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NIRAMAYA

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Beyond the Bite: Understanding and Combatting Vector-Borne Diseases

"The Smallest of the Mosquito Has the Power to Infect Our Bodies.
Never Take Anything Small So Light and Always Prepare to
Fight Such Infections With Stronger Immunity."

Overview of Vector-Borne Diseases

- Vectors are living organisms that can transmit infectious pathogens between humans, or from animals to humans.
- Many of these vectors are bloodsucking insects, which ingest disease-producing microorganisms during a blood meal from an infected host (human or animal) and later transmit it into a new host after the pathogen has replicated.
- Often, once a vector becomes infectious, they are capable of transmitting the pathogen for the rest of its life during each subsequent bite/blood meal.

Vector-borne diseases:

- Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors. Every year there are more than 700,000 deaths from diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis and onchocerciasis.
- The burden of these diseases is highest in tropical and subtropical areas, and they disproportionately affect the poorest populations. Since 2014, major outbreaks of dengue, malaria, chikungunya, yellow fever and Zika have afflicted populations, claimed lives, and overwhelmed health systems in many countries.
- Other diseases such as Chikungunya, leishmaniasis and lymphatic filariasis cause chronic suffering, life-long morbidity, disability and occasional stigmatization.

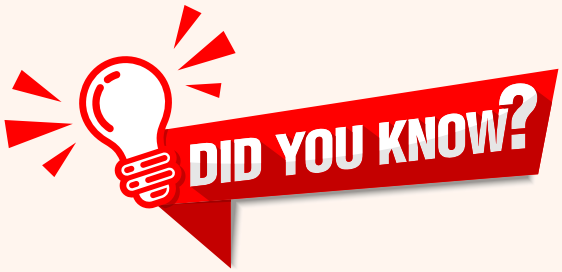
Understanding Vector-Borne Diseases: Types, and Key Vectors

List of vector-borne diseases, according to their vector

- The following table is a non-exhaustive list of vector-borne disease, ordered according to the vector by which it is transmitted. The list also illustrates the type of pathogen that causes the disease in humans.

Vector		Disease caused	Type of pathogen
Mosquito	Aedes	Chikungunya Dengue Lymphatic filariasis Rift Valley fever Yellow Fever Zika	Virus Virus Parasite Virus Virus Virus
	Anopheles	Lymphatic filariasis Malaria	Parasite Parasite
	Culex	Japanese encephalitis Lymphatic filariasis West Nile fever	Virus Parasite Virus
Aquatic snails		Schistosomiasis (bilharziasis)	Parasite
Blackflies		Onchocerciasis (river blindness)	Parasite
Fleas		Plague (transmitted from rats to humans) Tungiasis	Bacteria Ectoparasite
Lice		Typhus Louse-borne relapsing fever	Bacteria Bacteria
Sandflies		Leishmaniasis Sandfly fever (phlebotomus fever)	Parasite Virus
Ticks		Crimean-Congo haemorrhagic fever Lyme disease Relapsing fever (borreliosis) Rickettsial diseases (eg: spotted fever & Q fever) Tick-borne encephalitis Tularaemia	Virus Bacteria Bacteria Bacteria Virus Bacteria
Triatome bugs		Chagas disease (American trypanosomiasis)	Parasite
Tsetse flies		Sleeping sickness (African trypanosomiasis)	Parasite

Key Facts: Globally



Vector-borne diseases account for more than 17% of all infectious diseases, causing more than 700000 deaths annually.

Malaria causes an estimated 219 million cases globally, and results in more than 400,000 deaths every year.

More than 3.9 billion people in over 129 countries are at risk of dengue, with an estimated 96 million symptomatic cases and an estimated 40,000 deaths every year.

There are 100-400 million estimated cases of dengue worldwide each year.

There are 3.8 billion people living in dengue endemic countries, most of which are in Asia, Africa, and the Americas.

The largest number of dengue cases reported was in 2023 with the WHO Region of the Americas reporting 4.5 million cases and 2300 deaths.

Over 882 million people in 44 countries worldwide remain threatened by lymphatic filariasis.

