrhagic dengue fever. The juice of papaya leave is given to patient. This food therapy had been in use since Jahangir's period.

Figure 8:

4) Amrutharistam, Amruthottaram kashayam, sudarsanam gulika, Pachanamrutham kashayam can be given for treatment.

Unani Treatment: ☐ SheerahTukhm Khurfa 10 gm in normal water is beneficial in dengue fever.

☐ QursTabaseer with sharbat bazoori 40 ml

☐ SharbatDeenar 40 ml two times daily

☐ SharbatTamarhindi 40 ml with arq Gau zaban 100 ml two times

☐ HabbeShifa 2 tab two times

☐ Afsanteen6 gm, chiraita 6 gm, karanjwa 6gm decoction two times daily before meal very beneficial.

Home Remedies: **Orange Juice-** Orange juice can be given to the patients as it helps improve digestion and helps to replace fluid loss of the body or dehydration.

Basil Leaves- To improve immunity and to fight dengue fever, boil few basil leaves in water until it remains half. Strain the water, cool it down and drink it at least twice a day.

Black Grape Juice- Increases blood count, drink Black grape juice 2-3 times a day. You can have them whole, but the juice is much better and effective.

Coconut Water– Coconut Water is very good for a patient's health, as it helps replace body fluid loss and is very nutritious and improves immunity.

Fenugreek- Fenugreek is a pain reliever, Make Herbal tea using Fenugreek seeds. One cup of tea in a day will help cut down fever and relieve you from joint and muscle pain.

Coriander- Another effective herb is coriander. Either you can prepare a decoction of coriander leaves or you can wash and cut coriander leave and use them

in your food. They are healthy and tasty too, will reduce fever and help in digestion.

Water- This may seem like common sense, but due to the excessive sweating, bodily exertion, and the internal toll that dengue fever takes on the body, extreme dehydration is common. Drink as much water as possible to keep the body hydrated, which will also help to ease symptoms like headaches and muscle cramps, both of which are exacerbated by dehydration. Furthermore, water will help to flush the body and eliminate excess toxins that can complicate the viral impact of the pathogen.

Neem Leaves - Neem leaves are commonly prescribed for a variety of ailments, and dengue fever is no exception. Steeping neem leaves and then drinking the subsequent brew has been shown to increase both blood platelet count and white blood cell count, two of the most dangerous side effects of the virus. Properly brewed neem leaves can improve the immune system and return your strength much faster than many other home remedies.

1. Give patient a mixture of apple juice by adding a little lime juice, it is said to increase platelets counts.
2. Citron, Tomato, Guava is considered an effective food therapy by many nutritionalists.
3. In Sri Lanka, patient is given sugarcane juice with addition of small amount of beet juice and lemon juice.

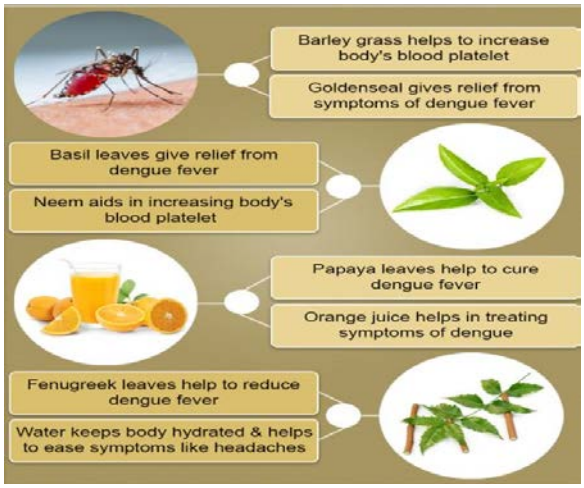


Figure 9:

PREVENTION & PRECAUTIONS: The prevention of dengue requires control or eradication of the mosquitoes carrying the virus that causes dengue.

The best way to reduce mosquitoes is to eliminate the places where the mosquito lays her eggs, like artificial containers that hold water in and around the home. In urban areas, Aedes mosquitos breed on water collections in artificial containers such as plastic cups, used tires, broken bottles, flower pots, etc.

