

MALARIA

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Specific Learning Objectives

- At the end of session, the learner shall be able to describe:
 - Magnitude of Malaria Problem
 - Clinical features of Malaria
 - Life cycle of Malarial parasite
 - Malaria Control Strategies

Outline of presentation

- Introduction
- Magnitude of Problem
- Clinical features of Malaria
- Life cycle of Malarial parasite
- Malaria Control Strategies

INTRODUCTION

- Malaria is a potentially life threatening parasitic disease caused by parasites known as
 - *Plasmodium vivax* (*P.vivax*)
 - ***Plasmodium falciparum* (*P.falciparum*)**
 - *Plasmodium malariae* (*P.malariae*)
 - *Plasmodium ovale* (*P.ovale*)
 - *Plasmodium knowlesi*
- It is transmitted by the infective bite of female *Anopheles* mosquito.

HISTORICAL PERSPECTIVE

- 5000 BC
- 600 BC, Intermittent fever, with high incidence during the rainy season, coinciding with agriculture, sowing and harvesting, was first recognized by Romans and Greeks who associated it with swampy areas.
- Intermittent fevers were due to the 'bad odour' coming from the marshy areas and thus gave the name '**malaria**' ('**mal**'=**bad** + '**air**') to intermittent fevers.
- In spite of the fact that today the causative organism is known, the name has stuck to this disease.

MAGNITUDE OF THE PROBLEM

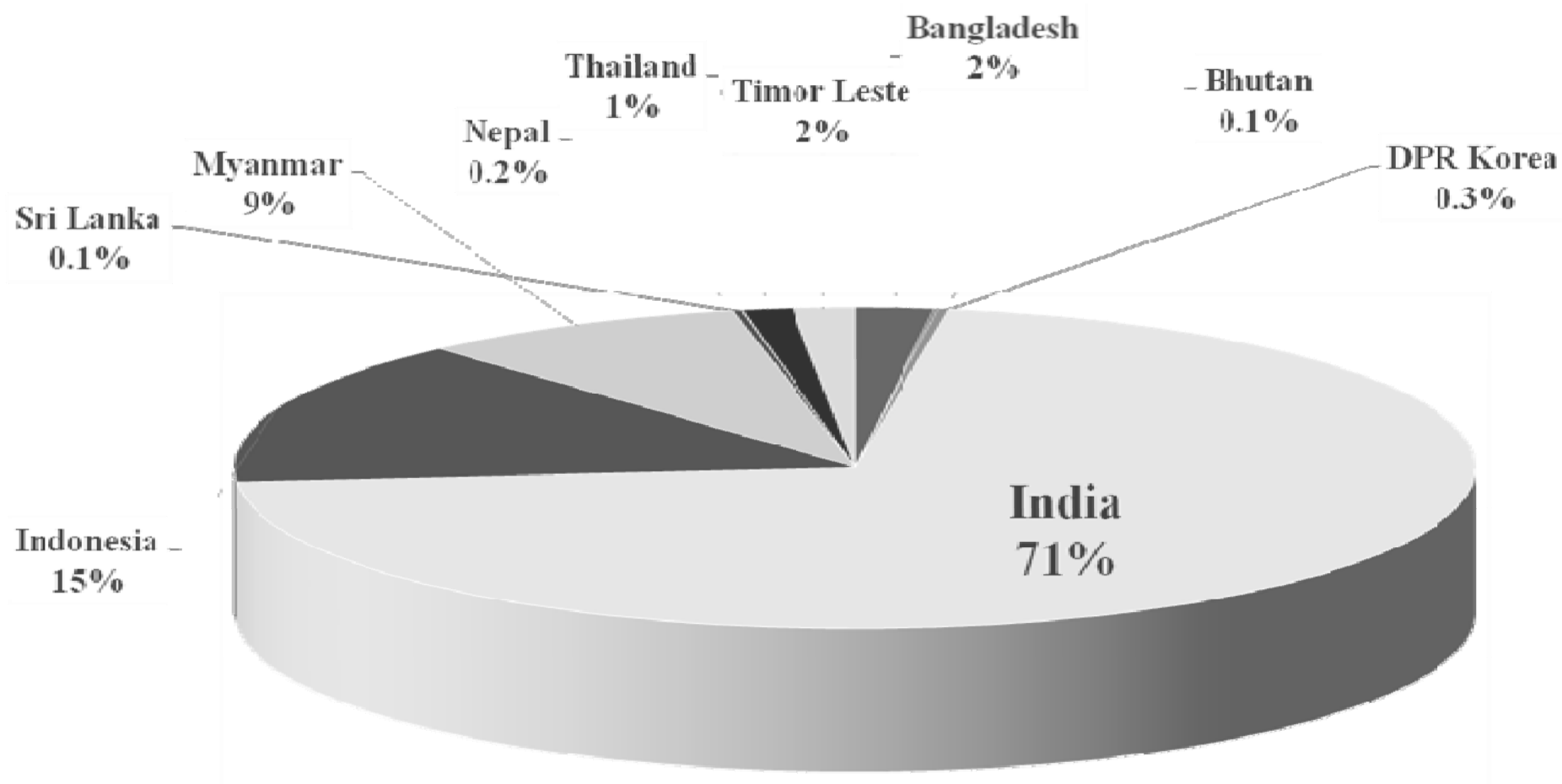
WHO Region	Estimated Cases	Estimated Deaths
African Region	122 million	116336
Americas Region	0.43 million	84
East Mediterranean Region	5 million	1027
European Region	317	03
South-East Asia Region	3 million	776
Western Pacific Region	1 million	422
TOTAL	132 million	1,18,648

