Editorial

Future Hopes of a Vaccine to Trigger Immune Response

The five articles in this number of Vidurava cover a range of fields related to the mosquito-borne disease dengue, and consequently provides almost all the necessary information on the onset of disease, its clinical manifestation, disease management, entomological aspects as well precautionary measures for prevention and control of the spread of the disease. The disease is seen to range from the milder self-limiting dengue fever (DF), to the more severe Dengue Haemorrhagic fever (DHF), and to the life-threatening Dengue Shock Syndrome (DSS). The consoling aspect of the disease seems to be the fact that around 75% of the patients may remain asymptomatic, while the rest may develop symptoms, and of this lot only about 1-2 percent will develop into the severe forms DHF or DSS.

Of the disease symptoms, the phenomenon referred to as fluid leakage, causes various complications, including increasing the severity of the disease resulting in liver and kidney failure and finally death. It is however, consoling to note that at least one drug called Rupatadine has been shown to contain or block what the medical scientists call the "Platelet Activating Factor" (PAF), which seems to promote the fluid leakage process resulting from increased capillary permeability.

In the meantime a news release of the National Institute of Health (NIH) of the US Department of Health and Human Services dated 21st February 2017, refers to the development of an experimental vaccine, which is said to target the mosquito saliva. According to this news release, The National Institute of Allergy and Infectious Diseases (NIAID), a constituent of NIH, has launched a phase I clinical trial to test the investigational vaccine intended to provide broad protection against a range of mosquito-transmitted diseases such as Zika, Malaria, West Nile Fever and Dengue Fever. This investigational vaccine called AGS-v is said to have been developed by a London-based pharmaceutical company called SEEK.

According to information provided, unlike other vaccines targeting specific mosquito-borne diseases, the AGS-v candidate is said to be designed to "trigger an immune response" to mosquito saliva rather than to a specific virus or parasite carried by mosquitoes. Currently a statistically designed study is claimed to be underway, where a set of 'participants' enrolled, are expected to be randomly assigned to receive one of three vaccine regimens over a pre-designed timeframe. The study is expected to be completed by summer 2018.

What seems to be significant about this study is that unlike other vaccines targeting specific mosquito-borne diseases, the AGS-v candidate is expected to not only to trigger an immune response to mosquito saliva rather than to a specific virus or parasite carried by mosquitoes, but also that mosquitoes who take a blood meal from a ASG-v- vaccinated participant, may have altered behaviour possibly resulting in early death or a reduced ability to reproduce. The experimental vaccine may also consequently hinder disease transmission by controlling the mosquito population. (see fact sheets and other NIAID-related materials on the NIAID website).

The Director of NIAID commenting on the expectations has said that "A single vaccine capable of protecting against the scourge of mosquito-borne diseases is a novel concept that, if proven successful would be a monumental public health advance."

M. Asoka T. De Silva

Dengue – An overview of determinants, distribution, clinical presentation and prevention

Dr Hasitha Tissera & Dr Indika Weerasinghe

Dengue is a mosquito borne viral disease caused by 4 closely related viruses: DENV 1, DENV 2, DENV 3 and DENV 4. All 4 virus serotypes cause human disease.

Dengue range from self-limited Dengue Fever (DF) to more severe Dengue Haemorrhagic Fever (DHF) and to life threatening Dengue Shock Syndrome (DSS). Of all infected people 75% will remain asymptomatic, while the rest will have symptomatic disease. From these majority will have the simple dengue fever, and only 1-2% will develop into DHF or DSS.

Infection with one serotype will provide lifelong immunity, but does not protect against the other serotypes. Subsequent infection with other serotypes puts the individual at greater risk of developing the severe form of Dengue if not diagnosed and treated in time.
Dengue is spread widely throughout the tropics and sub tropics. It is an endemic disease, occurring throughout the year, usually when rainfall is optimal for breeding. The other factors that influence the spread are, local spatial variations of rainfall, temperature, relative humidity, degree of urbanization and quality of vector control services in those areas.

Dengue was first reported in Sri Lanka in early 1960s, but it was not until the late 1980s that dengue haemorrhagic fever the more severe form became endemic. Since year 2000, the magnitude of dengue epidemics have increased and dengue viruses have started to spread from urban to semi-urban and rural settings.

Dengue is a vector borne disease, an intermediate host carrying the virus from one person to another. The virus is transmitted by the female mosquito of *Aedes aegypti* and *Aedes albopictus*. These vectors are found throughout the world, and in Sri Lanka the main vector is *Aedes aegypti*. This mosquito also transmits chikungunya, yellow fever and Zika infection.
Dengue should be suspected when a high fever (>38°C/104°F) is accompanied by 2 of the following symptoms: severe headache, pain behind the eyes, muscle and joint pains, nausea, vomiting, or rash. Symptoms usually last for 2–7 days, after an incubation period of 4–10 days following the bite from an infected mosquito. Some patients may also present with sore throat, and diarrhoea with the above main symptoms.
As it is a viral disease there is no medication for dengue or effective vaccine at present. Therefore the main method to control or prevent the transmission of dengue virus is to combat vector mosquitoes through integrated vector control methods.

History

All four dengue viruses (DENV1-4) originated in monkeys several years back. They independently jumped to humans in Africa or Southeast Asia between 100 to 800 years ago. Dengue remained a relatively minor, geographically restricted disease until the middle of the 20th century.
The first record of a case of probable dengue fever is in a Chinese medical encyclopaedia from the Jin Dynasty (265–420 AD), which referred to a "water poison" associated with flying insects. The first recognized

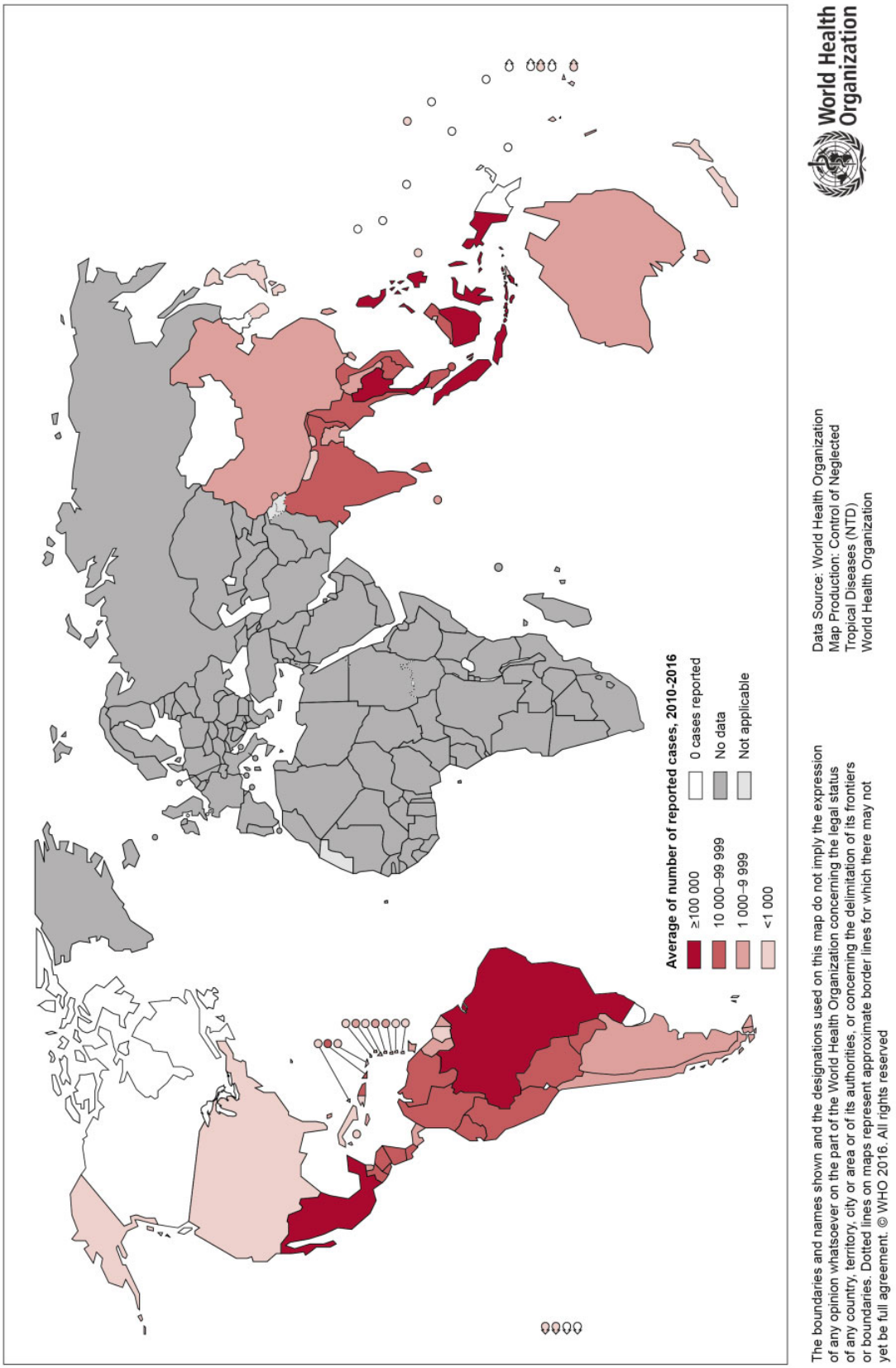


Fig 1 : Distribution of Dengue, worldwide, 2016

Dengue epidemics occurred almost simultaneously in Asia, Africa, and North America in the 1780s, shortly after the identification and naming of the disease in 1779. The first confirmed case was reported in 1779 by Benjamin Rush, who coined the term "break bone fever" because of the symptoms of myalgia (muscle pain) and arthralgia (joint pain).
The viral aetiology and the transmission by mosquitoes were discovered in the 20th century. Population movements during the World War II spread the disease globally. The first epidemic of dengue haemorrhagic fever (DHF) was described in Southeast Asia, Manila in 1953, after which, outbreaks of dengue fever became more common. In the 1950s, 9 countries reported dengue outbreaks. Epidemic dengue has become more frequent since the 1980s. By late 1990s, dengue was the most important mosquito-borne disease affecting humans after malaria, with around 40 million cases of dengue fever and several hundred thousand cases of dengue haemorrhagic fever each year.

Global situation of dengue

Before 1970, only nine countries had experienced severe dengue epidemics. At present, the disease is endemic in more than 100 countries in Africa, America, Eastern Mediterranean, South-East Asia and Western Pacific regions, with America, South-East Asia and Western Pacific regions being the most seriously affected (Fig.1).

According to the World Health Organization (WHO) a recent (2013) study estimates that, 390 million dengue infections occur every year (95% CI 284–528 million) world-wide, out of which 96 million (67–136 million) are with clinical manifestation (with any severity of disease, DF,DHF and DSS). Another (2012) study, on the prevalence of dengue, estimates that 3.9 billion people in 128 countries are at risk of infection with dengue viruses.

