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Dengue Virus explained: Understanding its features and impact on public health

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Abstract
Dengue fever is a major global health problem because its causative agent, the dengue virus, poses a significant threat to human populations worldwide. The aim of this review is to provide a comprehensive overview of the dengue virus, including its characteristics, transmission and public health implications. The research examines the current understanding of the structure, genetic composition and serotypes of the virus, as well as the clinical manifestations of dengue infection. In addition, the review discusses the challenges in developing effective preventive and therapeutic measures and highlights the critical role of early diagnosis and vector control in alleviating the burden of disease.

Keywords: Health, dengue, mosquito, vector, diseases, drug

Introduction

Dengue virus, a member of the family Flaviviridae, is the causative agent of dengue fever, a mosquito-borne viral disease that has become a major public health problem worldwide. An estimated 100 million cases of dengue fever and 500,000 cases of the more severe form, dengue hemorrhagic fever, occur annually, mostly in tropical and subtropical regions. The virus is transmitted primarily by the *Aedes aegypti* mosquito, which is becoming increasingly common in urban and semi-urban areas.

Dengue virus presents a complex challenge due to its genetic diversity with four different but closely related serotypes (DENV-1, DENV-2, DENV-3 and DENV-4) [1, 2]. Infection with one serotype results in lifelong immunity to that particular serotype but does not provide protection against the other three serotypes [3]. In addition, secondary infection with a different serotype can lead to a more severe form of the disease known as antibody-dependent enhancement, which is a significant problem in dengue-endemic regions [4]. The year of 2015-2024 dengue cases and deaths by states of India (Table 1).

Table 1: 2015-2024 Dengue Cases and Deaths by State (India)

S. No	States	Cases	Deaths	Peaked
1.	Andhra Pradesh	6,453	0	2022
2.	Arunachal Pradesh	130	0	2022
3.	Assam	8,208	2	2022
4.	Bihar	20,224	74	2022
5.	Goa	512	3	2022
6.	Gujarat	18,219	17	2019
7.	Haryana	11,835	13	2021
8.	Karnataka	19,300	11	2023
9.	Kerala	17,426	153	2023
10.	Maharashtra	19,034	55	2023
11.	Odisha	12,845	1	2022
12.	Punjab	23,389	55	2021
13.	Rajasthan	20,749	96	2021
14.	Tamil Nadu	9,121	12	2023
15.	Telangana	8,972	1	2022
16.	Uttar Pradesh	35,402	36	2023
17.	West Bengal	67,271	30	2022

This comprehensive dataset includes the yearly distribution of dengue cases and deaths across different states in India (Vector Control Center) (NCVBDC) (Vector Control Center).

Dengue virus features and transmission

Dengue virus is a single-stranded positive-sense RNA virus with a genome of approximately 10.7 kilobases [5, 6]. The virus is composed of three structural proteins (capsid, membrane and envelope) and seven non-structural proteins, each of which plays a crucial role in the life cycle and pathogenesis of the virus. Entry of the virus into host cells is a crucial step in the infection process as it determines the ability of the virus to replicate and spread in the body.

The dengue virus is mainly transmitted by the Aedes aegypti mosquito, which is found in tropical and subtropical regions. The virus can also be transmitted by the mosquito Aedes albopictus, although less efficiently. The mosquitoes become infected when they feed on a person during the viremic phase of infection, when the virus is present in the person's blood. After infection, the mosquitoes can transmit the virus to other people when they later eat (Fig 1) [5, 6, 7].

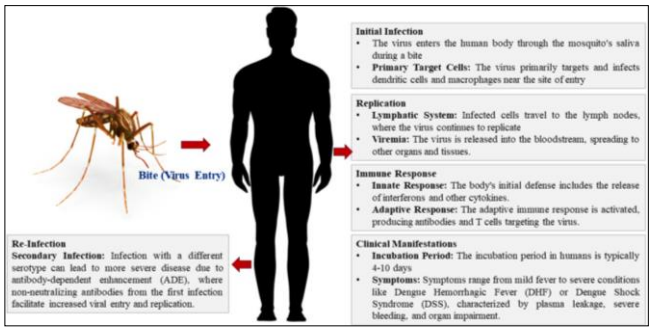

Fig 1: Dengue virus involves several stages in human

Dengue infection and clinical manifestations

Dengue infection can result in a variety of clinical manifestations, ranging from asymptomatic or mild febrile illnesses to more severe forms such as dengue hemorrhagic fever and dengue shock syndrome. Most dengue infections