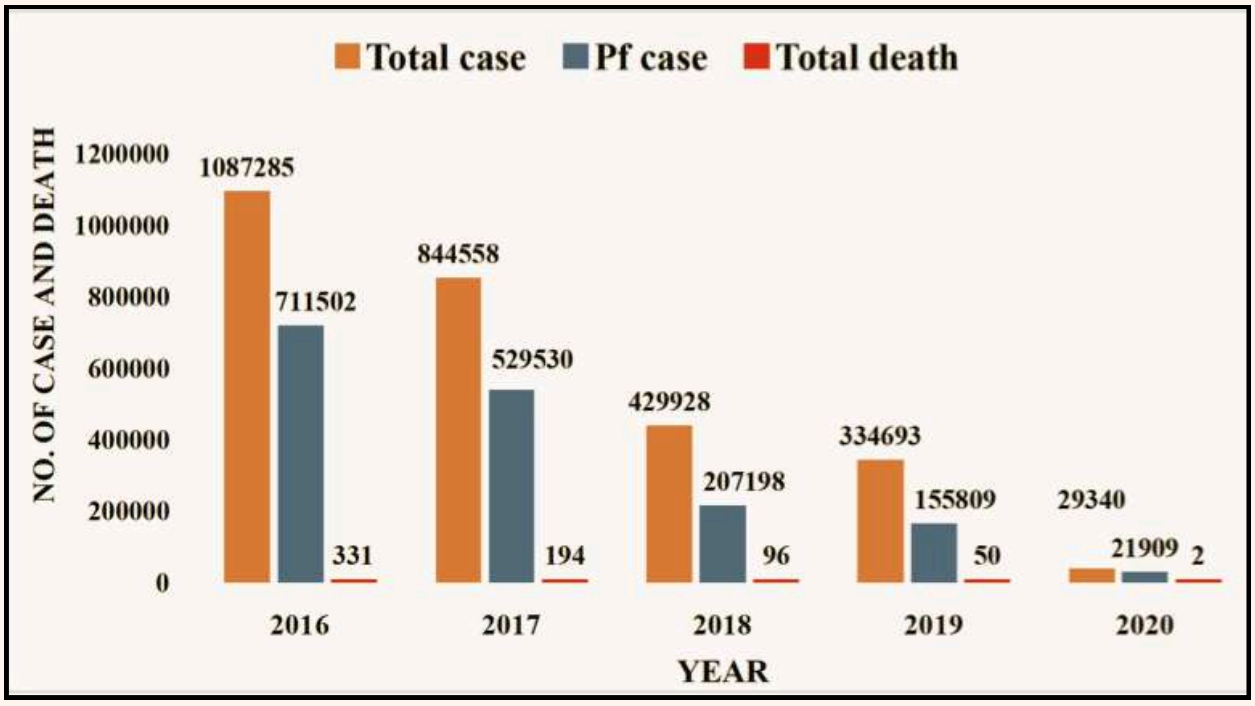


Figure 1: Malaria Situation in India from 2016 - 2020

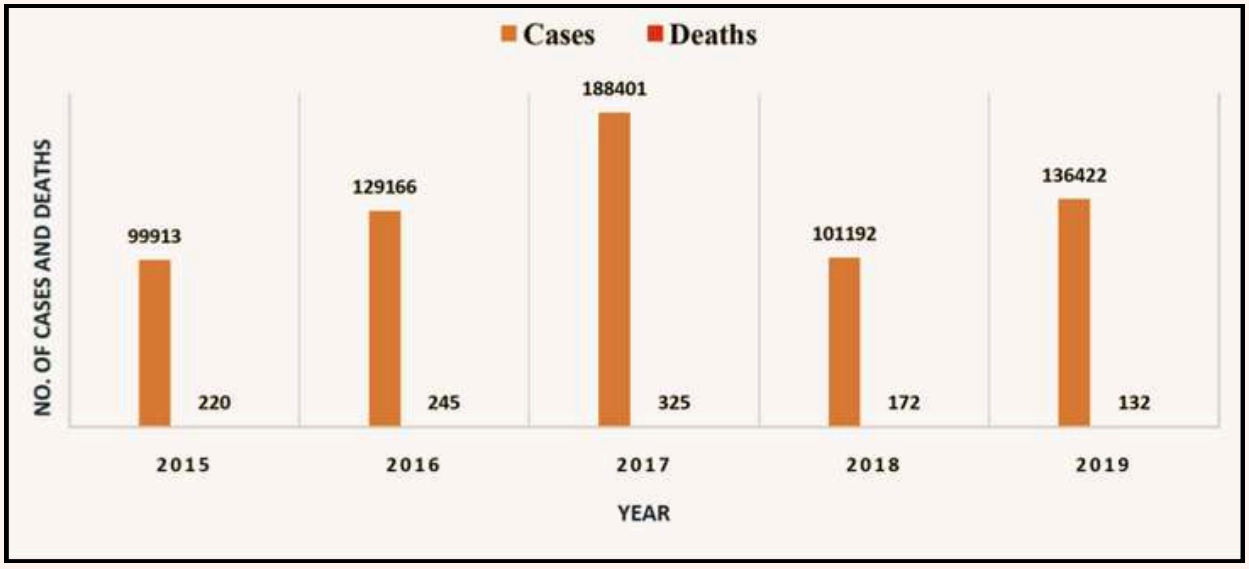


Figure 2: Dengue Situation in India from 2016 - 2020

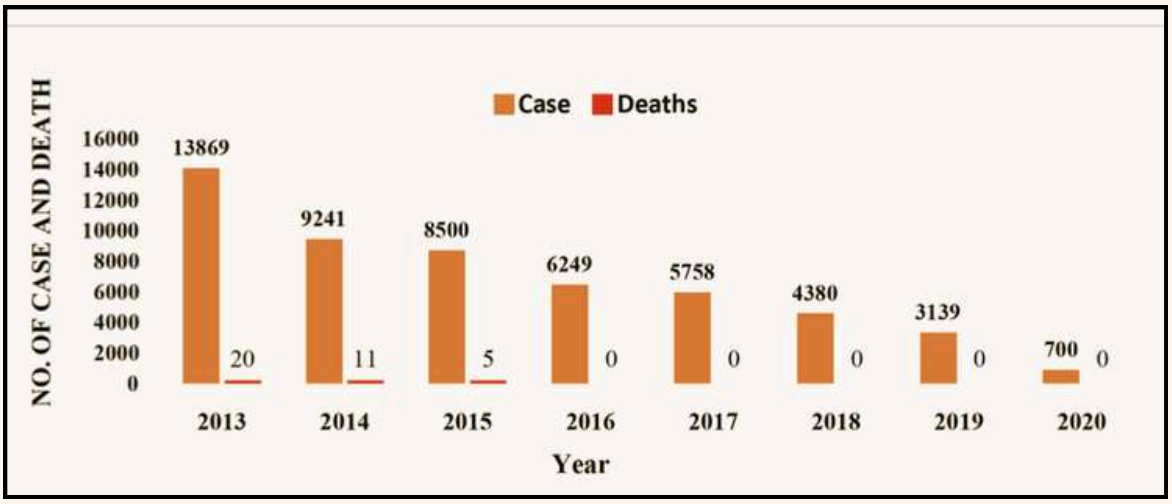


Figure 3: Chikungunya Situation in India from 2016 - 2020

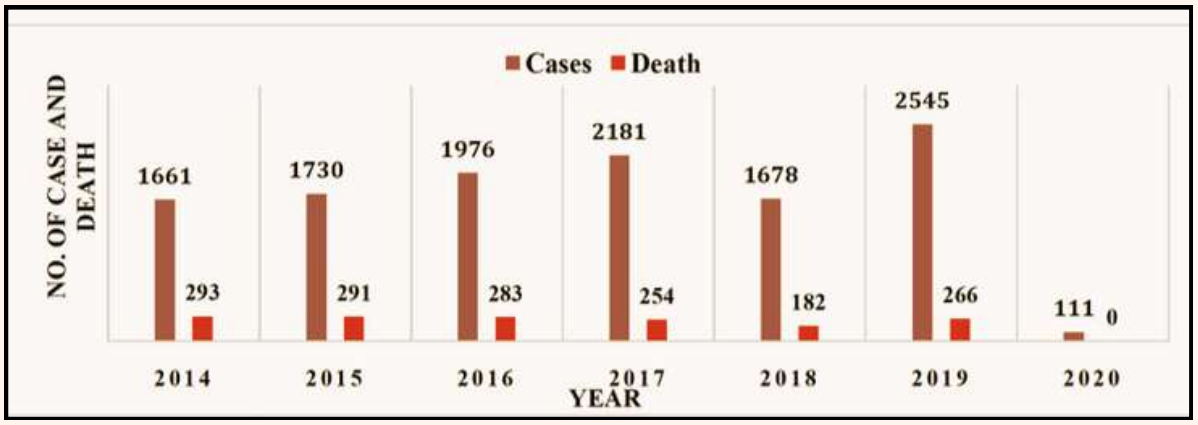


Figure 4: Japanese Encephalitis Situation in India from 2016 - 2020

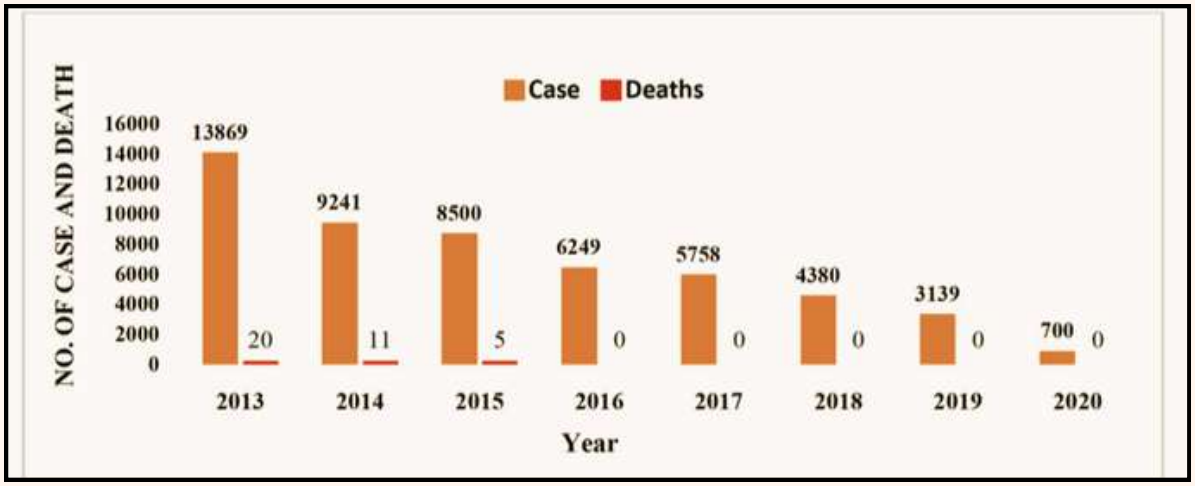


Figure 5: Kala Azar Situation in India from 2016 - 2020

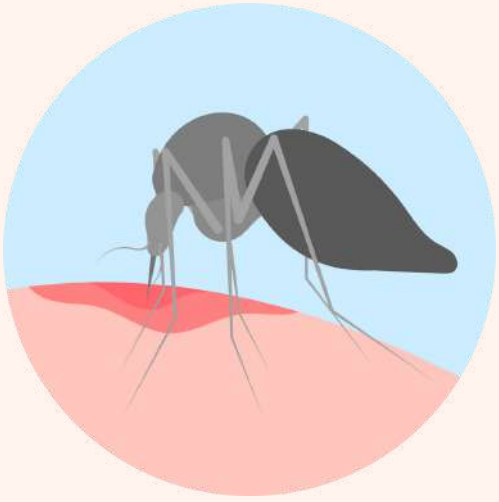
Spotlight on Major Vector-Borne Diseases

Malaria:

- Malaria is caused by obligate intraerythrocytic protozoa of the genus Plasmodium.
- Humans can be infected with one or more of the following four species: P. falciparum, P. vivax, P. ovale, and P. malariae.
- Plasmodia are primarily transmitted by the bite of an infected female Anopheles mosquito, but infections can also occur through exposure to infected blood products (transfusion malaria) and by congenital transmission.
- In industrialized countries, most cases of malaria occur from areas endemic for malaria (imported malaria). Exceptionally, local transmission through mosquitoes occurs (indigenous malaria) (Trampuz et. al., 2003).

