



Dengue Fever: Epidemiology, Clinical Insights And Strategies For Control

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Abstract: Dengue virus infection is one of the most common mosquito-borne diseases and a fast-growing virus primarily found in tropical and subtropical regions and is spread by Aedes mosquitoes. An estimated 100 to 400 million infections occur each year and it kills one person every 12 minutes, making dengue a danger to world health. The majority of dengue infections are moderate or asymptomatic, but severe cases can cause serious bleeding, shock, or organ damage, among other potentially fatal consequences. Climate change increased international travel, fast urbanization, and inadequate infrastructure have all played a part in the virus's global spread. Dengue does not currently have a specific treatment; instead, prevention depends on personal protection measures and efficient vector control. The Global Strategic Preparedness, Readiness, and Response Plan (SPRP) of the World Health Organization seeks to lessen the disease's burden by enhancing healthcare access, coordinating emergency responses, and protecting the population. Future control depends on enhanced surveillance and ongoing vaccine research. To combat dengue, a thorough, multifaceted strategy is needed at the international, national, and local levels.

Key words: Dengue fever, Epidemiology, clinical insights, Strategies, Control

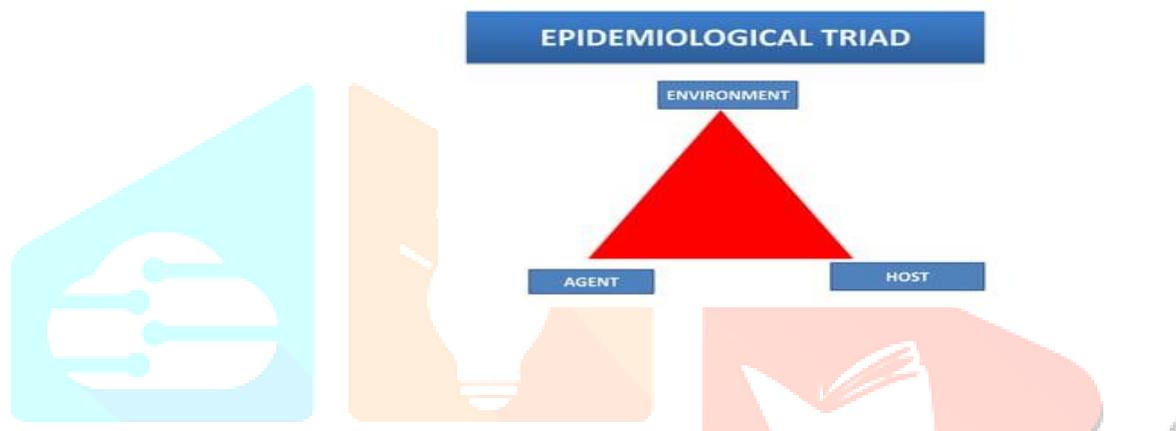
I. INTRODUCTION

Dengue fever (DF) is a rapidly emerging acute febrile illness that poses a global public health concern due to its potentially lethal consequences. People can contract dengue, a virus, by being bitten by an infected mosquito. An estimated 100 to 400 million dengue illnesses occur annually, putting almost half the world's population at risk. According to WHO reports, there were over 7.6 million dengue cases in 2024, including 3.4 million confirmed cases, over 16,000 severe cases, and over 3000 deaths. It is primarily prevalent in urban and semi-urban areas across the world in tropical and sub-tropical climates. The virus can sometimes result in more serious instances, including death, while most dengue infections are asymptomatic or only cause mild sickness. According to the World Health Organization, globally, an estimated four billion people are at risk of contracting an arbovirus, and by 2050, that figure is expected to rise to five billion. Ineffective vector control management may result from rapid urbanization and poor infrastructure development, which are major contributors to the spread of diseases carried by mosquitoes worldwide. Additionally, when people move from one place to another, business groups or individual travellers also contribute to the spread of infectious diseases carried by mosquitoes into unfamiliar areas. Although early detection and access to appropriate medical care significantly reduce the fatality rates of severe dengue, there is still no particular treatment for dengue or severe dengue. Vector control is essential for dengue prevention and management.

II.EPIDEMIOLOGY: UNDERSTANDING THE SPREAD

Dengue is endemic in over 100 countries across Africa, the Americas, Southeast Asia, the Western Pacific, and the Eastern Mediterranean. Southeast Asia and the Americas bear the highest burden. The primary vector responsible for transmission is the *Aedes aegypti* mosquito, which thrives in urban and semi-urban environments, breeding in stagnant water found in containers, tires, and other receptacles. Other *Aedes* species, like *Aedes albopictus*, can also transmit the virus.