The year 2016 was characterized by large scale dengue outbreaks worldwide. The American region reported more than 2.38 million cases in 2016, where Brazil alone contributed slightly less than 1.5 million cases, approximately 3 times higher than in 2014. 1032 dengue deaths were also reported in this region. The Western Pacific Region reported more than 375 000 suspected cases of dengue in 2016, of which the Philippines reported

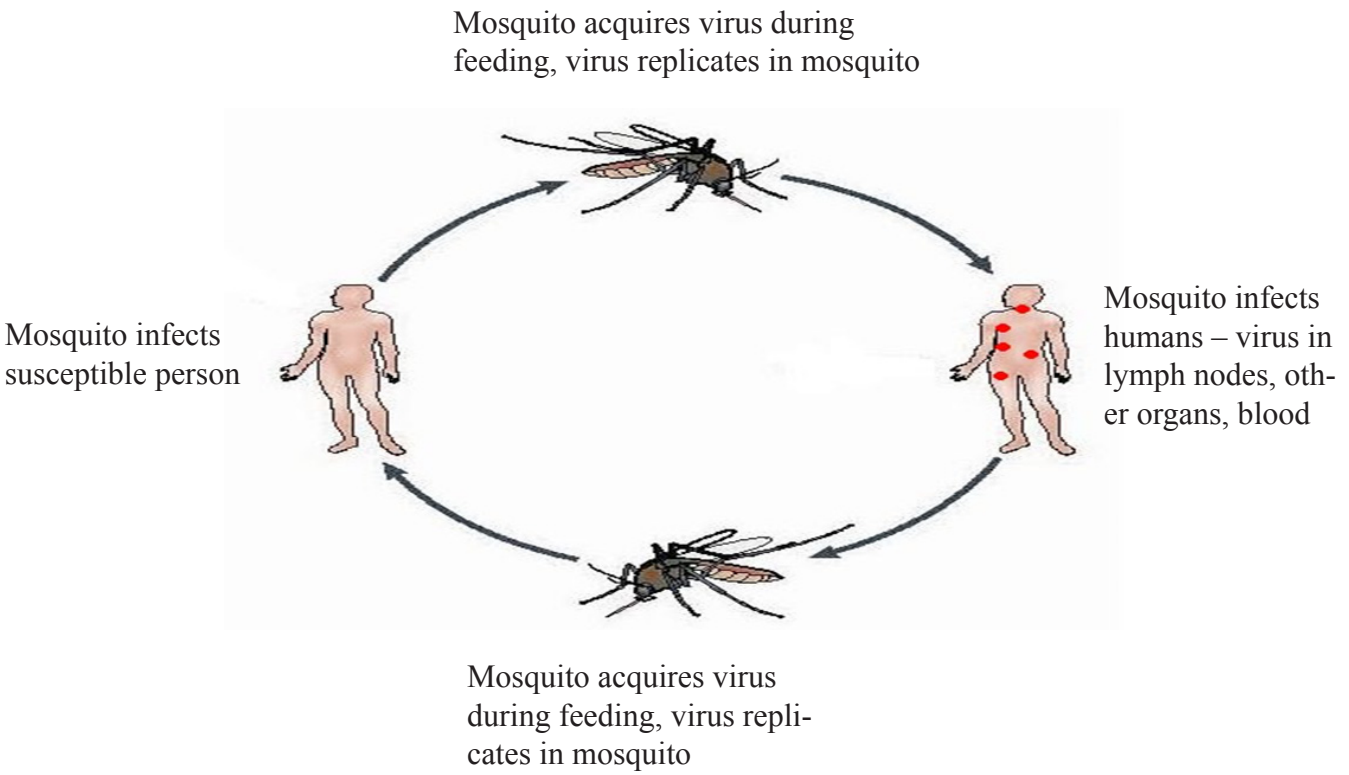


Fig 2 : Transmission of Dengue by mosquitoes

Fig 3 : Image of *Aedes aegypti*

Fig 4 : Image of *Aedes albopictus*

176 411 and Malaysia 100 028 cases, representing a similar burden to the previous year for both countries. The Solomon Islands declared an outbreak with more than 7000 suspected cases. In the African Region, Burkina Faso reported a localized outbreak of dengue with 1061 probable cases.

The map published by the WHO, indicates the distribution of dengue worldwide in year 2016.

Sri Lanka situation

In Sri Lanka serologically confirmed first dengue case was detected in 1962 in the Western Province. The First epidemic in Sri Lanka was reported during 1965-68 with 51 cases

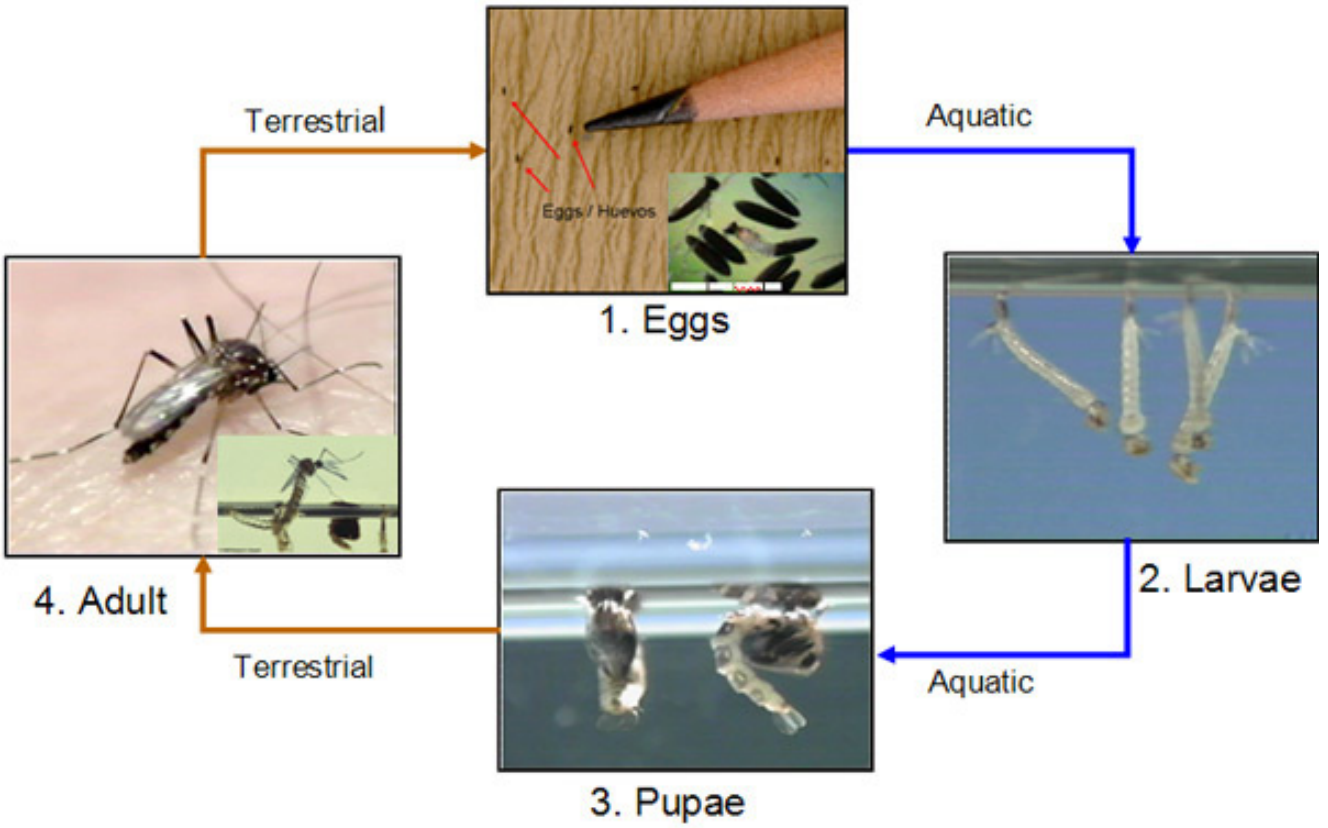


Fig 5 : Life cycle of *Aedes* mosquito

and 15 deaths with a case fatality rate (measure of the severity of a disease and is defined as the proportion of reported cases of a specified disease which are fatal within a specified time) of 30%.

In 1990 resurgence of disease occurred with 440 cases and 11 deaths with a case fatality rate (CFR) of 2%. Since the year 2000, a dramatic increase of cases with over 5000 per year in respect of both DF and DHF has been experienced in Sri Lanka. Reporting of cases has gradually increased yearly, but reducing the CFR to less than 1% from 2004. The year 2017 is exceptional for dengue in Sri Lanka, facing a huge outbreak which exceeded 100 000 cases in the first six months of the year and almost 150 000 cases to date with significant number of deaths. This is the highst ever in the history of this disease.

Disease transmission

The disease is transmitted by the female mosquito of *Aedes aegypti* and *Aedes albopictus*. In Sri Lanka the main vector is *Aedes aegypti*.

For transmission to occur, the mosquito must have a blood meal from a symptomatic person in the first few days (day 0 to 5) when a large amount of virus is in the human blood. But some people who never had significant symptoms, still can infect the mosquitoes. Once the virus enters the mosquito in the blood meal, it will take 8-12 days of incubation before it is transmitted to another person.
Symptoms of infection appear after 4-7 days of incubation period and lasts for 3-10 days.

As the mosquito has a life span of 2 weeks to one month the virus will remain in the mosquito once infected for a period which may be days or a few weeks. The infected mosquito can transmit the virus to several people during of its life span (Fig.2).

There is evidence for viral transmission from a pregnant mother to her foetus, if she got infected during her late pregnancy.

Aedes aegypti

Aedes aegypti, the principal mosquito vector of dengue viruses is well adapted to transmit Dengue virus among human beings (Fig.3). This mosquito is closely associated with humans and their dwellings and is adapted to breed near human habitations It also breeds

Fig 6 : Pictures of common mosquito breeding sites

year round and therefore is able to transmit the disease throughout the year. They prefer human blood meal (Anthrophophilic), and take multiple blood meals (Multiple feeder) for satire. It is identified as a day biter as it is active during the day time (6.00 am to 10.00 am in the morning and 4.00 pm to 6.00 pm in the evening)

inundates the eggs as a result of rains. In the following days, the larvae (picture 2- figure 5) will feed on microorganisms and particulate organic matter. They shed their skins three times to be able to grow from first to fourth stages. When the larva has acquired enough energy and size in the fourth stage, metamorphosis is

mosquitoes. There is a great variety of man-made containers on backyards or patios that collect rain water or that are filled with water by people where dengue vectors thrive.

The common breeding habitats (Fig.6);

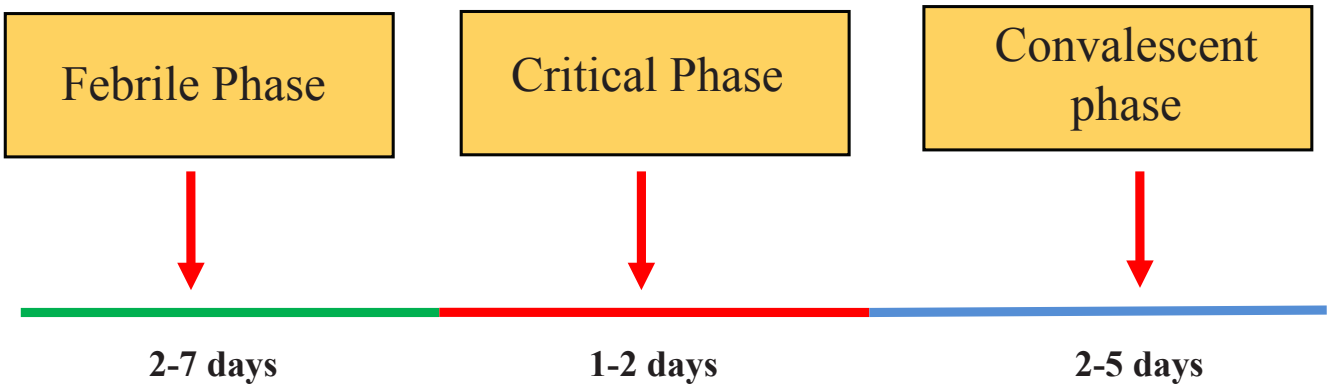


Fig 7 : The clinical course of DHF

Aedes albopictus

Another important mosquito vector of dengue is *Aedes albopictus* which is less adapted to transmit dengue virus, and prefer multiple animal blood meals (Fig.4). It goes into diapause (a period during which growth or development is suspended and physiological activity is diminished, as in certain insects in response to adverse environmental conditions) when cold. It is also a day biter which breeds near human habitation.