Dengue:

- Dengue is an acute febrile disease caused by the mosquito-borne dengue viruses (DENVs), consisting of four serotypes (DENV 1 to 4), that are members of the flaviviridae family, genus flavivirus (Westaway et. al., 1985).
- All four DENV serotypes have emerged from sylvatic strains in the forests of South-East Asia (Wang et. al., 2000). Dengue (pronounced Den' gee) is a disease caused by any one of closely related dengue viruses (DEN1, DEN 2, DEN 3 & DEN 4).
- The viruses are transmitted to human by the bite of an infected mosquito, AedesAegypti but 2001 outbreak in Hawaii was transmitted by AedesAlbopictus. The Asian genotypes of DEN-2 and DEN-3 are frequently associated with severe disease (Vaddadi Srinivas, 2015).
- Dengue virus is a RNA virus of the family flaviviridae; they are otherwise called arboviruses. The dengue virus genome contains 11,000 nucleotide bones.
- They have 3 different protein molecules that form virus partied (C, prM and E) and 7 other types of protein molecules (NSI, NS2a, NS2b, NS3, NS4a, NS4b, NS5) that are found in infected host cells and are required for replication of virus.
- There are 4 strains of virus, ex; DEN1, DEN2, DEN3, DEN4. ALL 4 serotypes can cause full blown disease. Infection with 1 serotype is believed to produce lifelong immunity to that serotype, but he can be infected with other serotypes in future (Shrinivas, 2011).
- The humans are the primary host for dengue viruses & transmitted by Aedes mosquitoes.



Spotlight on Major Vector-Borne Diseases

Japanese encephalitis:

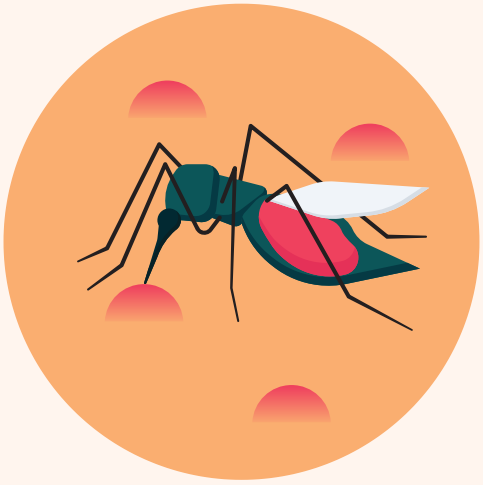
- Japanese encephalitis virus (JEV) is a single-stranded RNA virus belonging to the family Flaviviridae, genus Flavivirus.
- It is one of the leading forms of viral encephalitis worldwide, mostly prevalent in eastern and southern Asia, covering a region with a population of over three billion.
- Most infections of JE are asymptomatic, but if clinical illness develops, it causes significant morbidity and mortality.
- Though underreported, JE causes an estimated 50,000 cases and 15,000 deaths annually.
- JE is a disease of public health importance because of its epidemic potential and high fatality rate.
- In endemic areas, the highest age-specific attack rates occur in children of 3 to 6 years of age

Lymphatic filariasis:

- Filariae are microscopic roundworms that dwell in the blood and tissues of humans.
- The most important filarial diseases for humans are lymphatic filariases, in which the adult worms are found in the lymphatic system.
- The lymphatic form of filariasis will be the focus of the site. Lymphatic is also referred to sometimes as “elephantiasis.”
- Elephantiasis is actually Infection with lymphatic filariasis, commonly known as elephantiasis, occurs when thread-like, filarial parasites are transmitted to humans through mosquitoes.

Chikungunya:

- Chikungunya fever is an acute febrile illness caused by an arthropod-borne alphavirus, Chikungunya virus (CHIKV).
- The virus is primarily transmitted to humans by the bite of an infected Aedes species mosquito Chikungunya is a viral tropical disease transmitted also by Aedesmosquitoes.
- It is relatively uncommon and poorly documented. The disease has been found in Africa, Asia, and on islands in the Caribbean, Indian and Pacific Oceans.
- Typical symptoms are an acute illness with fever, skin rash and incapacitating joint pains that can last for weeks.



VECTOR CONTROL MEASURES

Personal Prophylactic Measures

- Use of mosquito repellent creams, liquids, coils, mats etc.
- Wearing of full sleeve shirts and full pants with socks
- Use of bednets for sleeping infants and young children during day time to prevent mosquito bite

Biological Control

- Use of larvivorous fishes in ornamental tanks, fountains, etc.
- Use of biocides

Chemical Control

- Use of chemical larvicides like abate in big breeding containers
- Aerosol space spray during day time

Environment Management & Source Reduction Method

- Detection & elimination of mosquito breeding sources
- Management of roof tops, porticos and sunshades
- Proper covering of stored water
- Reliable water supply and Observation of weekly dry day

Health Education

- Impart knowledge to common people regarding the disease and vector through various media sources like T.V., Radio, Cinema slides, etc.