are asymptomatic or result in a mild febrile illness characterized by fever, headache, retroorbital eye pain, myalgia, arthralgia, and minor hemorrhagic manifestations. In a small percentage of cases, dengue infection may progress to a severe form, dengue hemorrhagic fever, which is characterized by increased vascular permeability, thrombocytopenia, and coagulation disorders. Dengue shock syndrome, the most severe form of the disease, is associated with a high risk of death, with mortality rates as high as 44% in some cases [2, 3, 4, 5].

Challenges in dengue prevention and control

The increasing incidence and geographical spread of dengue fever poses major challenges for the development of effective prevention and treatment measures. There are currently no approved vaccines or specific antiviral treatments for dengue, and vector control remains the primary approach to disease prevention [8]. Developing a safe and effective dengue vaccine has been a major focus of research, but progress has been hampered by the genetic complexity of the virus and the risk of antibody-dependent amplification. Likewise, finding effective antiviral drugs has been challenging because the life cycle and pathogenesis of the virus are not fully understood. Early diagnosis of dengue infection is crucial for effective treatment of the disease and implementation of preventative measures. However, the nonspecific clinical presentation of dengue fever, particularly in the early stages of infection, can make it difficult to distinguish it from other febrile illnesses such as malaria or influenza (Fig. 2).

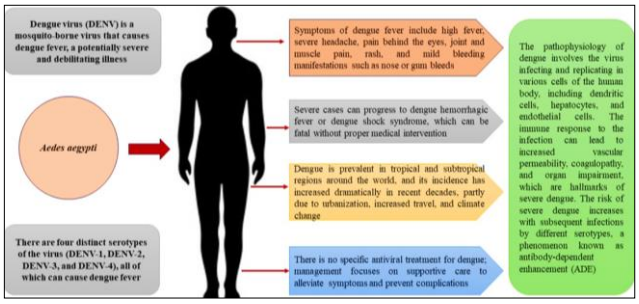

Fig 2: Dengue virus transmission and treatments

Current research and future directions

Ongoing research efforts aim to address the challenges in dengue prevention and control. The development of rapid diagnostic tests that can accurately detect dengue infection in the early stages of the disease is an important focus. Additionally, the search for safe and effective antiviral agents and vaccines continues, with several promising candidates in various stages of development. Vector control remains a central part of the global dengue control strategy. Efforts are focused on reducing Aedes mosquito populations through various methods including mechanical, chemical and biological control measures. The increasing public health burden of dengue highlights the need for a comprehensive, multifaceted approach to address this global health challenge. Strengthening surveillance systems, raising public awareness and promoting international cooperation are critical to mitigating the impact of this mosquito-borne disease (Table 2).

Table 2: Public Health Strategies for Dengue Control

Strategy	Details
Vector Control	- Insecticide spraying in outbreak areas
	- Removal of mosquito breeding sites (standing water)
	- Use of larvicides in water containers
Community Engagement	- Public awareness campaigns on dengue prevention
	- Encouraging community participation in vector control efforts
Surveillance and Monitoring	- Monitoring mosquito populations and infection rates
	- Early warning systems for outbreak detection
Vaccination Programs	- Targeted vaccination (e.g., Dengvaxia) in high-risk areas
	- Consideration of vaccine-associated risks, especially in seronegative individuals
Healthcare System Strengthening	- Training healthcare workers to recognize and manage dengue cases
	- Ensuring availability of supportive care, especially during outbreaks
International Collaboration	- Cross-border cooperation for vector control and surveillance
	- Participation in global initiatives like the World Mosquito Program

Conclusion

Dengue virus, a significant threat to public health, continues to pose a major challenge worldwide. This review highlights the complexity of dengue virus, its transmission and the impact it has on public health. Developing effective preventive and therapeutic measures remains a critical priority and requires a multifaceted approach that combines improved understanding of the biology of the virus, early diagnostic tools and integrated vector control strategies.

Author contributions

Prakash: Writing Original draft, Review and Editing.

Ethics approval and consent to participate

Nil

Declaration of interest statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The original contributions presented in the study are included in the article and further inquiries can be directed to the corresponding author.

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