Life cycle of the *Aedes*

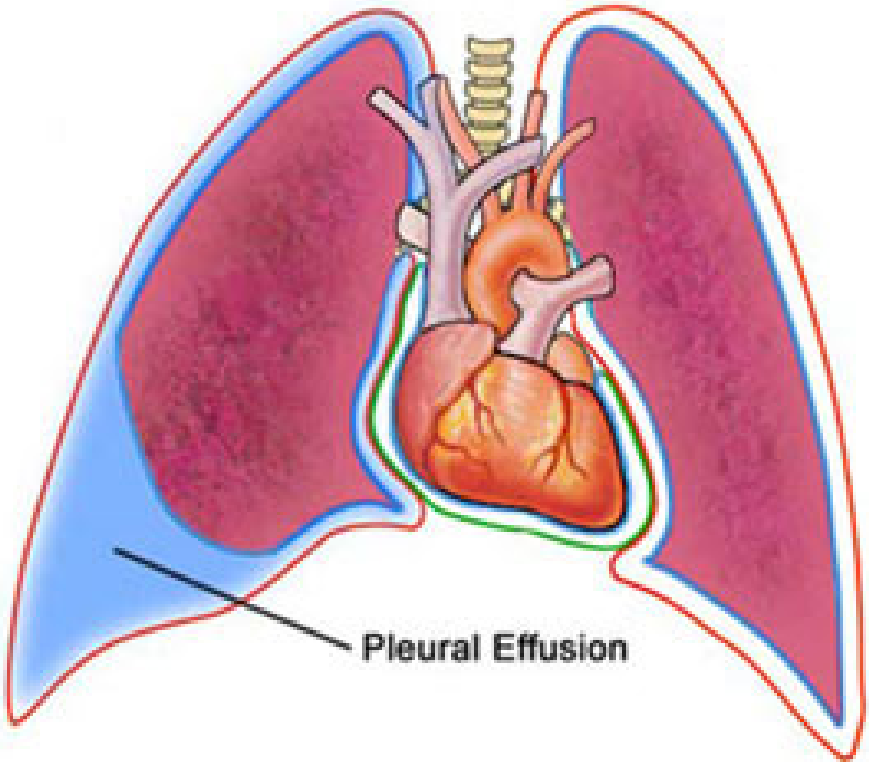
Aedes mosquitoes have a short life-cycle with changes in shape, function, and habitat. It has two phases, terrestrial (eggs, adults) and aquatic (larvae, pupae). Female mosquitoes lay their eggs on the inner, wet walls of containers with water. Larvae hatch when water

triggered, changing the larva into a pupa (picture 3- figure 5). Pupae do not feed; they just change in form until the body of the adult, flying mosquito is formed. Then the newly formed adult emerges from water after breaking the pupa skin (picture 4- figure 5). The entire life cycle lasts 7-10 days at room temperature, depending on the level of feeding.

There is a very important adaptation of dengue vectors; their eggs can withstand desiccation for several months (6 to 12). This allows even if all larvae, pupae, and adults were eliminated at some point in time, repopulation will occur as soon as the eggs in the containers are flooded with water. Female mosquitoes can lay 100 to 200 eggs during their lifetime. Aquatic habitats are containers in which eggs develop into adult

- Disposed items
- Uncovered tyres
- Concrete slabs
- Non usable commodes and cisterns
- Refrigerator and air conditioner trays
- Roof gutters Ponds and bird baths
- Blocked flower pots and plates
- Construction sites
- Blocked drains and manholes
- Covering polythene
- Water tanks and water collecting containers
- Plants collecting rain water eg. Bromelia
- Tree holes

Aedes mosquitoes are highly sensitive to environmental conditions. Temperature, precipitation and humidity are critical for mosquito survival, reproduction, and development, and can influence mosquito



Fluid leak to the lung cavity known as pleural effusion

Fluid leak to the abdominal cavity known as ascites

presence
in

Fig 8 : Plasma leakage during the Critical Phase

abundance.

Clinical features and treatment

People who suffer from dengue fever have no risk of death as it is a self-limiting condition, but rarely some of them develop Dengue Haemorrhagic Fever (DHF) or Dengue Shock Syndrome (DSS). Patients present with fever (>38 oC) with 2 or more of the other symptoms; headache, myalgia (muscle pain), arthralgia (joint pain), purpuric rash, bleeding (eg. gum bleeding), nausea and vomiting need to be suspected as DF.

Severe dengue (DHF) is a potentially deadly complication due to plasma leaking, fluid accumulation, respiratory distress, severe bleeding, or organ impairment. Warning signs occur 3–7 days after the first symptoms in conjunction with a decrease in temperature (below 38°C/100°F) and include, severe abdominal pain, persistent vomiting, rapid breathing, bleeding gums, fatigue, restlessness and blood in vomit. The next 24–48 hours of the critical stage can be lethal; proper medical care is needed to avoid complications and risk of death, DHF and DSS.

It is difficult to identify DF vs DHF in the first 2-3 days as both are clinically very similar. Loss of appetite, Defervescence (afebrile state but sick), Haemodynamic changes (low blood pressures, rapid pulse rate, reduce urine output or no urine output for last 4-6 hours) and laboratory findings (mentioned below) are the mainstay to detect DHF.

If a clinical diagnosis is made early, a health care provider can

effectively treat DHF using fluid replacement therapy. Adequate management of DHF requires hospitalization.

The clinical course of DHF can be demonstrated as below (Fig.7);

Critical Phase

• The critical phase is also known as the leakage phase starting with onset of plasma leakage (often after the 3rd day of fever, with settling of fever)
• Plasma leakage is due to increased capillary permeability. Plasma leakage is transient and usually lasts 24-48 hours.
• Plasma leakage occurs selectively in lungs and abdomen.
• However some patients may enter the critical phase while having high fever.

During this phase there may be significant fluid accumulation in the chest and abdominal cavity due to increased capillary permeability and leakage (Fig.8). This leads to depletion of fluid from the circulation and decreased blood supply to vital organs.

The main laboratory findings noted are leucopenia (White Blood Cell count less than 5000), Thrombocytopenia (low platelets or platelet count less than 100 000) in Full Blood Count (FBC). Thrombocytopenia can be seen 50% in DF and 100% in DHF.
Because dengue is caused by a virus, there is no specific medicine or antibiotic to treat it, the only treatment is to treat the symptoms. For typical dengue, the treatment is purely concerned with relief of the symptoms (symptomatic). Rest and fluid intake for adequate hydration is very important.
The mainstay of treatment is timely supportive therapy to tackle shock due to haemoconcentration and bleeding. Close monitoring of vital signs (pulse rate, blood pressure, and capillary refilling time) in the critical period (between day 2 to day 7 of fever) is vital. Increased oral fluid intake is recommended to prevent dehydration. Supplementation with intravenous fluids may be necessary to prevent dehydration and significant concentration of the blood if the patient is unable to maintain oral intake. The presence of bleeding may require red blood cell transfusion.

What to DO and What NOT to DO if you suspect Dengue Fever
What to DO

• Take only recommended dose of PARACETAMOL and hot water sponging to control fever

• Adequate fluids along with the patient's normal diet (Water, Milk, Fruit juices,
Kanji, ORS)
• The patient should take complete rest
• Immediately consult a qualified doctor or go to the nearest hospital if any of the following manifestations are present;

• No clinical improvement or worsening of the situation
• Persistent vomiting with blood,
• Severe abdominal pain
• Lethargy and/or restlessness, sudden behavioral change
• Black stools
• Giddiness
• Pale, cold clammy hands and feet
• Less/no urine output for 4-6 hours
• Bleeding from the nose or gums
• If a baby crying constantly
• Difficulty in breathing

What NOT to DO

• Taking pain relieving drugs : Aspirin, Diclofenac Sodium, Ibuprofen, Mefenamic acid and Steroids (NSAIDs)
• Resorting to unsolicited treatment methods
• Engaging in vigorous exercise and attending tution
• Do not wait until warning signs appear

Prevention and control

To avoid dengue it is important to break the link between virus, human and mosquito.

This is done through integrated vector control measures (IVM) aiming at both immature and adult stages of *Aedes* mosquito. IVM strategy incorporates the following environmental, biological/bio chemical methods, chemical methods, and law enforcement.

A. Environmental management
- Preventing mosquitoes from accessing egg-laying habitats by:
• Environmental modification (source reduction) – long lasting physical translation of vector breeding habitats to eliminate and/ or prevent mosquito breeding
eg. Disposal of solid waste properly and removing artificial man-made habitats

• Environmental manipulation (source reduction) – temporary changes in vector breeding habitats to prevent or to reduce breeding
eg. Covering, emptying and cleaning of domestic water storage containers on a weekly basis

• Personal protection (changes to human habitation or behaviour) – action to reduce human vector contact
eg. Using personal household protection such as window screens, long- sleeved clothes, insecticide treated materials (mosquito nets), coils and vaporizers, skin applicable repellents

B. Biological/ bio-chemical methods
• Biological – vector control agents parasitize and/or compete with the target vector species
eg. Larvivorous fish- guppy, nalahandaya, dandi, Bti
• Bio-chemical – interfere with the development of vector species
eg. Insect growth regulators (IGR)

C. Chemical methods - Applying appropriate insecticides for larval and adult mosquito control
• Chemical larviciding - applying insecticides to water storage outdoor containers
eg. Temephos
• Adult vector control - applying insecticides as space spraying
eg. Fogging

D. Intersectoral collaboration with Health education - improving community participation and mobilization for sustained vector control

E. Law enforcement – Taking legal action (spot fine, court case) against those who deliberately keep breeding places with larvae even after repeated notifying.

Active monitoring and surveillance of vectors should be carried out to determine effectiveness of control interventions.

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Management of Dengue Fever

Dr Ananda Wijewickrama

What is dengue and dengue haemorrhagic fever:

Dengue is a viral infection caused by dengue virus which is transmitted to human beings by mosquitos. The clinical course of dengue infection varies from individual to individual and even in the same individual from time to time.

Many patients infected with dengue virus remain asymptomatic. Others, after an incubation period of 4-7 days, develop a febrile illness which could turn out to be an undifferentiated fever, classical dengue fever or dengue hemorrhagic fever.

Those infected with dengue virus, especially for the first time (i.e. primary dengue infection), may develop a simple fever indistinguishable from other viral infections (undifferentiated fever).

Classical Dengue fever is generally an acute febrile illness, which may be coupled with clinical symptoms such as severe headache, myalgia, arthralgia and a rash. Decrease in the count of white blood cells and platelets may be observed in hematological tests. Although dengue fever may be benign, it could be an incapacitating disease due to severe body aches, especially backache. Thus dengue fever is also known as "Breakbone Fever"

Undifferentiated febrile illness and classical dengue fever can be managed as any other viral fever with symptomatic treatment. However, often it is difficult to differentiate dengue fever from dengue hemorrhagic fever in the early phase (febrile phase) of the illness.

Dengue hemorrhagic fever is characterized by the acute onset of high fever, and is associated with signs and symptoms similar to dengue fever in the early febrile phase. Plasma leakage is the hallmark of dengue hemorrhagic fever which generally occurs soon after the end of the febrile phase. There is a possibility of developing hypovolemic shock (dengue shock syndrome) due to plasma leakage if a significant amount of plasma leaks out. Importance of early detection of beginning and end of plasma leakage, treatment of shock and other complications are important for the survival and swift recovery of the patient.

If you have fever:

Dengue is now considered a hyper

endemic disease in Sri Lanka, thus it is important to suspect dengue in any patient who is having fever.