Community Participation

- Sensitilizing and involving the community for detection of Aedes breeding places and their elimination

Newer Tools for Vector Management

Biolarvicides:

- Biolarvicides are biological agents that target and kill mosquito larvae in water habitats. An example is Bacillus thuringiensis israelensis (Bti), a bacterium producing toxins that kill mosquito larvae upon ingestion.
- Biolarvicides offer an eco-friendly alternative to chemical insecticides, reducing environmental harm and minimizing resistance development in mosquito populations.

LLINs (Long-Lasting Insecticidal Nets):

- Long-Lasting Insecticidal Nets (LLINs) are mosquito nets treated with insecticides that remain effective for years, even after multiple washes.
- For instance, PermaNet and Olyset Net are popular LLIN brands. They provide a physical barrier and chemical protection against mosquito bites, significantly reducing malaria transmission when widely used in endemic areas.

IGRs (Insect Growth Regulators):

- Insect Growth Regulators (IGRs) disrupt the development of mosquitoes, preventing larvae from maturing into adults.
- An example is methoprene, which mimics insect hormones and stops larvae from developing. IGRs are environmentally friendly and specific to mosquitoes, making them a sustainable option for reducing mosquito populations and controlling diseases.

Mosquito Attractants:

- Mosquito attractants lure mosquitoes to traps or specific areas for effective control. Carbon dioxide (CO2) and lactic acid are common attractants used in traps like the BG-Sentinel.
- These attractants mimic human scents, drawing mosquitoes away from people and into traps, helping to reduce the risk of mosquito-borne diseases.

Mosquito Traps:

- Mosquito traps capture and kill mosquitoes, lowering their populations and disease transmission risks. The Mosquito Magnet, for example, uses CO2 and heat to attract mosquitoes, which are then vacuumed into a net where they dehydrate and die.
- Mosquito traps are essential tools in integrated pest management, particularly where chemical control is impractical or resistance is a concern.

WHO response

- The "Global Vector Control Response (GVCR) 2017–2030" was approved by the World Health Assembly in 2017. It provides strategic guidance to countries and development partners for urgent strengthening of vector control as a fundamental approach to preventing disease and responding to outbreaks. To achieve this a re-alignment of vector control programmes is required, supported by increased technical capacity, improved infrastructure, strengthened monitoring and surveillance systems, and greater community mobilization. Ultimately, this will support implementation of a comprehensive approach to vector control that will enable the achievement of disease-specific national and global goals and contribute to achievement of the Sustainable Development Goals and Universal Health Coverage.
- WHO Secretariat provides strategic, normative and technical guidance to countries and development partners for strengthening vector control as a fundamental approach based on GVCR to preventing disease and responding to outbreaks. Specifically WHO responds to vector-borne diseases by:
  - providing evidence-based guidance for controlling vectors and protecting people against infection;
  - providing technical support to countries so that they can effectively manage cases and outbreaks;
  - supporting countries to improve their reporting systems and capture the true burden of the disease;
  - providing training (capacity building) on clinical management, diagnosis and vector control with support from some of its collaborating centres; and
  - supporting the development and evaluation of new tools, technologies and approaches for vector-borne diseases, including vector control and disease management technologies.
- A crucial element in reducing the burden of vector-borne diseases is behavioural change. WHO works with partners to provide education and improve public awareness, so that people know how to protect themselves and their communities from mosquitoes, ticks, bugs, flies and other vectors.
- Access to water and sanitation is a very important factor in disease control and elimination. WHO works together with many different government sectors to improve water storage, sanitation, thereby helping to control these diseases at the community level.

Integrated Vector Management

The concept

- IVM is a rational decision-making process for the optimal use of resources for vector control. The approach seeks to improve the efficacy, cost-effectiveness, ecological soundness and sustainability of disease-vector control. The ultimate goal is to prevent the transmission of vector-borne diseases such as malaria, dengue, Japanese encephalitis, leishmaniasis, schistosomiasis and Chagas disease.

Rationale

- Driving forces behind a growing interest in IVM include the need to overcome challenges experienced with conventional single-intervention approaches to vector control as well as recent opportunities for promoting multi-sectoral approaches to human health.

Operational strategy

- The Global Strategic Framework for IVM notes that IVM requires the establishment of principles, decision-making criteria and procedures, together with timeframes and targets. The Framework identifies the following as five key elements for the successful implementation of IVM:
  - Advocacy, social mobilization, regulatory control for public health and empowerment of communities.
  - Collaboration within the health sector and with other sectors through the optimal use of resources, planning, monitoring and decision-making.
  - Integration of non-chemical and chemical vector control methods, and integration with other disease control measures.
  - Evidence-based decision making guided by operational research and entomological and epidemiological surveillance and evaluation.
  - Development of adequate human resources, training and career structures at national and local level to promote capacity building and manage IVM programmes.

National Vector Borne Disease Control Programme (NVBDCP)

- The **National Vector Borne Disease Control Programme (NVBDCP)** is an initiative of the Ministry of Health and Family Welfare, Government of India, aimed at the prevention and control of vector-borne diseases.
- Established to address the significant public health impact of these diseases, NVBDCP focuses on the following major vector-borne diseases in India:
  - **Malaria**
  - **Dengue**
  - **Chikungunya**
  - **Japanese Encephalitis (JE)**
  - **Kala-azar (Visceral Leishmaniasis)**
  - **Lymphatic Filariasis**

- **Key Objectives**
- ***Disease Surveillance and Monitoring*:** Establishing a robust surveillance system for early detection and timely treatment of vector-borne diseases.
- ***Integrated Vector Management (IVM)*:** Implementing comprehensive strategies to control vector populations, including environmental management, chemical control, and use of biological agents.
- ***Case Management*:** Ensuring prompt diagnosis and effective treatment of vector-borne diseases to reduce morbidity and mortality.
- ***Capacity Building*:** Training healthcare workers and community volunteers to enhance their skills in disease prevention, control, and management.
- ***Public Awareness and Community Participation*:** Educating the public about prevention measures and involving communities in vector control activities.
- ***Research and Development*:** Promoting research to develop new tools and strategies for vector control and disease management.