Periodic draining or removal of artificial containers is the most effective way of reducing the breeding grounds for mosquitos. Larvicide treatment is another effective way to control the vector larvae but the larvicide chosen should be long-lasting and preferably. There are some very effective insect growth regulators (IGRs) available which are both safe and long-lasting (e.g. pyriproxyfen). For reducing the adult mosquito load, fogging with insecticide is somewhat effective.

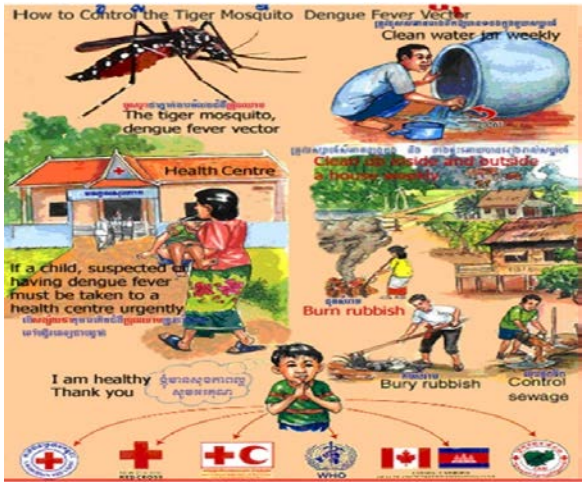


Figure 10:

To eliminate standing water:

- Unclog roof gutters;
- Empty children's wading pools at least once a week;
- Change water in birdbaths at least weekly;
- Get rid of old tires in your yard, as they collect standing water;
- Empty unused containers, such as flower pots, regularly or store them upside down;
- Drain any collected water from a fire pit regularly.

Table 1: BREEDING HABITATS IN HOME

Breeding Habitats in Homes

Category	Year 2012	Year 2013	Year 2014
Top 5 Breeding Habitats found in Homes	1. Domestic Containers 2. Flower Pot Plates / Trays 3. Ornamental Containers 4. Plants (Hardened Soil and Plant Axils) 5. Canvas Sheet / Plastic Sheet	1. Domestic Containers 2. Flower Pot Plates / Trays 3. Ornamental Containers 4. Plants (Hardened Soil and Plant Axils) 5. Gully Traps	1. Domestic Containers 2. Flower Pot Plates / Trays 3. Ornamental Containers 4. Plants (Hardened Soil and Plant Axils) 5. Toilet Bowl / Cistern

Breeding Habitats in Public Areas

Category	Year 2012	Year 2013	Year 2014
Top 5 Breeding Habitats found in Public Areas	1. Discarded Receptacles 2. Closed Perimeter Drains 3. Gully Traps 4. HDB Corridor Scupper / Gullies 5. Open Perimeter Drains	1. Discarded Receptacles 2. Closed Perimeter Drains 3. Plants 4. HDB Corridor Scupper / Gullies 5. Puddle / Ground Depression	1. Discarded Receptacles 2. Closed Perimeter Drains 3. Gully Traps 4. Plants 5. HDB Corridor Scupper / Gullies

- Keep home, environment and surrounding hygiene
- Remove all stagnant water and containers
- Keep all drains well maintained and repair all chokes
- Avoid accumulation of ground water
- Fill up all defective grounds
- Don't store water
- Avoid unnecessary irrigation
- Cover all containers properly
- Change flower vase water once a week to prevent dengue mosquito breeding there
- Wrap all unused plastic tyres
- Regularly change water in animal drinking containers
- Use mosquito repellents to avoid mosquito bite
- Use mosquito screen to prevent mosquito attack
- Use aerosols and mosquito coils to kill mosquitoes
- Wear long sleeve and fully covered clothes
- Use mosquitoes net around bed while sleeping

Top breeding places found in homes and nearby places:

- *Domestic Containers/ Flower pots*
- *Toilet Bowls/ Cistern*
- *Gully Trap*
- *Roof gutters*
- *Roadside Drains*
- *Plant Axil*
- *Air conditioner tray*
- *Air Cooler Tanks*
- *Canvas Sheets covered to save things from rain*
- *Discarded Waste material like Tyres, broken things etc.*

Apart from cleaning these places regularly, you must use, **mosquito repellent creams**, **Sprays, Coils, Nets** to save yourself and your family from mosquitoes.