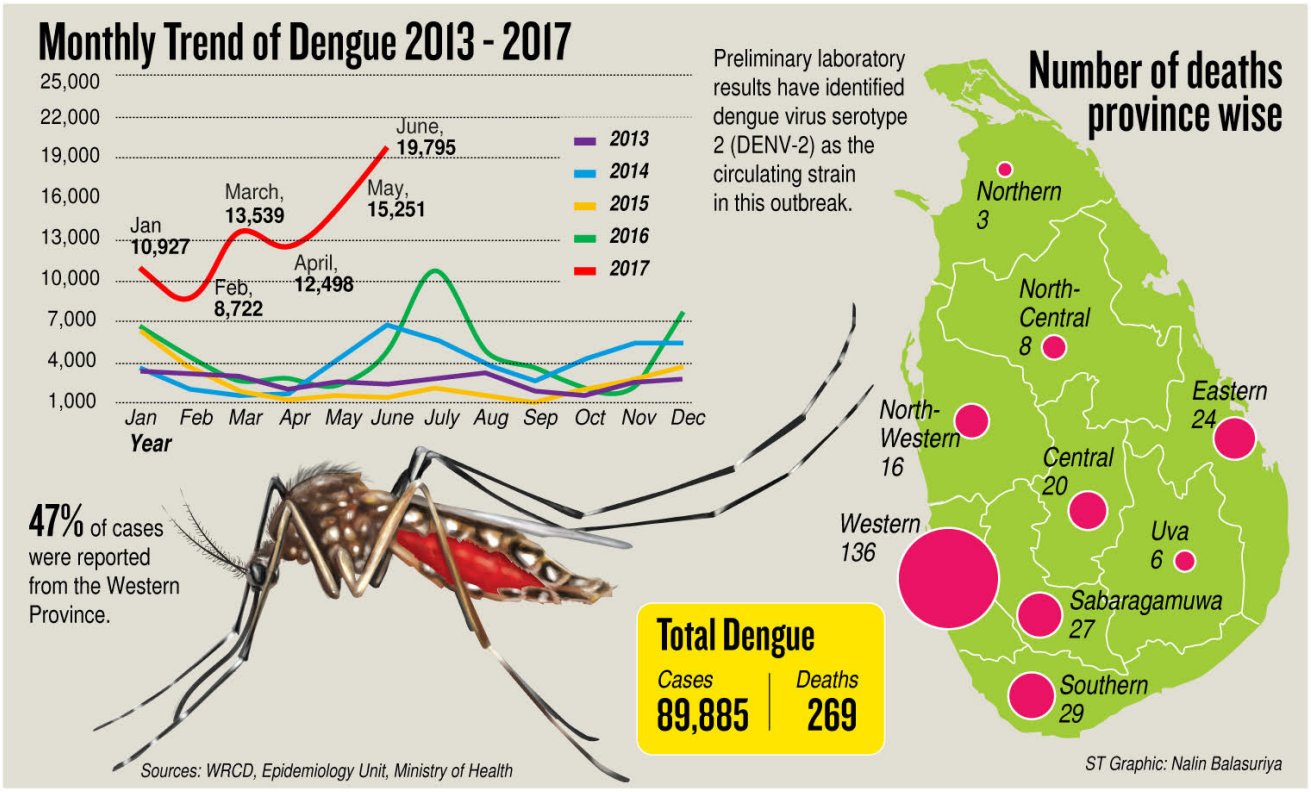
It is recommended to do a Full Blood Count (FBC) at the end of the second day of fever. A Normal full blood count does not exclude the possibility of dengue fever. Therefore follow up FBCs are essential. It is recommended to do FBC daily if the platelet count is >150,000/. FBC should be done twice daily if the platelet count is <150,000/. However a FBC should be done on the first day of fever in pregnant patients and in patients with co-morbidities.

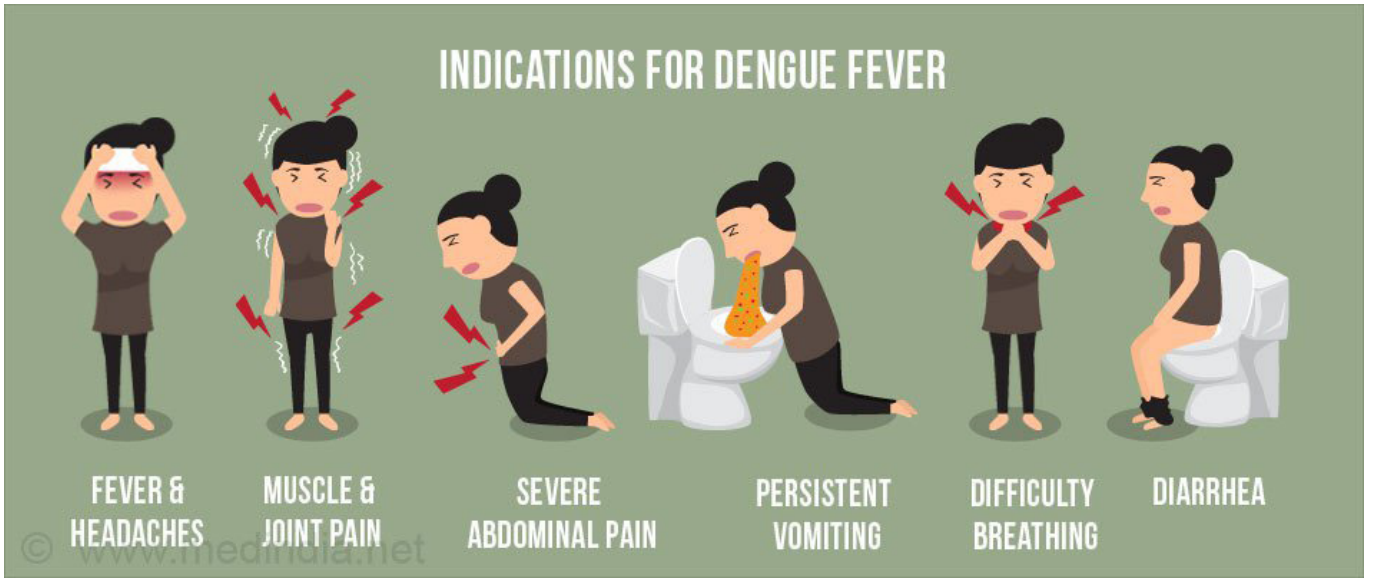
Abnormalities in FBC will be the deciding factor when it comes to admitting a patient to the hospital. NS1 (nonstructural protein1) antigen test is a useful test to identify dengue in the early phase. It is important to note that the NS1 test has to be done within the first 3 days to obtain a reliable result. The likelihood of Dengue infection is high if NS1 antigen test is positive, but a negative test does not exclude the possibility of Dengue. Even if the NS1test is positive, the decision regarding admission to a hospital will be done based on the results of the FBC and clinical condition of the patient.

If the patient does not need admission, he or she can be followed up as an out-patient with continuous assessment of clinical condition and repeated FBCs.

During this period, it is important to ensure adequate oral fluid intake in a patient with fever (about 2500 ml within 24 hours - for an adult). Recommended forms of fluid include- oral rehydration fluid, king coconut water, fruit juice, kanji or soup rather than plain water. It is advised to avoid red or brown drinks which could cause confusion with blood vomiting.

Physical rest is very important. Tepid sponging and cooling using a fan is recommended as adjuvant therapy to paracetamol to bring down the fever. Paracetamol not exceeding 2 tablets six hourly (reduce dose for patients with lower body weights) should be given. It is important to note that fever may not fully settle with paracetamol and should not be taken in excess. Anti-emetics (to control vomiting) can be given if necessary. Avoid NSAIDS (non-steroidal anti-inflammatory drugs) and steroids at all times as these drugs can increase





the bleeding tendency and can affect the liver in dengue.

When the platelet count drops close to 100,000/mm3 patients need to be admitted to a hospital as monitoring is necessary. Even if the platelets count is above this figure, hospital admission will be considered if any of the following 'warning signs' are present after day 3 of fever/illness:

Warning signs-

Abdominal pain, persistent vomiting, clinical signs of plasma leakage, pleural effusion, ascites, mucosal bleeding, lethargy, restlessness, liver enlargement >2 cm, increase in hematocrit (HCT) concurrent with rapid decrease in platelet count

Other patients who may need admission even without the above warning signs are: Pregnant mothers, elderly patients, obese patients, patients with co-morbid conditions like diabetes, chronic renal failure, ischemic heart disease, thalassemia and other
Blood disorders.

Managing In-ward Patients

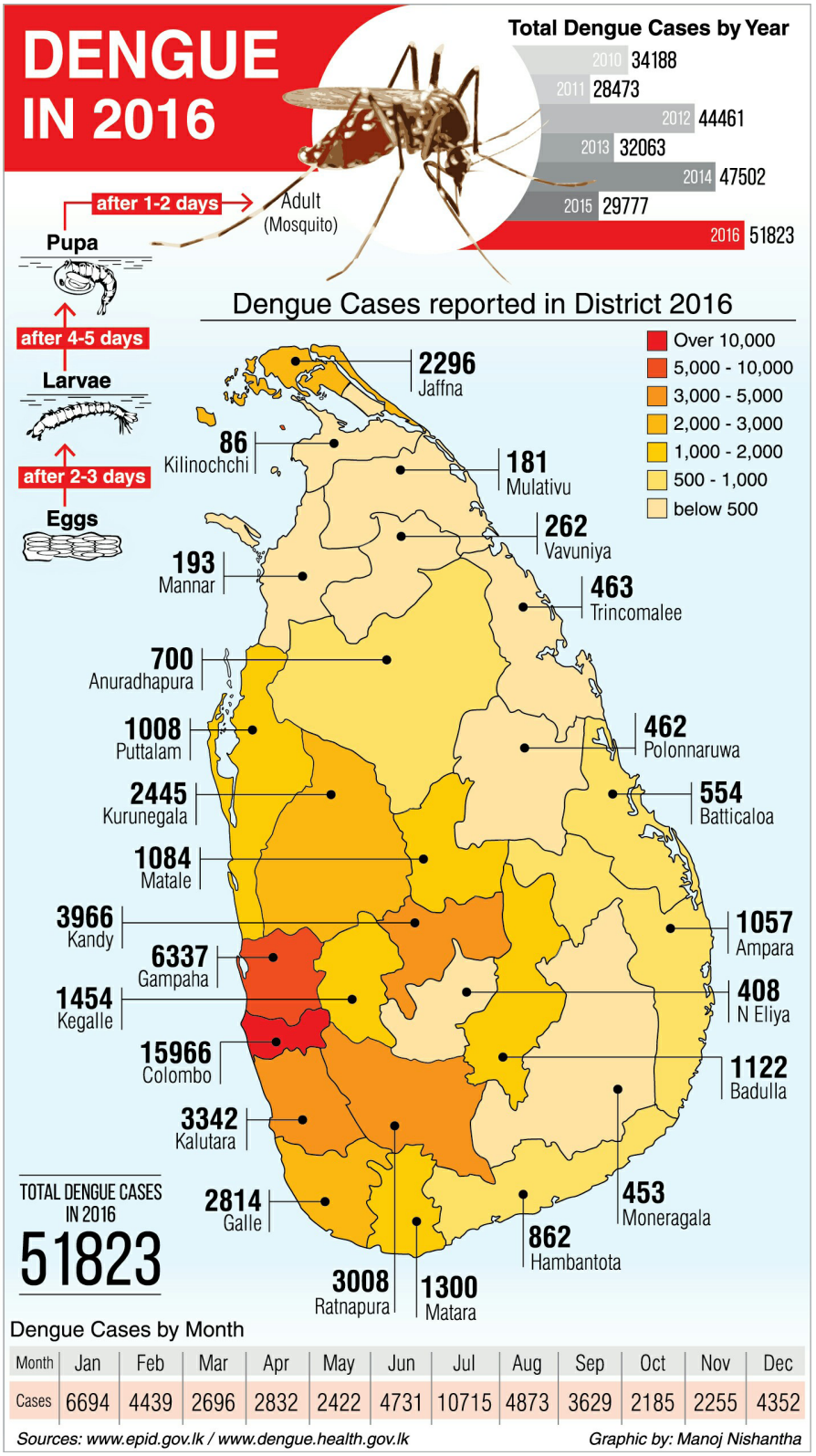
In-ward patients include patients with DF or DHF. Differentiation between these two is difficult during the initial few days (First three to four days of fever). The hallmark of DHF is plasma leakage. Plasma leakage is the main cause for shock, subsequent bleeding, organ failure and death. The only way of diagnosing a patient with DHF clinically is the detection of plasma leakage. Therefore the mainstay of in-ward care is: Early detection of plasma leakage (onset of critical phase) and judicious fluid management to prevent shock and fluid overload. For this, purpose regular monitoring of vital signs (such as pulse rate, blood pressure), intake of fluid and urine output, and hematocrit are very important. Ultra sound examination of the abdomen and chest is a useful investigation to detect plasma leakage. If plasma leakage is detected, monitoring has to be intensified as the leak can continue for the next 48 hours or so. Further the degree of leak vary from person to person and the rate also can vary with time even in the same individual.