Major Initiatives and Strategies

- ***Malaria Control***: Use of insecticide-treated nets (ITNs), indoor residual spraying (IRS), and introduction of rapid diagnostic tests (RDTs) and effective treatment protocols.
- ***Dengue and Chikungunya Control*:** Source reduction, public awareness campaigns, and introduction of novel vector control measures like Wolbachia-infected mosquitoes.
- ***Japanese Encephalitis Control*:** Mass vaccination campaigns in endemic areas and strengthening surveillance systems.
- ***Kala-azar Elimination*:** Vector control through insecticide spraying, early diagnosis, and treatment, along with active case detection.
- ***Lymphatic Filariasis Elimination*:** Mass drug administration (MDA) campaigns and morbidity management for affected individuals.

Recent advances in disease control

1. National strategic plan Malaria Elimination 2023-2027 :

- ·Over the last few years, India has shown a remarkable decrease in the incidence of malaria. Despite various challenges of complex geographies and heterogeneous population, India aims to achieve zero indigenous cases by 2027 and Malaria Elimination certification by 2030.

- ·The current NSP envisages to consolidate on the achievements of the previous NSP and strengthen the efforts towards the goal of elimination. In sync with National Framework for Malaria Elimination 2016-30 and guided by the Global Technical Strategy (GTS) of WHO, the National Strategic Plan (NSP) for the period 2023-27 has been developed with focus on district-based planning, implementation and monitoring.

- ·Development of the current NSP 2023-2027 involved a series of high-level consultations and a detailed Malaria Programme Review (MPR) in April 2022. The key recommendations of the MPR were: strengthening of surveillance systems at all levels, implementation of case-based surveillance and foci investigation for interruption of local/indigenous transmission of malaria, real time data reporting through Integrated Health Information Portal (IHIP), monitoring of cases, deaths and outbreaks, intensified malaria control activities, increased focus on training and capacity building and transmission in tribal, forest, urban, cross border and project areas.

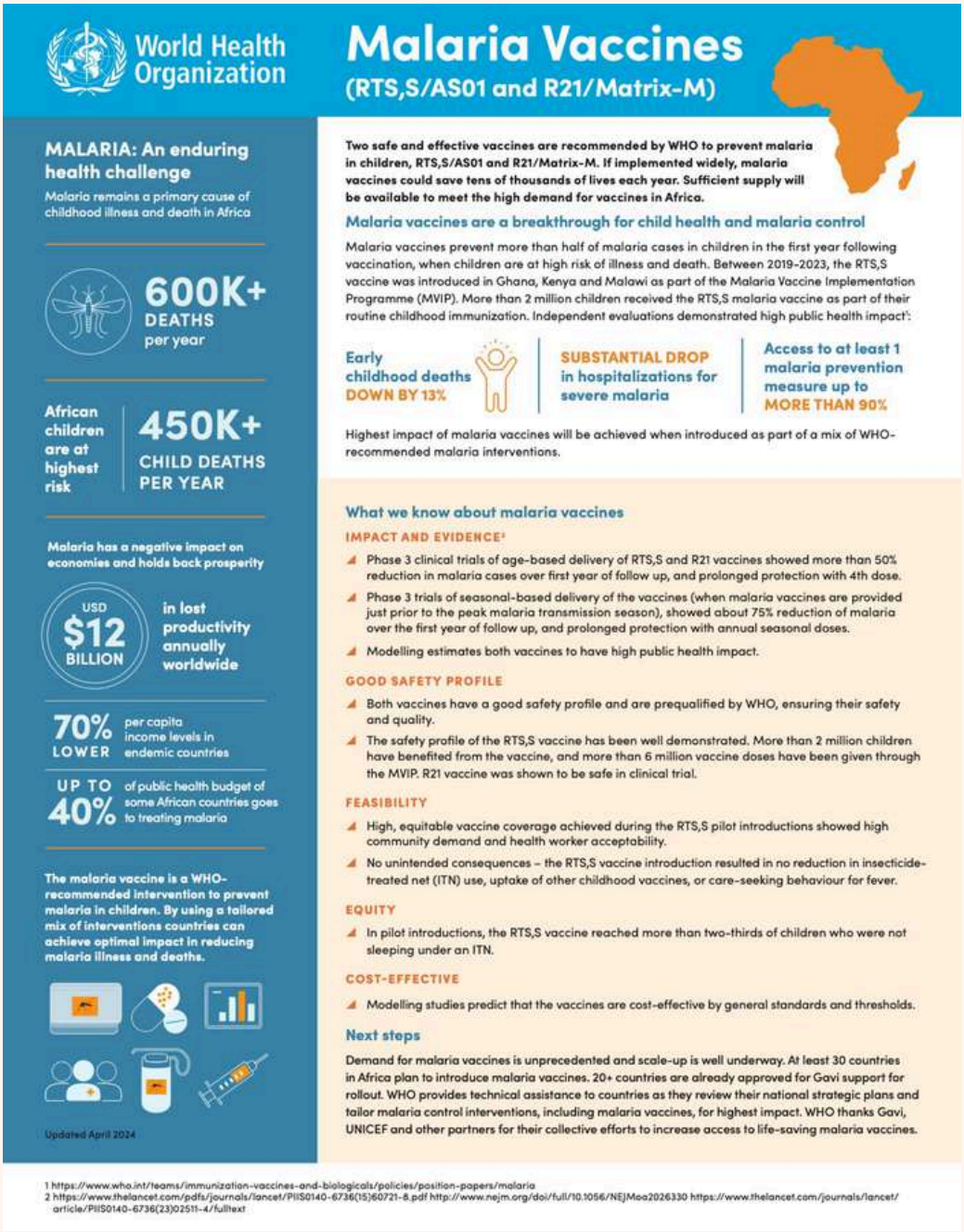
- ·The previous National Strategic Plan 2017-2022, adopted various principles and pillars such as (a) Diagnosis and case management (b) Surveillance and epidemic response(c) Prevention-integrated vector management(d) Cross-cutting interventions - advocacy, communication and community mobilization, programme management and coordination, monitoring and evaluation, research & development.