The incidence of dengue has dramatically increased in recent decades, driven by factors like population growth, rapid urbanization, climate change, and increased travel. The WHO estimates 390 million dengue infections annually, with 96 million manifesting clinically. This rise underscores the need for effective control measures. To understand this complex interplay of factors driving dengue's spread, the epidemiological triad provides a useful framework. This model considers the interaction between the agent causing the disease, the host susceptible to it, and the environment facilitating their interaction.



AGENT: The agent in dengue is the dengue virus itself, existing in four distinct serotypes (DENV-1 through DENV-4). A unique characteristic of dengue is antibody-dependent enhancement (ADE). While infection with one serotype provides lifelong immunity to that specific type, it can paradoxically increase the risk of severe dengue upon subsequent infection with a different serotype. This phenomenon plays a critical role in the disease's epidemiology and the development of severe cases

HOST: The *host* in dengue is primarily human. However, susceptibility and disease severity vary. Children, for instance, are often more vulnerable to severe dengue. Genetic factors and pre-existing health conditions can also play a role. Even previous dengue infection, while conferring immunity to that specific serotype, can, through ADE, increase the risk of severe disease upon subsequent exposure to a different serotype.

ENVIRONMENT: The *environment* plays a crucial role in dengue transmission. Tropical and subtropical climates provide ideal conditions for *Aedes* mosquitoes, as warmer temperatures accelerate both mosquito breeding and the virus's replication cycle. Rapid urbanization, often characterized by inadequate sanitation and water management, creates abundant breeding sites in discarded containers and stagnant water. Climate change, with its potential to alter temperature and rainfall patterns, may further expand the geographic range of *Aedes* mosquitoes and prolong transmission seasons, posing a significant threat.

Outbreaks often occur when a susceptible human population (host) encounters the dengue virus (agent) in an environment (tropical climate, abundant breeding sites) that favors mosquito proliferation. Changes in any of these elements—for example, increased rainfall leading to more breeding sites, or the introduction of a new serotype—can trigger an outbreak.

The four serotypes of DENV are DENV-1, DENV-2, DENV-3, and DENV-4. One serotype of infection confers permanent immunity to that serotype and only temporary immunity to the other serotypes; subsequent infections with a different serotype raise the risk of developing severe dengue. Most dengue cases are either asymptomatic or cause moderate feverish sickness. On the other hand, severe dengue can develop in certain situations, leading to serious organ damage, shock, or severe bleeding. The warning indications of this stage include severe abdominal discomfort, recurrent vomiting, bleeding gums, fluid accumulation, lethargy or restlessness, and liver enlargement. This stage usually begins after the fever has subsided.

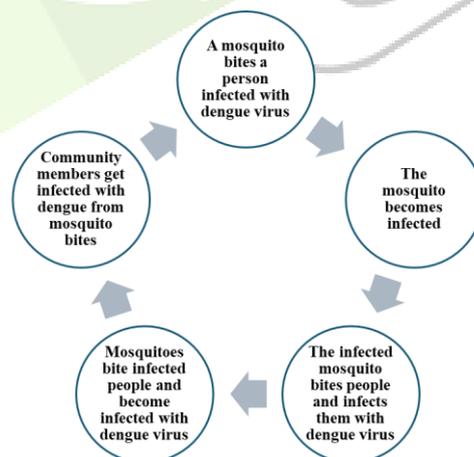
Despite intensified efforts to slow or reverse the upward trend, the burden of dengue, one of the fastest-growing viral diseases in the world, has increased by an estimated 30 times over the past 50 years. Dengue is spreading quickly around the globe due to several factors, including unplanned urbanization, inadequate water, sanitation, and hygiene standards, climate change, and international travel.

A virus called dengue, also known as break-bone fever, is transmitted from mosquitoes to humans. In tropical and subtropical regions, it is more prevalent. The majority of dengue patients won't show any symptoms. However, the most typical symptoms for those who do include rash, headache, body aches, nausea, and a high temperature. Most will recover in a week or two. Dengue can be lethal in extreme situations, and some patients require hospital treatment. Avoiding mosquito bites, particularly during the day, can reduce your risk of contracting dengue. Since there is currently no specific treatment for dengue, pain medication is used to treat it.

Risk factors

- Previous infection with DENV increases the risk of severe dengue.
- Urbanization
- social and environmental factors such as population density, human mobility, access to reliable water source, water storage practice etc.
- Community risks include water storage, plant keeping, and self-protection against mosquito bites.