Prevention or early treatment of shock is essential if more serious complications are to be avoided. To detect shock early, observation for symptoms and signs are important. Hence, monitoring of following is important:

If the patient is clinically stable on admission and DF/DHF is suspected, the following parameters are measured,

- Vital signs (temperature, blood pressure, respiratory and heart rate)
- Fluid intake and output chart. Fluid balance should be measured, and documented every 2 hourly.
- Hematocrit (PCV)
- Evidence of bleeding- especially melena (dark tarry stools) or bleeding per vagina and quantify.
- Any other fluid loss from the body such as vomiting, diarrhoea with attempt to quantify.

Specific treatment will depend on these parameters. Maintaining the monitoring charts is for accurate fluid management and early detection of shock. And also to decide on the amount of fluid to be given, type of fluid and whether the patient needs blood transfusion. Patients are encouraged to take fluids during hospital stay. The amount of fluid that needs to be taken will be advised according to the parameters. Patients are encouraged to take Solutes over water. If fluid intake is not adequate saline will be given. Type and rate of saline infusion will be determined according to patient's condition. If the patient is capable of taking food, it is allowed; but if vomiting persists fluid intake is encouraged over solid foods.



In convalescent phases

Once the critical period is over, the patient will show features of improvement. The appetite will improve, general well being will improve and patient may have increased amount of urine. Both the WBC and platelets improve. Some people get itching of hand

and feet during this period which is transient. Generally, when the patient is afebrile for about 48 hours, and when the platelet count improves the patient is ready to be discharged home. This usually occurs around the 7th day of the illness. Occasionally patients can get bacterial infections which occur towards the recovery stage of dengue illness. Such patients will have continuing fever and will need antibiotics

Platelet count and complications in dengue.

Earlier it was believed that complications in dengue are due to low platelets. Therefore, the practice many years ago was to transfuse platelets. However, this is not done now not only because it is of no use, but also because it can lead to complications. Platelet drop is common in patients with dengue. Usually this reaches a nadir around 5th or 6th day of the illness and then starts to rise. Complications in dengue are not due to the low platelet count. Platelet rise starts when the patient starts to recover. Therefore, it is not recommended to take other remedies (like papaya leaf extract) to artificially increase the platelet count. This confuses the standard treatment methods and can lead to faulty management of the condition.

Once the patient is discharged home.

Generally patients are recommended to have physical rest (not strict bed rest) for a few days after being discharged from the hospital. Most individuals can even start commencing work after a few days of rest. If the patient had complications during the hospital stay, he/she may be advised to have rest for a longer duration of time, occasionally up to two weeks.

Getting dengue again.

There are four serotypes of dengue. When an individual gets an infection with one type, he becomes immune to that type. But he can get an infection from another type. However, a person contracted and cured of dengue is immune to all four serotypes of dengue for several months. Hence it is highly unlikely that a person who had dengue would get it again within next few months.

Dengue vaccine.

One dengue vaccine was marketed recently. World Health Organization recommends countries to consider using it only in certain geographic settings according to certain criteria. Therefore, it is not registered in Sri Lanka. Furthermore, the present vaccine is not effective against the serotype 2, which is the serotype prevalent in Sri Lanka at present. However, experts are regularly reviewing the data regarding the vaccine.

There are extensive methods of treating dengue, but the important thing to keep in mind is that Dengue always need to be considered as a possibility (given the hyper-endemic situation in the country) when somebody gets fever.

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{This article is based on the interview done with Dr. Ananda Wijewickrama, Consultant Physician, Infectious Diseases Hospital on the 16th of October 2017 by Jithmal Meegoda and Sarith Ranawaka (3rd year medical students, Faculty of Medicine Colombo)}

Entomological aspects of Dengue

Prof. Nissanka De Silva

World Health Organisation (WHO) has shown that among the diseases transmitted by mosquitos, dengue has become a rapidly spreading disease throughout the world. During the past 50 years or so, the incidence of dengue has increased by about 50 fold. Numerical data has revealed that dengue occupies the second place in this respect, the first being malaria.

The dengue causing virus belongs to the flavivirus category, and occurs in four forms. The manner in which these forms multiply within the mosquito vector is not identical. Also the distribution of the different forms changes from time to time.

The main mosquito vector that spreads dengue is *Aedes aegypti.* In addition a few other types of mosquito with the potential ability to spread the disease (potential vectors) have been identified. The main among these is *Aedes albopictusas.* Both these species of mosquito live in many tropical and sub tropical countries in which dengue has been spread.

Aedes aegypti has an African origin. There is scientific evidence to show that initially these lived mostly in forests, but with the establishment of human settlements close to forests two sub species-Aedes *aedes aegypti* and *Aedes aegypti formosus* have evolved. It is believed that the ancient *aegypti* mosquito spread to Europe with the slave trade, and the eggs of the mosquito were transported from Africa to Europe through the ports of Portugal and Spain. Subsequently it spread to Asia and Australia from Europe.

The origin of the *Aedes albopictus* mosquito is associated with the countries of the western Pacific and South Eastern Asia. It has also be seen that this mosquito is spreading fast in the temperate regions of the world. Due to its ancient origin this mosquito is also known as the Asian Tiger Mosquito.

Aedes mosquito is characterized by its black colour, and small to moderate body size (4-7mm) with black and white striped markings arranged as rings. These striped markings are also seen in the 3 pairs of legs. It is possible to distinguish between *Aedes aegyptis* and *Aedes albopictus* by the shape of the white coloured markings on their shoulders. In *Aedes aegypti* it is lyre shaped while in *Aedes albopictus* it is present as a white coloured line on the shoulder. (Fig. 1)

One hundred and forty one (141)

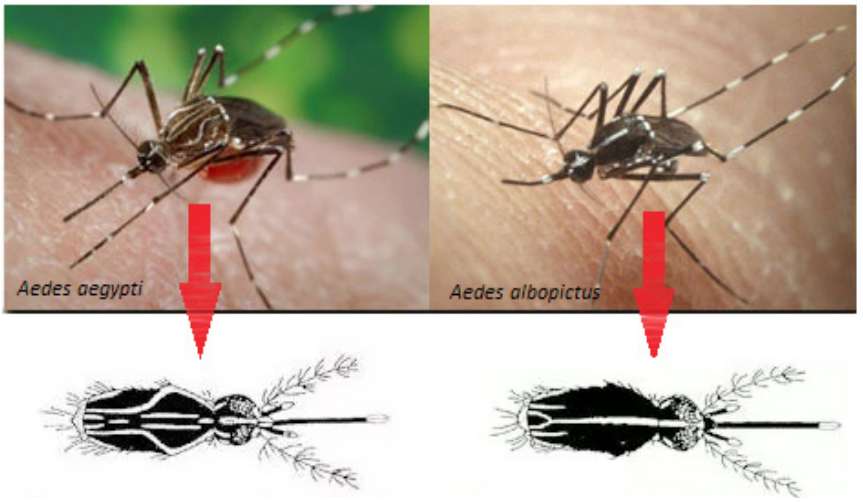

Fig 1 : Differences between *Ae.aegyti and Ae.albopictus*

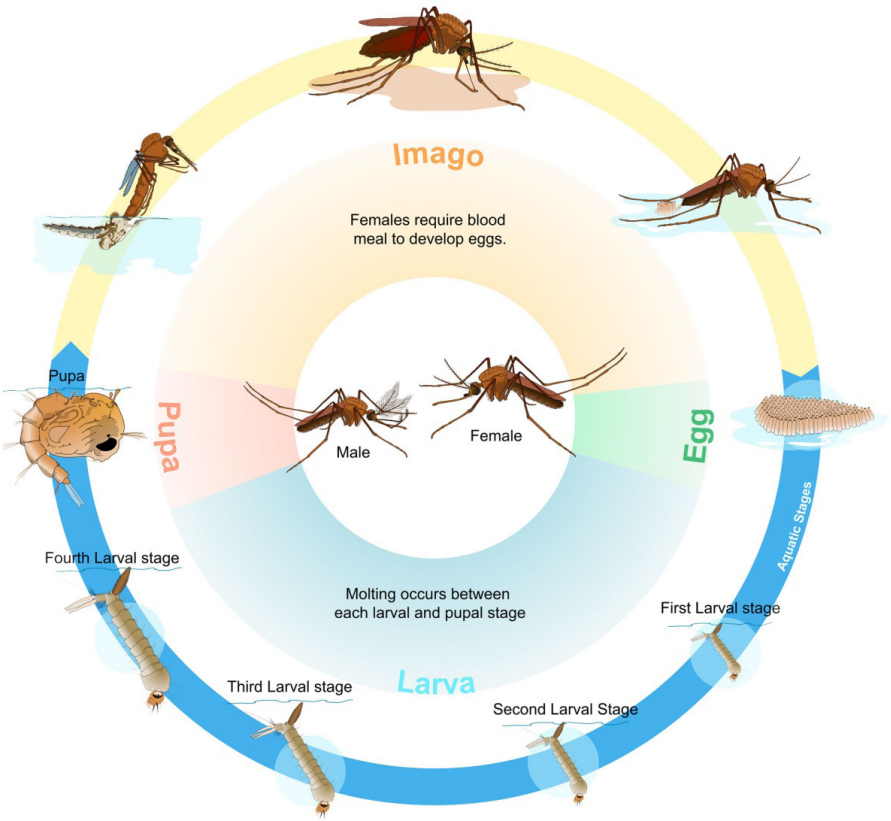

Fig 2 : Life Cycle of Mosquitoes

mosquito species have been reported from Sri Lanka, of which 48 species belong to the genus *Aedes*. Of these the vectors of dengue in Sri Lanka are *Aedes aegypti* and *Aedes albopictus*. *Aedes aegypti* is the main vector. Research has shown that *Aedes albopictus* acts as a reservoir and contributes to maintain the virus during the dry seasons during which dengue is not an epidemic. The life span of *Aedes aegypti* and *Aedes albopictus* is about 2-3 weeks (Note 1)

Vector competence and Vectorial capacity

Heparin which is an anti-clotting agent present in the saliva of the mosquito is introduced into the blood of the human when the mosquito sucks the blood. Heparin temporarily prevents the blood from clotting. The dengue virus is introduced into the body of the human along with this saliva. Subsequent to sucking the blood from the human, the virus multiplies efficiently within the mosquito. The ability of the virus to travel easily within the body of the mosquito to reach its salivary glands, and the subsequent ability to again introduce the virus into the human host is known as the vector competence. Vector competence has been observed in both *Aedes aegypti* and *Aedes albopictus*. The vectorial capacity is the yard stick used to indicate the efficiency with which the vector transmits the diseases. It is determined by environmental factors as well as the biological factors of the mosquito. The vectorial capacity of *Aedes aegypti* is greater than that of *Aedes albopictus*. The reason for this is that *Aedes aegypti* mosquito inhabits house holds and sucks blood specially from humans. In order to obtain a full blood meal (that is to completely fill the abdomen) it sucks the blood several times. Hence when considering the efficiency of spread of the disease among humans, *Aedes aegypti* is the important and capable mosquito. *Aedes albopictus* mostly inhabits places outside of dwelling houses and prefers to suck blood from animals. It sucks blood mainly from mammals, but shows a tendency to suck blood from amphibians, reptites and birds too. In addition *Aedes albopictus* tries to obtain its full blood meal in one attempt. Hence *Aedes albopictus* shows a lesser tendency in spreading the disease. The virus can be seen in these mosquitos throughtout its life span, and it has been discovered that the virus can be transmitted to the next

Note 1.

The mosquito exhibits complete metamorphosis. The female mosquito lays eggs after fertilization. Then after four larval stages it reaches the pupal stage. The adult mosquito emerges form the pupa (figure 1). The egg, larval and pupal stages are spent in an aqueous environment. Only the adult stage is terrestrial. The life span of the adult mosquito varies with the species of the mosquito.

Fig 3 : Intercourse of Mosquitoes takes place in the air

generation too through its eggs.