Global burden of disease (GBD) in 2015

- **214 million new cases** of malaria (range 149–303 million).
 - The **African Region** accounted for most global cases of malaria (**88%**), followed by the South-East Asia Region (10%).
- An estimated **438 000 malaria deaths** (range 236 000–635 000).
 - Most of these deaths occurred in the **African Region** (**90%**), followed by the South-East Asia Region (7%).
- Between 2000 and 2015,
 - Malaria incidence rates fell by 37% globally, and by 42% in Africa.
 - Malaria mortality rates fell by 60% globally and by 66% in the African Region.

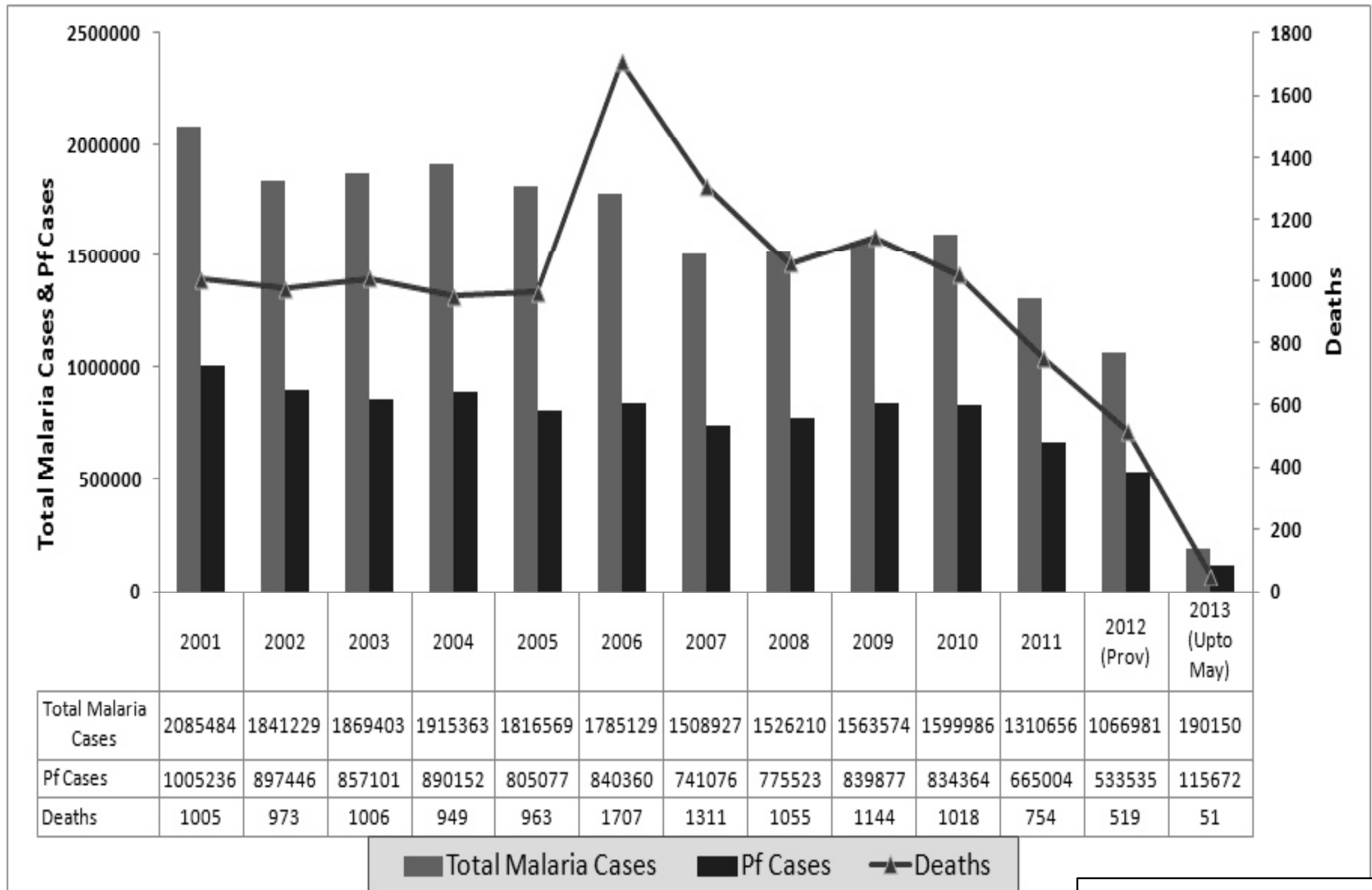
- In India the number of recorded cases is about 1.5 million per year.
 - About 95% population in the country resides in malaria endemic areas
 - 80% of malaria reported is confined to areas consisting 20% of population residing in tribal, hilly, difficult and inaccessible areas.
- The transmission pattern in most parts of India is usually low
- Intense transmission is seen in NE states and large areas of Orissa, Chattisgarh, Jharkhand and Madhya Pradesh.