Dengue Virus Transmission Cycle



Clinical Insights: Recognizing the Symptoms and Warning Signs

The majority of dengue patients recover in one to two weeks and have minimal or no symptoms. Dengue can occasionally be fatally severe. In most cases, symptoms start 4–10 days after infection and last 2–7 days. It includes the following,

Dengue infection can range from asymptomatic to severe. Classic dengue fever typically presents with a sudden onset of high fever(40°C/104°F), severe headache (often behind the eyes), intense muscle and joint pain (hence the nickname "breakbone fever"), nausea, and vomiting. A characteristic maculopapular rash

often appears a few days after the fever begins. This rash consists of small, flat (macules) and raised (papules) red or pink spots that are typically distributed on the trunk, limbs, and face. It may be itchy and can sometimes resemble a measles rash. This rash usually fades within a few days.

While a maculopapular rash is more common in classic dengue, petechiae (tiny, pinpoint-sized red or purple spots caused by bleeding under the skin's surface) can also occur, particularly in more severe cases. Petechiae do not blanch (lose color) when pressed and are often found on the arms, legs, and trunk. It's important to note the difference: maculopapular rashes are a common feature of dengue, while petechiae can be a warning sign of worsening condition.

Severe dengue, a potentially life-threatening complication, can develop. It is characterized by plasma leakage, leading to fluid accumulation in the chest and abdomen, as well as bleeding manifestations. Petechiae can become more widespread and prominent in severe dengue. Other warning signs of severe dengue include persistent vomiting, severe abdominal pain, restlessness, and decreased consciousness. Any signs of bleeding, including petechiae, easy bruising, nosebleeds, or bleeding gums, warrant immediate medical attention. Prompt medical attention is crucial in such cases.

Diagnostics and Treatment

Diagnosis relies on a combination of clinical assessment and laboratory testing. Viral detection methods, antibody tests (detecting IgM and IgG), and blood tests to assess platelet counts and other markers play a vital role. Differentiating dengue from other febrile illnesses can be challenging, highlighting the importance of accurate diagnostic tools.

Currently, there is no specific antiviral treatment for dengue. Management focuses on supportive care, including rest, oral rehydration, and pain management with acetaminophen (avoiding NSAIDs like ibuprofen, which can increase bleeding risk). Severe dengue necessitates hospitalization, intensive monitoring, and fluid management.

Strategies for Control: A Multifaceted Approach Informed by the Triad

Effective dengue control requires a comprehensive strategy encompassing various approaches, all informed by an understanding of the epidemiological triad:

Vector Control: This remains the cornerstone of dengue prevention. Eliminating mosquito breeding sites is crucial. *Aedes aegypti* mosquitoes, the primary vectors of dengue, prefer to breed in containers that hold clean, stagnant water. This can include anything from discarded tires, flower pots, and uncovered water storage containers to even small, seemingly insignificant accumulations of water in bottle caps or blocked gutters. It's important to emphasize that while the water may be clean, it must be stagnant; flowing water is generally not a suitable breeding site. Regularly emptying and cleaning such containers is essential. Promoting the use of mosquito repellents (containing DEET, Picaridin or IR3535), coils and vaporisers, insecticide-treated nets, window screens and protective clothing can reduce mosquito bites. Community participation in these efforts is essential. This directly targets the environment component of the triad. It's particularly important to emphasize the use of these measures during peak biting times, which are typically around dawn and dusk, as *Aedes aegypti* mosquitoes are most active during these periods.

Personal Protection: Beyond general vector control, individual precautions are vital. Using effective mosquito repellents containing DEET, picaridin, IR3535, or other EPA-approved ingredients is highly recommended, especially when outdoors. Wearing long-sleeved shirts and pants can provide additional protection. Given that *Aedes aegypti* mosquitoes primarily bite during the day, with peak activity around **dawn and dusk**, it's crucial to be particularly vigilant during these times. Consider staying indoors during

these peak periods if possible, and ensure that screens on windows and doors are in good repair to prevent mosquitoes from entering.

Vaccination: Dengue vaccines are now available in some countries. The WHO recommends vaccination for individuals living in endemic areas, particularly those with a history of dengue infection. One vaccine (Q Denga) has been approved and licensed in some countries, recommended only for the age group of 6 to 16 years in high transmission settings. Several additional vaccines are under evaluation. Vaccination strategies should be tailored to the local epidemiological context. This strategy strengthens the host's defences.