Mating and oviposition behavior

Generally the mosquito is fertilized only once during its life span. The female mosquito stores a large number of sperms in the sperm storage sac, the spermotheca. Another special feature is that intercourse takes place in the air (inflight) (Fig. 3).

Aedes aegypti lays its eggs mostly inside discarded waste materials such as inside tin containers and yoghurt cups (Fig.4). *Aedes albopictus* lays its eggs usually in places where "natural" water collects such as in cavities of tree trunks, flowers and leaves with accumulated water (Note 2).

The female mosquito generally lays about 100-200 eggs at a time. A single mosquito lays eggs about 4-5 times during its life span. The eggs are pasted singly keeping varied distances between them. Therefore there is the risk of the eggs drying up. Even if the eggs dry up, in most instances they are not destroyed. More over all the eggs are not laid at a single location. Few eggs are laid at a time in a location and thus the eggs are distributed throughout a region. The probability of observing eggs of other species of *Aedes* and a few of the *culex* and *Anopheles* mosquito eggs in a given location does exist. However, due to the present environmental and other factors there seems to be a change in the locations where eggs are laid. The latest research shows that both species of *Aedes* may lay eggs in open water bodies of extreme salinity, as well as in wells and in toilet pits.

Feeding and resting behavior

The dengue vector mosquitos suck blood at times when there is light. They sting between about 6-11am and 3-7pm. But these times may vary slightly depending on the prevailing environmental and biological factors. Theoretically

Note 2.

The sites or locations where Aedes aegypti and Aedes albopictus mosquito frequently lay their eggs in Sri Lanka, are as follows:
1. Discarded waste materials (plastic containers, clay vessels, yoghurt and ice cream cups, broken porcelain objects, coconut shells).
2. Vessels in which water is stored (cement water stroage tanks, barrels).
3. Tyres and non functioning appliances.
4. Buildings (rain water gutters, open concrete balconies).
5. House hold and institutional appliances (Trays in refrigerators, flower vases, vessels used for feeding of pets, bird baths).
6. Natural sites(crevices) holes in tree trunks, the cut surfaces of bamboos, the tips of plant leaves.
7. Other locations (abandoned boats, wells cemeteries and pit latrines).

Fig 4 : Environmental Management Sources

even though these mosquitos do not sting during night time, inside well lit houses sometimes they may suck blood in the night.

Aedes aegypti rests in dark and high humidity locations such as on hanging clothes, window curtains, the dark (shaded) sides of furniture in houses and buildings. The chances of these mosquitos resting in dark location of vegetation outside of houses is very little. However *Aedes albopictus* rests mostly in the dark locations of vegetation outside of houses and in the dark locations of materials thrown out.

Flight range and dispersal of mosquitos

The basis for this is the chances of being able to lay eggs and the extent of the human population. These two factors are well provided in the urban and semi urban environments. So the dengue disease is common in them. Generally these mosquitos are dispersed over distances of about 100-200 meters from where the eggs are laid. However if the above conditions exist to a lesser extent, the distance increases to about 400m. These mosquitos (the adult mosquitos or eggs) may disperse throughout the entire globe. They may be transmitted by vehicles, aeroplanes and ships. In addition to this horizontal dispersal, *Aedes aegypti* especially could be seen at higher elevations (vertical dispersal) too. There are reports of them being present in 6-7 storied buildings.

The rapid spread of both *Aedes aegypti* and *Aedes albopictus* is affected by climatic changes, such as high temperature, rainfall and changes in humidity, and also by man's effect on the environment. The main causes are irregular urbanization, the deficiencies in the management of waste materials, the inefficient and disorganized methods employed by local government institutions and other governmental institutions to control the mosquitos. The breakdown of the attitudes of people is also a cause. The introduction of medication which could destroy the dengue virus, or the production of a vaccine to confer immunity to the virus are still in the experimental stage. Therefore it has become necessary to control the disease by the use of compulsory control measures the spread of the mosquito.

Now let us consider the methods and actions to be followed to

Fig 5 : Man made mosquito breeding and multiplication locations

control the mosquito.

The completion of the life cycle of the mosquito and the sucking of blood takes place in a restricted area. The most suitable solution to control the mosquito is to destroy the breading and multification locations of the mosquito (Fig.5). These locations are provided by the activities of man in his dwelling (home) environments. It is possible to deprive the mosquito of most locations where the mosquito lays eggs by the management of solid waste. To achieve this end it is compulsory to clean houses and institutions on a regular basis, at least a few days every week, and dispose the waste material in an organized and correct manner. In order to make this mission successful it is necessary to enforce the exsisting laws and regulations, and constantly make the people aware through communication media on a regular basis. Also it is possible to spray Bti bacteria to pineapple plantations, ornamental plantings such as pandanus, bromeliads, and to rainwater gutters. Introduction of larvae eating (Larvivorus) fish into water storing tanks and barrels is a successful solution. Because *Aedes albopictus* mostly lays its eggs in places where 'natural' water collects and also because it is difficult to clean the rainwater gutters in very tall buildings it is possible to multiply the larvae eating mosquitos - Toxorhynchites in a laboratory and 'release' them (Fig.6).

These control methods come under the categories of environmental management and biological control. Through these the larvae of the vector mosquitos can be controlled. However, when the mosquito population increases or when a large number of dengue patients are reported, it is compulsory to destroy the vector mosquito by

Fig 6 : Larvivorus fish, Bti, and Toxorhyuchites Larvivorous mosquitoes for biological control

Fig 7 : Application of chemical incesticides - chemical control

chemical methods. The larvae destroying liquid Temphos or its granules (pebbles) can be used. In order to destroy the vector mosquitos chemical insecticiales such as malathion and pyrethroids can also be used. The application of these chemical insecticides can be done by Thermal fogging (Fig.7) or as ultra low volume sprays. For this it is necessary to get the advice of scientists dealing with larvae. Using the data, that these scientists have obtained by investigation of vector mosquitos, the insecticides are sprayed according to an organized procedure. If the insecticides are sprayed in an irregular manner the mosquito will very soon develop resistance to the insecticide. That is, the mosquito population becomes resistant to the insecticide faster than the production of successful insecticides. Due to the adverse effects of insecticides on the environment and on animals including man, insecticides should be used only on specific occasions. In addition various types of mosquito repellents can be used to prevent being bitten by mosquitos. Various types of repellents are available in the market and most of them belong to the category of insecticides known as pyrethroids. In addition there are the plant extracts such as citronella oil, margosa oil and oscimum (maduruthala) species that can be used.

The simultaneous introduction of a variety of methods of control in a region is known as integrated vector control. The necessity of employing a scientific larval control procedure is obvious in such methods of control. The need for collaboration of many related parties such as the Ministry of Health, local government bodies, Ministry of Environmental affairs, security forces, civil societies and the public, and also the use of a great deal of resources reflect the constrains in controlling dengue.

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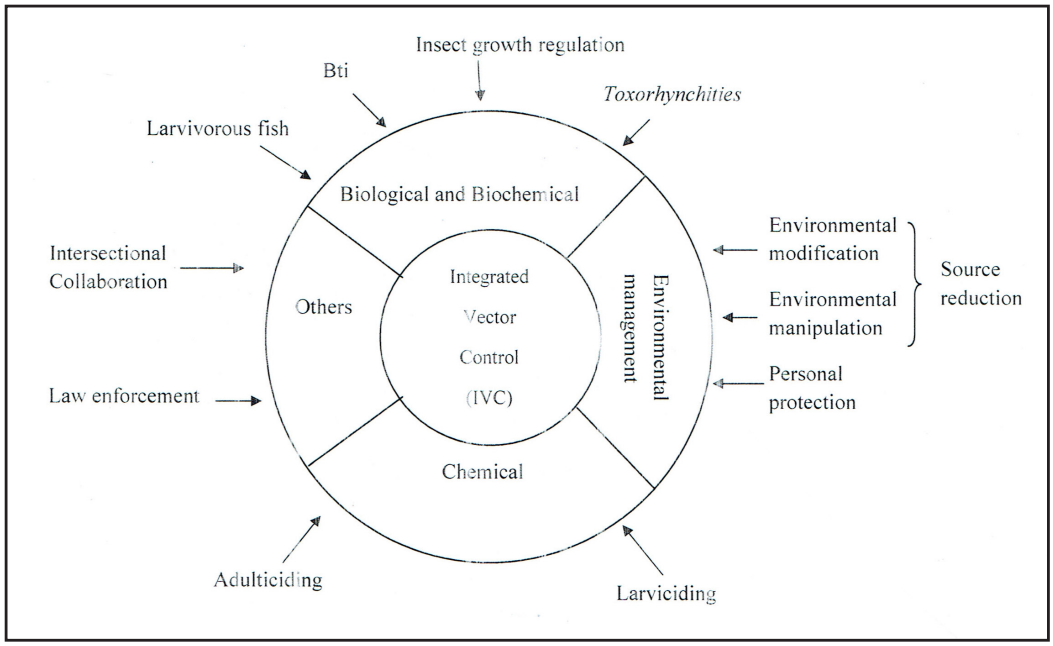
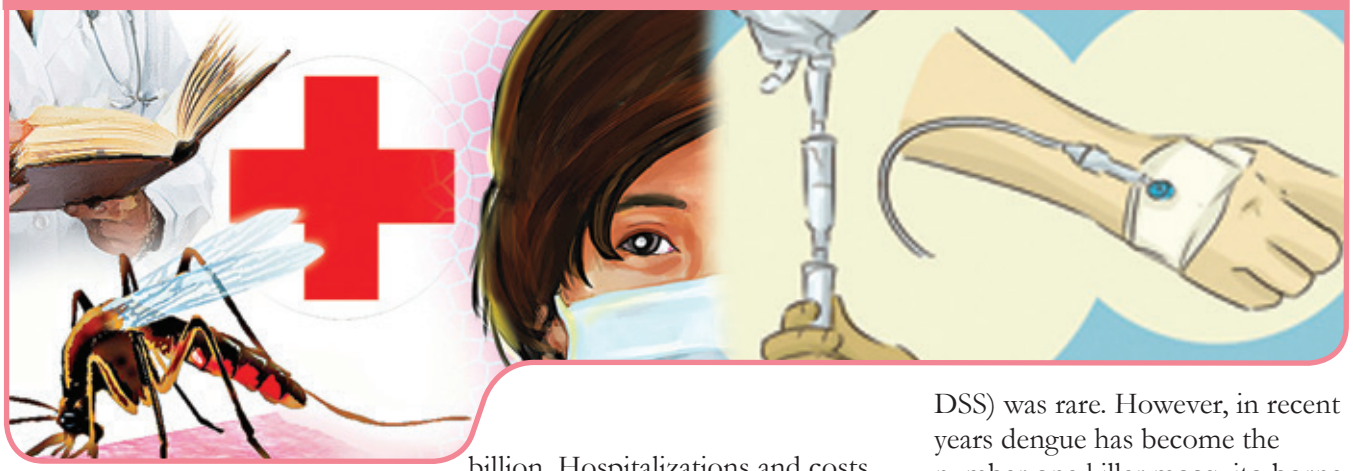


Diagram 1 : Integrated Dengue Vector Control

Novel interventions in treating dengue

Prof. Neelika Malavige



Dengue viral infections represent one of the most rapidly emerging mosquito borne infections in the world, spreading to many geographical regions. It is estimated that 390 million individuals are infected every year with the virus. As approximately 75% of those who are infected do not show any symptoms at all. 70% of those who are infected with the dengue virus live in Asia. The estimated annual global cost associated with dengue is $8.9 billion. Hospitalizations and costs due to dengue control activities was estimated to be US$ 3.45 million in year 2012, in Colombo, Sri Lanka, which highlights the economic burden due to these diseases in developing resource poor countries. Dengue viral infections have been endemic in Sri Lanka since the mid-1960s which was when the first cases of DF/DHF were reported. Although the Sri Lankan population had been exposed to the virus for decades, severe forms of dengue infection (DHF/DSS) was rare. However, in recent years dengue has become the number one killer mosquito borne infection in Sri Lanka. Not only is the incidence of dengue infections rising in Sri Lanka, but the infection is also spreading to all parts of Sri Lanka. The largest ever dengue epidemic occurred this year and more than 150,000 cases have been reported up to now (Diagram 1).