- ·Achievement of NSP 2017-2022 - The country achieved 79% reduction in malaria cases and 57% reduction in malaria deaths in the year 2022 when compared to the year 2017. The country reported 128 districts with zero indigenous cases and 603 districts with API below 1 in 2022.

2. Malaria vaccine:

- As of October 2023, WHO recommends the programmatic use of malaria vaccines for the prevention of P. falciparum malaria in children living in malaria endemic areas, prioritising areas of moderate and high transmission. This applies to both RTS,S/AS01 and R21/Matrix-M vaccines.

- The first malaria vaccine, **RTS,S,** was recommended by WHO to prevent malaria in children in October 2021. The vaccine has reached nearly 2 million children in Ghana, Kenya and Malawi through the Malaria Vaccine Implementation Programme, MVIP, since 2019.



3. Dengue vaccine:

- There is a growing public health need for effective preventive interventions against dengue, a disease caused by four viruses, termed serotypes 1–4.
- Two dengue vaccines have been licensed, Dengvaxia® (CYD-TDV), developed by Sanofi Pasteur, and Qdenga® (TAK-003), developed by Takeda.
- Another dengue vaccine developed at the Laboratory of Infectious Diseases, at the National Institutes of Allergy and Infectious Diseases (NIAID) in the United States, is in the late stages of clinical development.
- **CYD-TDV** was the first dengue vaccine to be licensed. CYD-TDV is a live recombinant tetravalent dengue vaccine, given as a 3-dose series with 6-month interval been doses, for individuals aged 9–45 years or 9–60 years (depending on the country-specific regulatory approvals) living in dengue-endemic countries or areas. It requires individuals to have pre-vaccination screening for previous dengue virus infection. Only those who test positive should receive the vaccine. Because of the requirement of pre-vaccination screening, this vaccine is currently not being widely used.
- **TAK-003** is the second dengue vaccine to be licensed. TAK-003 is a live-attenuated vaccine containing weakened versions of dengue virus serotypes 1, 2, 3 and 4 developed by Takeda. TAK-003 uses the DENV2 strain as the genomic backbone. The vaccine schedule is a 2-dose series three months apart, given to specific age groups and in specific circumstances according to WHO recommendations.

4. Ministry of Health & Family Welfare launches nationwide Sarva Dawa Sevan or Mass Drug Administration (MDA) campaign to Eliminate Lymphatic Filariasis (LF):

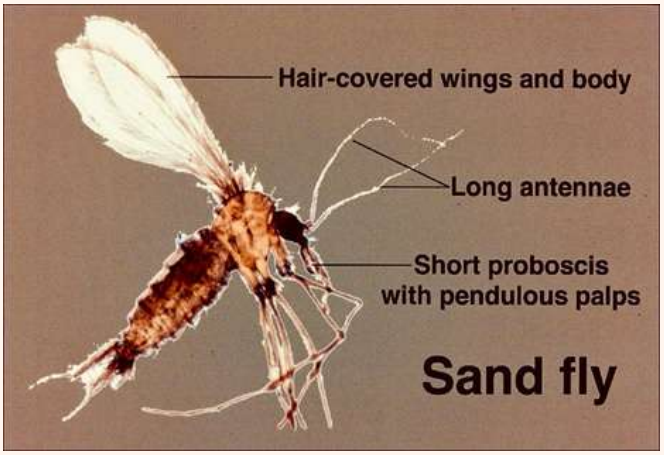
- Aim to eliminate Lymphatic Filariasis by 2027, three years ahead of the global target
- Health workers will go door-to-door to administer anti-filaria medicine in 10 filaria affected States Focus on High-burden districts in Bihar, Chhattisgarh, Jharkhand, Maharashtra, Uttar Pradesh, West Bengal, Karnataka, Odisha, Madhya Pradesh, and Andhra Pradesh
- Intensive monitoring at block level to be focused upon along with daily analyses of coverage and monitoring reports at all governance levels

Chandipura virus Infection:

- It is a viral infection first outbreak of febrile illness was reported in **1965** in Chandipura Village of **Nagpur district of Maharastra state**. Thereafter, few outbreaks occurred in Andhra Pradesh, Maharashtra & Gujarat. This virus belongs to family Rhabdoviridae, genus Vesiculovirus.