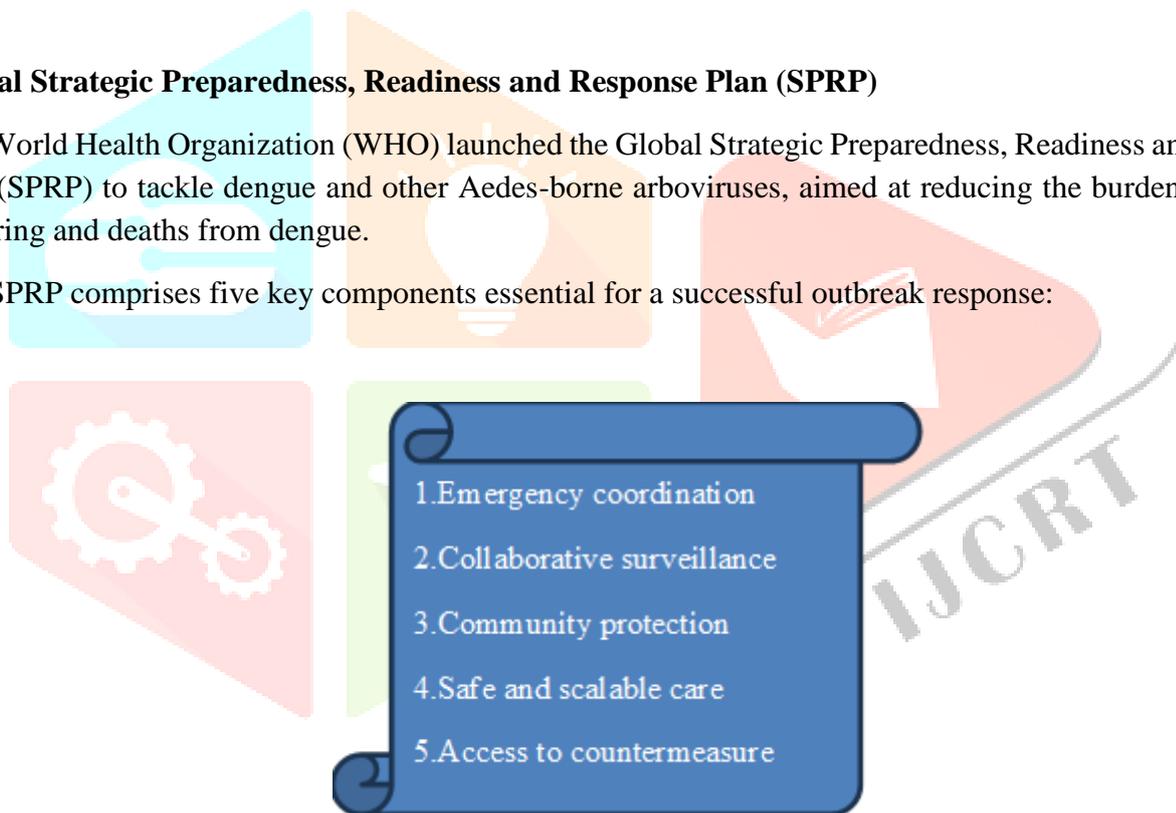
Public Health Measures: Public awareness campaigns play a critical role in educating communities about dengue prevention, mosquito breeding sites, and the importance of seeking timely medical care. Strengthening surveillance systems and improving diagnostic capacity are also essential components. These measures address the interplay between all three elements of the triad.

Community Engagement: Engaging communities in dengue control efforts is vital for sustainability. Empowering individuals to take ownership of prevention measures can lead to long-term behavioural changes.

Global Strategic Preparedness, Readiness and Response Plan (SPRP)

The World Health Organization (WHO) launched the Global Strategic Preparedness, Readiness and Response Plan (SPRP) to tackle dengue and other Aedes-borne arboviruses, aimed at reducing the burden of disease, suffering and deaths from dengue.

The SPRP comprises five key components essential for a successful outbreak response:



III. CONCLUSION

In conclusion, dengue fever remains a significant worldwide health concern, particularly in tropical and subtropical places. The majority of dengue cases are mild, but severe cases can be lethal, highlighting the importance of early detection and efficient prevention. Understanding its epidemiology through the framework of the epidemiological triad, recognizing its clinical manifestations, and implementing effective control strategies are crucial for mitigating its impact. Managing the disease requires a multi-prolonged approach combining personal protection, vector control, vaccination, public health measures, community engagement, and international programs like the WHO's SPRP is essential for achieving sustainable dengue control and reducing the burden of this debilitating disease.. There is promise for improved control in the future due to ongoing research into improved diagnostics, vaccines and treatment.

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