Dengue infection can occur following infection with any of the four dengue virus (DENV) serotypes (DENV1-4) which cause dengue disease and which are

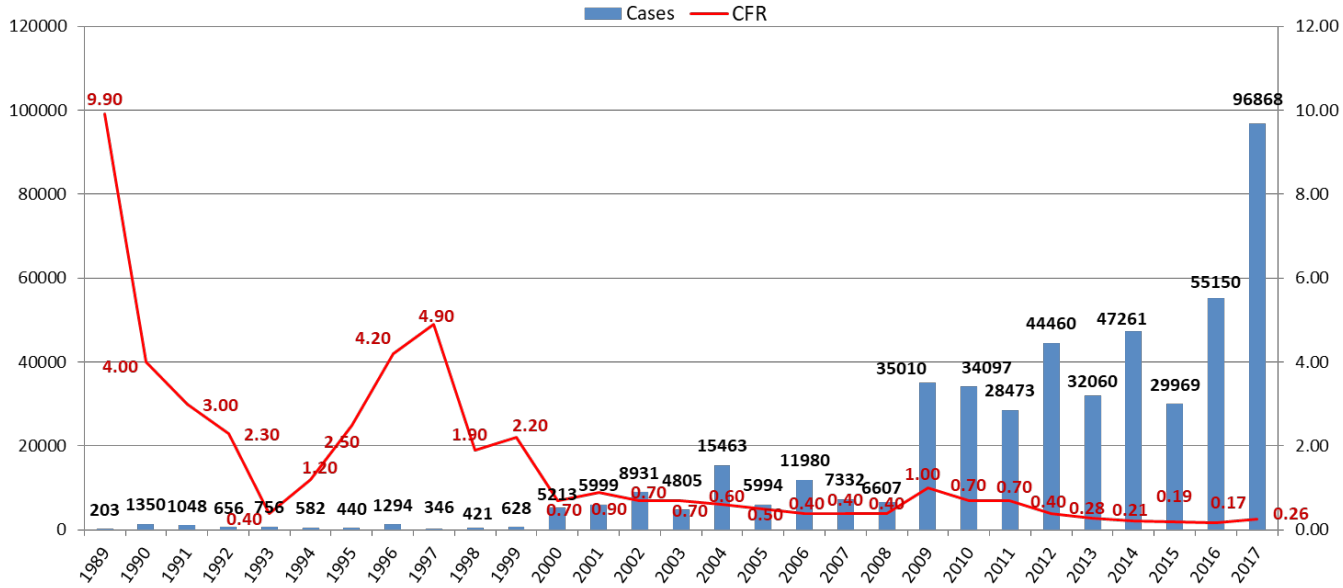


Diagram 1:The incidence and case fatality rates (CFR) due to dengue from 1989 up to June 2017 (kindly provided by Dr. Hasitha Tissera, Director, Dengue Control Unit, the Epidemiology Unit Sri Lanka)

closely related. The four viruses are 65% to 70% similar to each other (ie.the viruses are 65 to 70% homologous). Initial infection with a particular serotype is known as primary infection, which is usually asymptomatic or results in mild disease manifestations. Subsequent infection with other serotypes (secondary dengue infections) may lead to severe disease which manifests in the form of DHF/ DSS .Although infection is associated with a self-limiting illness in the majority of individuals, it can cause severe clinical disease manifestations such as dengue haemorrhagic fever (DHF) and organ involvement in a significant proportion of individuals. One of the research projects carried out by us showed that approximately 50% of children living in the suburban region in Colombo have had dengue by 10 years of age, and by 45 years approximately 95% of those living in the suburban areas in Colombo have had dengue.

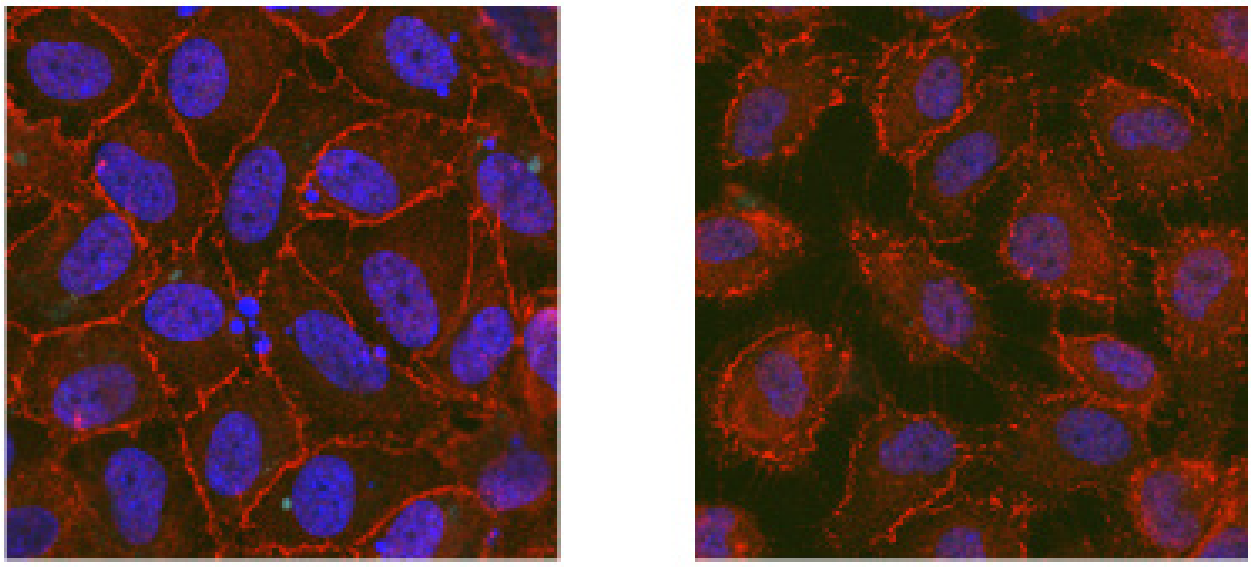
Clinical features and complications of dengue

Dengue infection typically manifests as a sudden onset febrile illness with muscle pain, joint pain and headache. The majority of individuals proceed to an uneventful recovery whereas some develop DHF, which is characterised by fluid leakage due to increased capillary permeability. Complications occur as a result of fluid leakage such as shock, pleural effusions, ascites along with other complications such as liver failure and encephalopathy. One of the most important issues to be monitored is the vascular leak from the blood vessels/ capillaries, which is the cause of severe dengue (DHF). In DHF fluid leaks from the capillaries accumulate in the lung and abdominal cavity. Therefore, once the patient is admitted, ultra sounds scans are done to see if the patient has developed leaks. Also the packed cell volume (PCV) or the haematocrit (HCT) is also monitored as an indicator of leaks. It is very important to know the moment when the patient is leaking and the extent of the leak. If leaking goes undetected, and if there is rapid leakage, the patient will go in to shock state. This in turn leads to liver and kidney failure, and if the shock persists for a few hours, it will lead to death. Therefore, the biggest challenge is to detect which patients show signs of a leak, as only 20-25% of those who develop symptomatic dengue do so.

During the leakage phase it is important to monitor the fluid that goes in, in the form of oral fluids or intravenous fluids and also the output in the form of urine. This is an abosolute requirment to calculate how much fluid that should be given to the patient. Giving too much as well as too little leads to complications, and the optimum amount should be given, which varies widely from

patient to patient. The rapid drop of the platelet count is an indicator that the patient may developing the severe disease (DHF). However, the lowering of platelet count is only an indicator of the possibility of a severe disease. Actually, low platelet counts are the result of severe illness and not the cause of it. Some individuals may have very low platelet counts but still may not have severe disease, whereas some with relatively high platelet counts develop severe disease. Therefore, although platelet counts are useful as an indicator to monitor and decide if the patient needs admission, the most important factor is the 'leakage'.

As shown in the above illustration (Fig.1), the fluid leaks through the gaps between the endothelial cells which line the capillaries. The image on the left shows what endothalial cells usually look like. As shown they are stuck together by a cement like substance. In the presence of serum from dengue patients (right image) gaps form between endothelial form leading to fluid leakage.



Endothelial cells in the presence of normal serum

Endothelial cells in the presence of serum from a dengue patient

Fig 1: Vascular leak in dengue patient

The cause of vascular leak and new treatment methods

We have found that the most important mediator that causes this leakage is what is known as the platelet activating factor (PAF). Once you detect that a patient is showing signs of leaking, it is important to replace the exact amount of fluid that is leaked. This leaking phase lasts only for 48 hours. Forty eight hours after the patient being in the leakage phase (critical phase), the fluid leakage stops, and the fluids that leaked is reabsorbed. This usually coincides with the rise in platelets. So it is natural for platelets to drop for 2 to 3 days and suddenly start picking up. No magical treatment is needed for this as this is what happens naturally.

Patients with DHF were shown to have very high levels of PAF during the critical phase (leakage phase). Fortunately there is already a drug known as rupatadine available that blocks this mediator. To find out if rupatadine is effective in dengue, we carried out a clinical trial to see if it works in dengue, and also whether it is safe to use.

Rupatadine has already been used for certain types of allergic diseases in many European countries, as well as in Australia, Japan, USA and India. So we know that the drug is safe and could also be given to children. We designed this trial so

that half of the patients will be given the drug and the other half a placebo (a drug which looks similar but with inactive ingredients). It is important to use a placebo in drug trials because, otherwise patients might feel that they are better when they are told that they are

been given a drug that might work. The treating doctors might also be biased when they are treating patients when they know certain patients are taking a drug. So in this trial, both doctors and patients were blinded (they did not know if they were taking the drug or placebo). This is very important to make sure that proper, unbiased scientific data are being collected. Also a proper statistically designed sample size should be taken to know if meaningful conclusions can be drawn instead of depending on 'unproven, non-scientific' claims.

We have completed the initial trial for a drug that reduces/ prevents this leakage and the results look promising. People given this drug (rupatadine) had fewer complications and a shorter duration of illness when compared to the placebo, especially when given early. Since the results look promising, we have just started the next phase of this trial, where we will give the drug in the outpatient department (before patients are admitted to hospital).

Precautions to take if you are diagnosed with dengue

It is very important to obtain medical attention if you have fever, at its very early stages. It would be dangerous to try unproven home remedies. Fortunately, most patients who develop dengue do not develop severe disease (DHF) and will be fine if given anything. However, there is no way to know who will develop severe disease, and it is too late when some people come to hospital. If patients come to hospital when they have developed shock the outcome is not good. Therefore, it is important to understand that if treatment is sought in a timely manner, deaths due to dengue would be extremely rare.

If you have fever it is important to do a full blood count and show the report to your doctor. You can also do the dengue NS1 antigen test at the same time. If your NS1 is positive, there is no need to panic because only around 20-25% of those who get dengue develop severe dengue (DHF). The likelihood of NS1 being positive is highest on day 1 of fever. Subsequently the rates of NS1 positivity gradually drops even if you have dengue. If NS1 is positive, it means that you do have dengue. However, even if you do the dengue NS1 test on day 1 of fever and it is negative, you can still have dengue. NS1 is negative in a significant proportion of patients, despite having dengue. Therefore, it is of utmost important to seek medical advice if you have fever, irrespective of whether your NS1 antigen test is positive or not.

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Ensuring safety from Dengue: Our responsibility

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Effective and sustainable prevention and control of dengue needs a multi-sectoral approach combating all the factors favouring vector breeding. Global evidence has however shown that, dengue prevention and control cannot be achieved/ sustained without community empowerment and ownership in those activities. Health authorities nor the government or other organizations alone can control and prevent dengue transmission. A major part of this can be achieved via active community participation. Community has an individual as well as collective responsibility in prevention and control of dengue. School children are the best changing agents to take valuable messages to the community. They can easily adopt themselves to have better behaviours and also can promote such changes in adults as well. When children are changed to have positive behaviors those will sustain for their life which will give long term good impact to the community.