DENGUE OUTBREAKS: The interval between epidemics in South and Central America and in Asia has shortened until there are annual major epidemics. Massive outbreaks have occurred when a susceptible population (one already exposed and innoculated against one serotype) is exposed to a new dengue serotype. Some of the first notable outbreaks occurred:

- 1779, Asia, Java, and Africa, epidemics
- 1780, Philadelphia, U.S., epidemic
- 1897, Australia, epidemic

The next major outbreak of dengue occurred in Manila, in 1953, and introduced viral strain dengue-2, hemorrhagic dengue. By 1981, dengue was reentrenched in Manila. The virus now reemerges at the onset of every rainy season, affecting tens of thousands of children each year, killing approximately 15% of those affected.

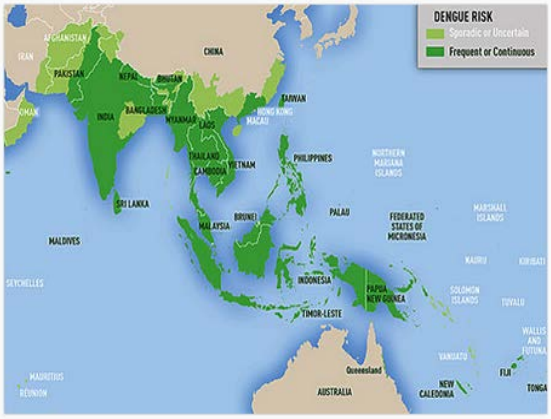
Following the 1953 Manila outbreak, an epidemic occurred in 1958 in Bangkok, affecting 2,297 (mostly children), and leaving 240 dead. The hemorrhagic form of dengue persisted in Bangkok from 1958 to 1963, affecting over 10,300 people and killing almost 700. Almost all victims in the Bangkok epidemic had been exposed to other, less pathogenic strains of dengue.

Since the 1960's, dengue has reemerged throughout the world. Some notable outbreaks in the last two decades:

- 1977, Cuba: mild epidemic of dengue-1.
- 1977, Seychelles (Africa) - first major epidemic
- 1979, Laredo, Texas: two residents developed hemorrhagic fever.
- 1981, Havana, Cuba: A new strain of dengue-2 from Southeast Asia causes its first major epidemic: 350,000 infected; 115,000 hospitalizations; 156 dead. It was later found that 44.5% of Havana's residents had been exposed previously to dengue-1 during the 1977 epidemic.
- 1982, New Delhi, India: 20% of the 5.6 million residents fall ill to dengue-2
- 1982, Keyna - first major epidemic of dengue-2
- 1982-1984, Somalia - dengue-2
- 1985 - Mozambique, first major epidemic (dengue-3)
- 1985-1986, Nicaragua: indigenous population of Managuans
- 1985, Hainan Island, China - first major epidemic of dengue-2
- 1988, U.S.: 124 suspected cases of imported dengue, of which 27 (in 7 states) were definite, and 25 were uncertain.
- 1990, Venezuela
- 1991, Brazil: epidemic, indigenous population.
- 1991-1992, Djibouti (Africa) - first major epidemic
- 1993, Somalia: U.S. troops.
- 1994, Pakistan, first epidemic
- 1994, Nicaragua: dengue-3 reappears (a new strain genetically distinct from previous dengue-3 strains in the Americas) and causes an epidemic of dengue hemorrhagic fever.
- 1994, Saudi Arabia, first major epidemic of dengue-2.

New Delhi, India, reported an outbreak of dengue fever, with 1,872 testing positive for the illness as of September 2015. In American Samoa, there were 370 cases of dengue reported from May 2015 to Sept. 2, 2015; 133 people were hospitalized. In 2015, two nonnative species of mosquito were found in California, including the Aedes aegypti mosquito, which can transmit dengue. No cases of dengue have been reported yet. Thailand reported the worst dengue outbreak in 20 years, with 126 deaths and 135,344 people infected with the virus, in October 2013.

According to the CDC, there are an estimated 400 million cases of dengue fever with several hundred thousand cases of dengue hemorrhagic fever requiring hospitalization each year. Nearly 40% of the world's population lives in an area endemic with dengue. The World Health Organization (WHO) estimates 22,000 deaths occur yearly, mostly among children.



Picture of dengue fever distribution map

Figure 10:

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