- It is characterized by bullet shaped particles, 150-165 nm long, 50-60 nm wide, showing distinct surface projections 9-11 nm in size & a stain-filled canal at the base of the virus particles.

- It is transmitted by vectors such as **sand flies** and **ticks.**



- Vector control by Pyrethrum Fogging and Indoor residual sparing (IRS) by Alphacyper methrin 5%, hygiene, and awareness are the only measures available against the disease. The Ministry said, although there is no specific treatment available for CHPV and management is symptomatic, timely referral of suspected AES cases to designated facilities can improve outcomes.

- The Ministry added that since early June 2024, cases of Acute Encephalitis Syndrome have been reported in children under 15 years of age in Gujarat. As of today, a total of 78 AES cases have been reported, with 75 from Gujarat, two from Rajasthan, and one from Madhya Pradesh. Of these, 28 cases have resulted in death. (20/07/2024)

World Days with themes

1. World Malaria Day - 25th April 2024:
"Accelerating the fight against malaria for a more equitable world"

- On World Malaria Day, let's "Accelerate the fight against malaria for a more equitable world" through:
  - Ending discrimination and stigma
  - Engaging communities in health decision-making
  - Bringing health care close to where people live and work through primary health care
  - Addressing factors that increase malaria risk
  - Including malaria control interventions in universal health coverage

2. National Dengue Day - 16th May 2024:
"Dengue Prevention: Our Responsibility for a Safer Tomorrow".

- The theme for National Dengue Day 2024 was "Dengue Prevention: Our Responsibility for a Safer Tomorrow".
- The day was celebrated on May 16, 2024 to raise awareness about the viral disease and how to combat it.
- The theme emphasized the importance of community participation and individual action in preventing the spread of dengue.

Take Away Messages

1 Vector-Borne Diseases Overview

Vector-borne diseases, caused by parasites, viruses, and bacteria transmitted by vectors like mosquitoes, ticks, and flies, are a significant health challenge globally. These diseases result in over 700,000 deaths annually and disproportionately affect tropical and subtropical regions and the poorest populations.

2 Major Diseases and Vectors

Key vector-borne diseases include malaria, dengue, chikungunya, yellow fever, Zika, Japanese encephalitis, and onchocerciasis. The vectors include various species of mosquitoes, fleas, lice, sandflies, ticks, and triatome bugs, each responsible for transmitting specific pathogens that cause these diseases.

3 Global Impact and Statistics

Malaria causes over 219 million cases and 400,000 deaths annually. Dengue affects over 3.9 billion people in 129 countries, with 100-400 million cases yearly.
Lymphatic filariasis threatens 882 million people in 44 countries, highlighting the widespread and severe impact of these diseases.

4 Personal and Community Preventive Measures

Effective vector control measures include using mosquito repellents, wearing protective clothing, using bed nets, and eliminating breeding sites.
Community participation and health education are crucial for the successful implementation of these preventive strategies.

5 Integrated Vector Management (IVM)

IVM is a comprehensive approach to vector control, emphasizing the integration of chemical and non-chemical methods, evidence-based decision-making, and collaboration across sectors. It aims to improve the efficacy, cost-effectiveness, ecological soundness, and sustainability of vector control efforts.

6 National and Global Initiatives

The Global Vector Control Response (GVCR) 2017–2030 and the National Vector Borne Disease Control Programme (NVBDCP) in India are key initiatives. These programs focus on strengthening surveillance, improving infrastructure, and mobilizing communities to achieve disease-specific and global health goals, including the Sustainable Development Goals and Universal Health Coverage.

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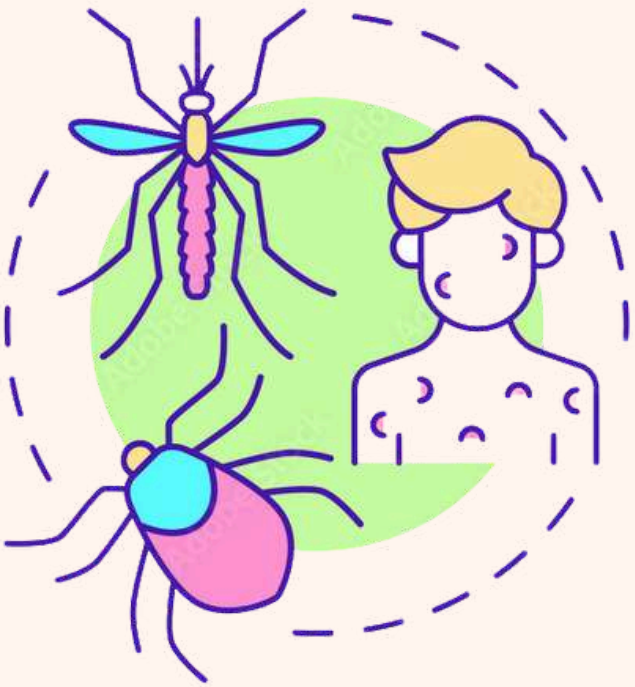

A Message from the Executive Director

Prof. (Col.) Dr. C D S Katoch
Executive Director,
AIIMS, Rajkot

Dear Team and Readers,

Your dedication fuels our mission to bridge healthcare gaps and promote wellness. Our e-magazine serves as a comprehensive resource, delving into various health topics in detail. Together, we're reshaping the future of healthcare in India, benefiting faculty, students, and communities alike. Thank you for your invaluable contributions to our collective journey towards excellence.

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