Responsibility of the school in case of a sick child

When a child presents with fever, headache and vomiting in the school sick room, it is the doctor's duty to treat the child without uncertainty.
During this season when anyone presents with fever, dengue has to be suspected as the first disease in differential diagnosis. Many patients (90%) infected with dengue virus remain asymptomatic while others will develop a febrile illness after about 6 days from the infection (incubation period).

Dengue has to be suspected in a child with acute onset of high fever accomparuied with following features.
• Headache and retro-orbital pain
• Muscle pain/ joint pain
• Diffuse, reddish rash
• Nausea and vomiting
• Bleeding manifestations
Living in an endemic area, as well as presence of patients with dengue fever in that area increase the likelihood of diagnosing dengue. It is difficult to differentiate dengue fever from dengue haemorrhagic fever during the first few days of the febrile phase. Therefore close monitoring of the patient is highly important in this period.

The medical officer can manage the initial stage at the sick room.
• Take a good history
• Measure the temperature
• Look for any signs of bleeding manifestations
• Give Paracetamol in adequate dosage according to the body weight
• Ensure adequate oral fluid intake
• Inform parents

If the child can be managed at home without admitting to a hospital parents should be advised regarding home-based care by the school medical officer.
• Provide adequate physical rest. Until the child is completely cured school, classes, sports or other trips should be avoided and ensure rest at home.
• Fever should be controlled only with adequate doses of paracetamol.
• Pain killers like ibuprofen, diclofinac sodium, mefenamic acid and steroids like prednisolone, dexamethasone should be avoided. They may induce severe bleeding.
• Fever should be controlled with tepid sponging using luke warm water.
• Adequate clear fluids like jeevani, king coconut water, fruit juices,

kanji or soup should be used instead of plain water.
• Red and brown coloured drinks should be avoided.
• Must advice to do a full blood count after the second day of fever and the report shown to a doctor.
• Following danger signs should be informed to the parents and advised to seek medical treatment immediately.
• Deterioration of the condition with the settling of fever
• Inability to eat/ drink
• Severe abdominal pain/ vomiting
• Bleeding manifestations: gum bleeding/ nasal bleeding/ coffee ground vomiting/ dark stools etc.
• Reduced urine output/ not passing urine for more than 6 hours
• Child should be kept under a mosquito net to prevent mosquito bites as the child can transmit the infection during this period.

Responsibility of the school authority

When there are several fever cases in the school, the school medical authorities should be informed to take relevant actions. Dengue control and prevention actions should be conducted with the participation of all teachers and students. It is mainly the environmental management that needs to be focused on.
• A school dengue control committee should be established and a responsible person should be allocated to carry out the dengue control and preventive activities
• School should engage in cleaning their premises for an hour in a selected day every week to remove mosquito breeding sites
• The dengue control committee should daily inspect the premises for mosquito breeding sites and provide a report to the principal weekly

Responsibility of students

Prevention and control of dengue is not only a responsibility of teachers but also of the parents. It is a collective responsibility of all citizens. Students play an important role in keeping their environment clean.
• Waste segregation and disposal
Most of the school premises contain different coloured dustbins. Therefore student should make it a habit to throw away garbage to the correct container.
• No polythene policy
It is very important to reduce the use of polythene which in turn reduces the disposal to the environment. Reusable bags can be used. Students should be advised to bring food in a reusable container without using lunch sheets which are environmental hazards. Furthermore whatever the container/ bottle they bring these should be taken back home without disposing at school. These habits will be very advantageous in their adult lives as well.
• Environmental cleanliness
Keeping the environment clean will make sure that it is free of mosquito breeding sites. At the same time clean environment at school will make students realize its importance and will in turn make them change their home environment as well.
• Self-protection
All school children are at risk of getting mosquito bites during school hours as the mosquitos are very active during this period. Therefore, students can get themselves protected from mosquito bites wearing protective clothes covering their extremities and also by using repellents.
• Home environment

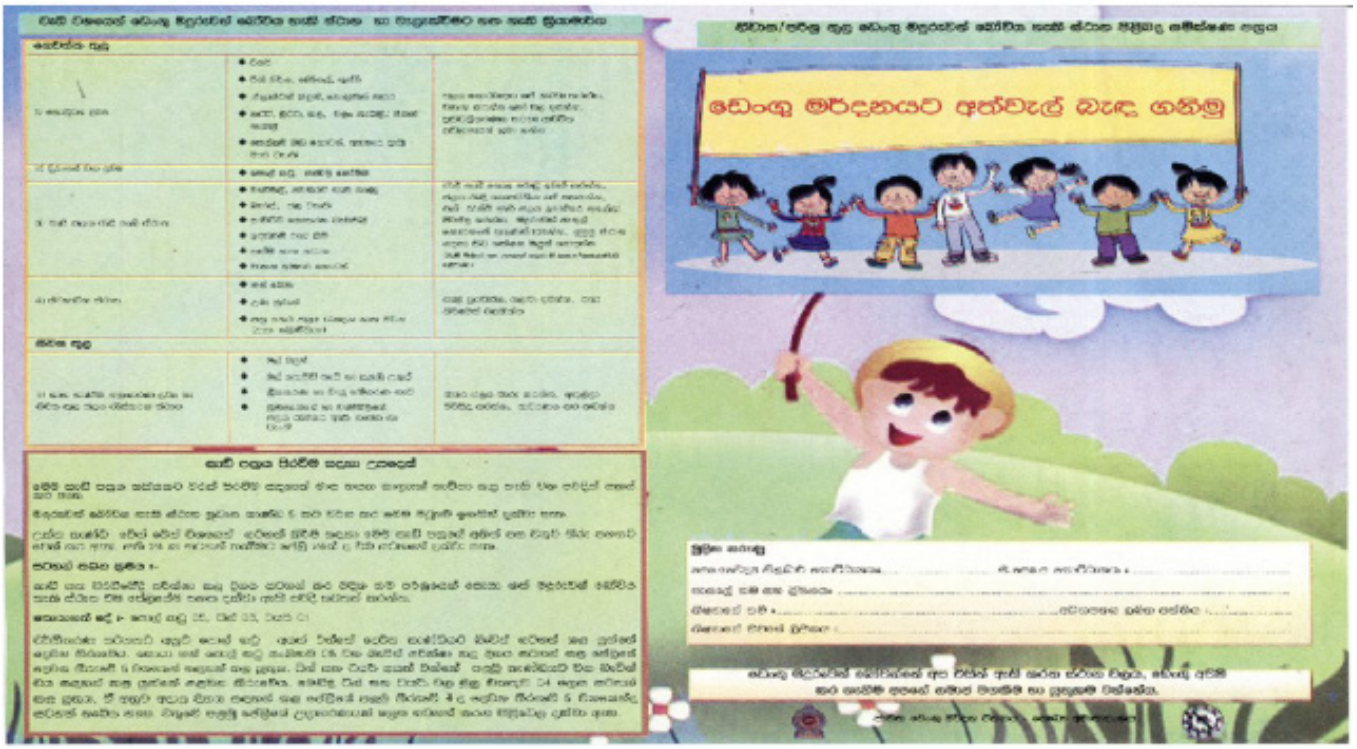

Fig 1 : School Card

It is

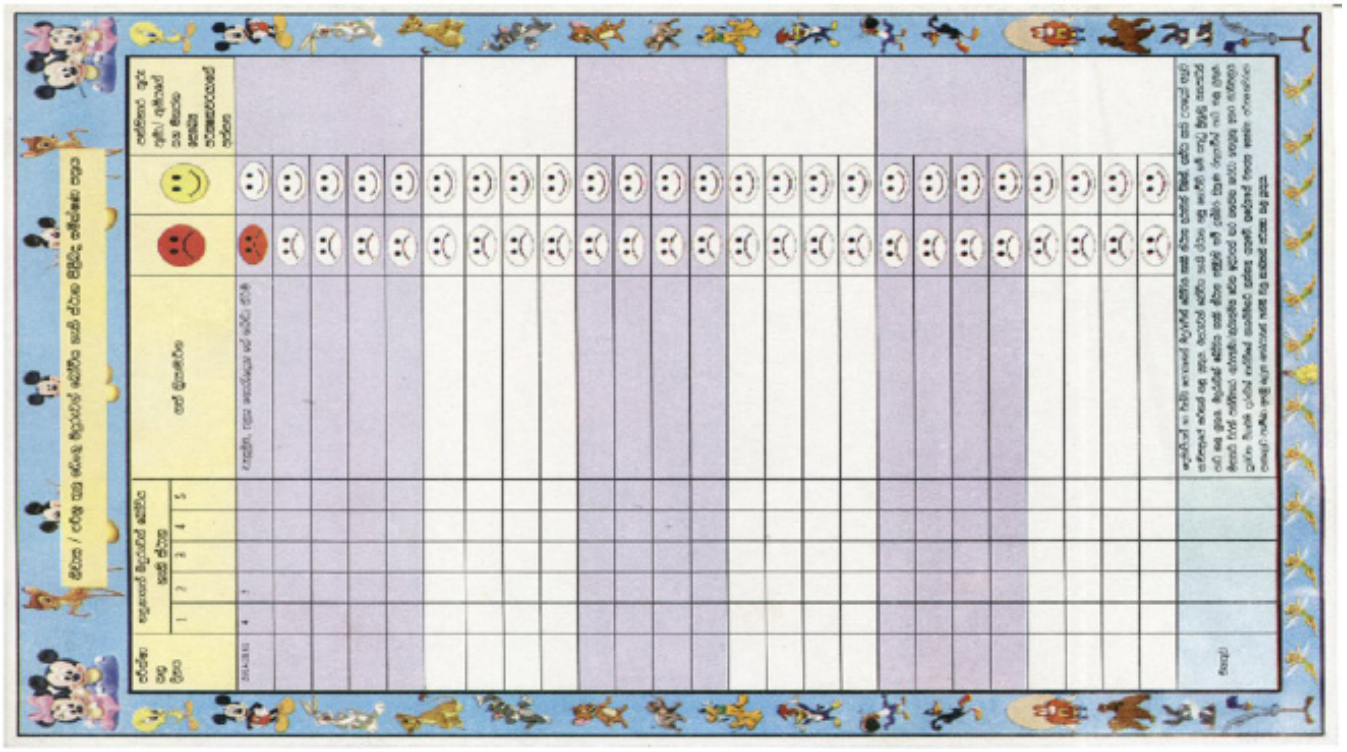

Fig 2 : Home Inspection Card

not only the school environment that need to be kept clean. Home environment should be kept clean and safe to prevent mosquito breeding. If there are possible breeding sites at home parents can be made aware by students to remove them.

Responsibility of parents

• Seek medical advice on time
When a child is having fever, action must be taken immediately to get medical advice and also need to adhere to the given advice. A sharp eye needs to be kept on the child to identify any danger signs and act immediately.
• Educate students by doctors
There will be a lot of old boys/ girls now working as doctors. They can be utilized to give medical advice to the students, teachers and parents on a regular basis. Continuous awareness campaigns are important to prevent and control dengue. In case of several fever patients present in the school immediate control and preventive actions can be taken by the doctors with the help of other relevant authorities.
• Clean the school premises
Regular cleaning programmes can be arranged in schools with the help of parents, old boys/ girls and make the environment free from dengue breeding sites.
• Updating the school card (Fig. 1)
The National Dengue Control Unit introduced a school card to be filled by students to inspect both schools and houses in 2015.
• Updating the home inspection card (Fig. 2)

The National Dengue Control Unit has introduced a new home inspection card to be kept at home. There is a list of possible mosquito breeding sites given in the card and also the actions needed to be taken in case of identifying such a site. The card should be kept in a secure place and inspect the home and the surrounding premises weekly and fill it up continuously for a year. When a healthcare worker visits the house they will check the card and take necessary actions.
Parents can give the responsibility to their children and make them do it weekly under supervision. It will make sure the environment is clean and also it will make them adopt a behaviour which will last lifelong.
All in all if all students, teachers/ school authorities and parents can get together as a team, it is very easy to prevent and control dengue in the future.

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