India's contribution to Malaria in SEAR

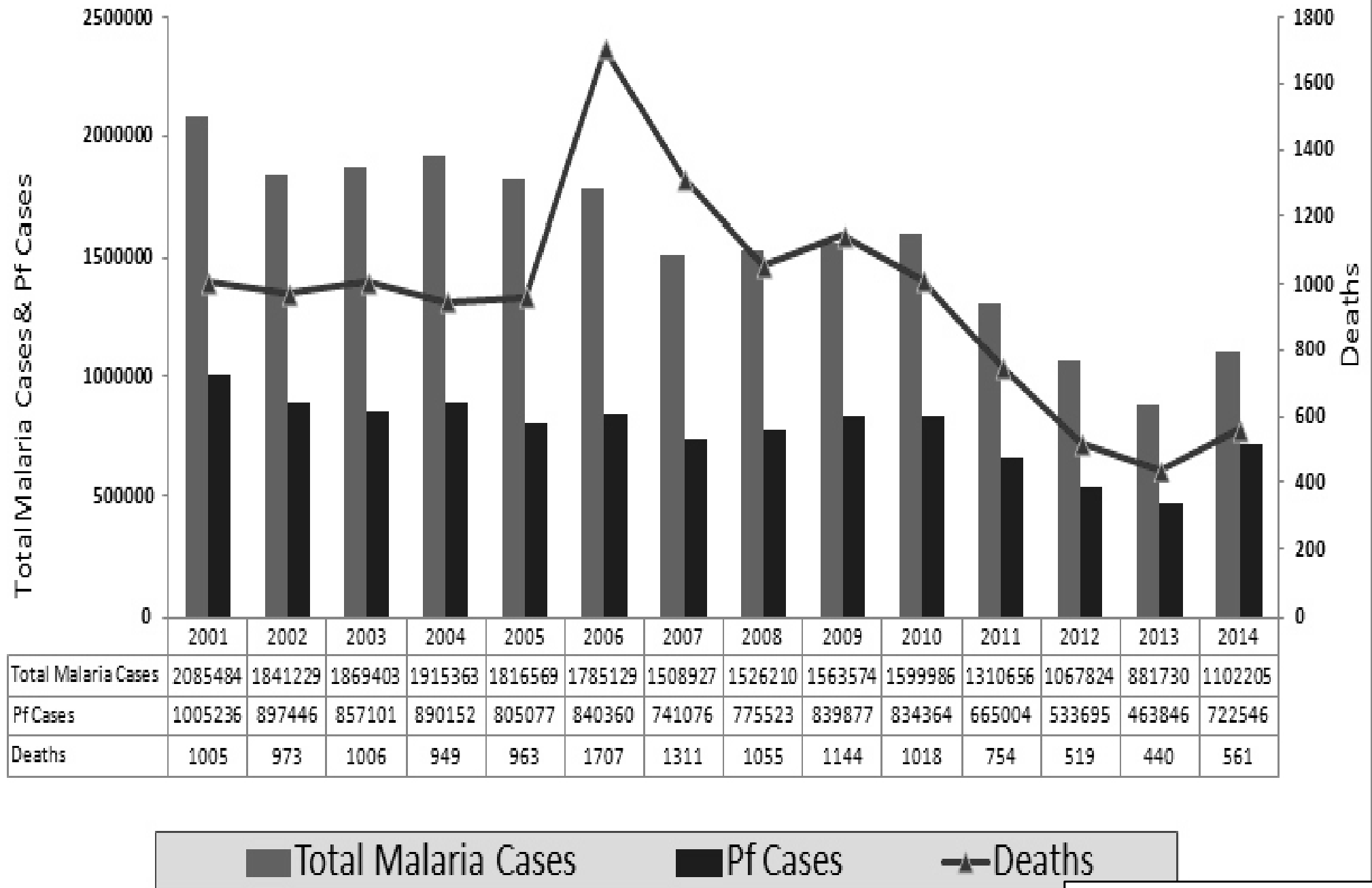


India contributes to 71% of total malaria cases in the SEAR

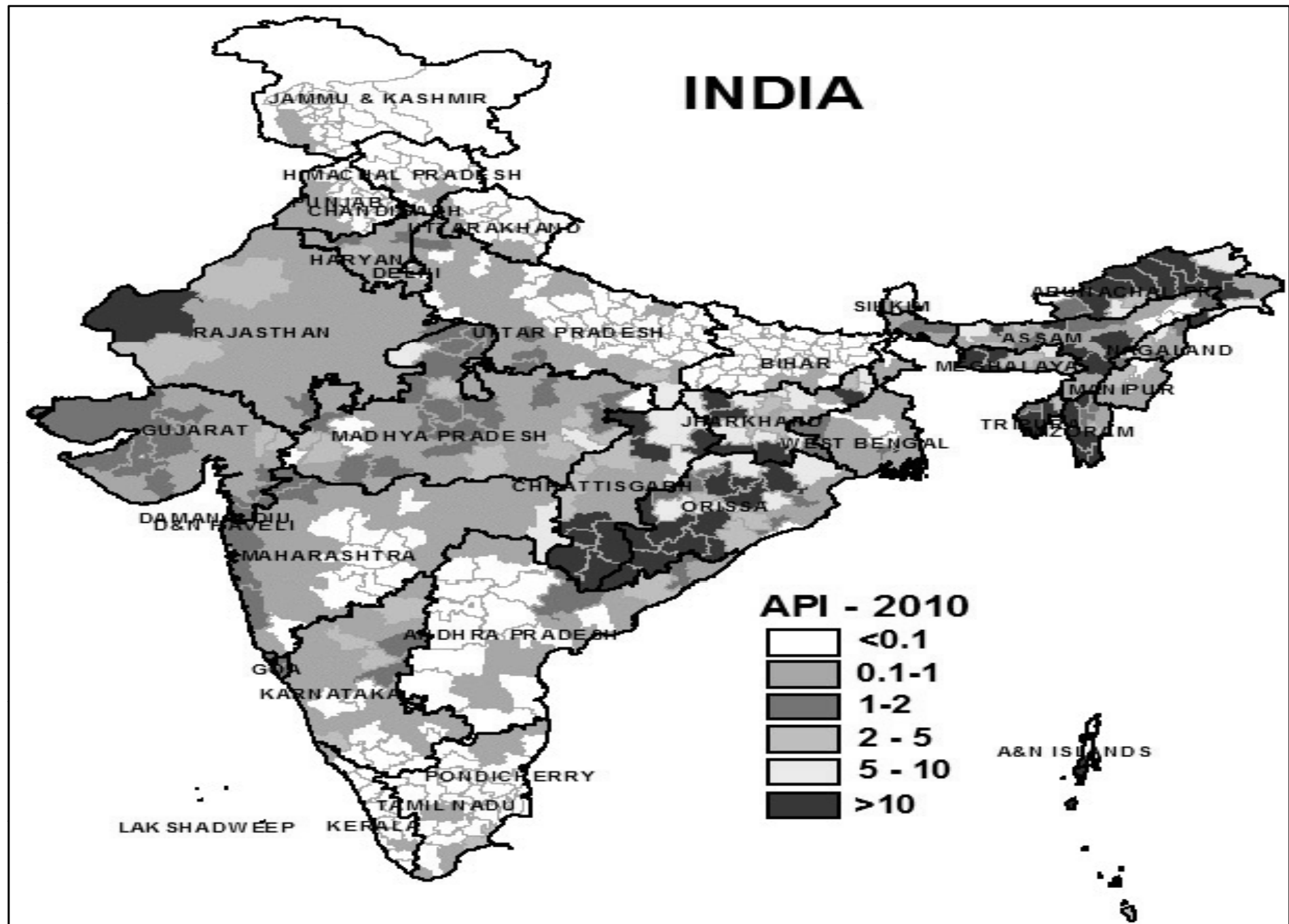
Trends of Malaria cases & deaths (2001-2013)



Trend of Malaria Cases and Deaths in India (2001-2014)



Malaria Situation in India



Malaria Situation in India (2014)

	India	Chandigarh
Total no. of Malaria Cases	10,70,513	114
Pf cases	7,03,587	0
Deaths	578	0

Malaria Situation in India (2015-16)

	2015		Up to March 2016	
	India	Chandigarh	India	Chandigarh
Total no. of Malaria Cases	11,26661	152	1,45741	0
Pf cases	7,56751	1	1,04655	0
Deaths	287	0	13	0

Milestones of Malaria control activities in India

**Prior to
1953**

- Estimated Malaria cases in India: 75 million

1953

- National Malaria Control Programme (NMCP)

1958

- NMCP --→ NMEP (National Malaria Eradication Programme)

1965

- Cases reduced to 0.1 million

**1970-
76**

- Resurgence of malaria
- 6.46 million malaria cases

1977

- Modified Plan of Operation implemented

1995

- Malaria Action Programme (MAP) in high risk areas

1999

- Renaming to National Anti Malaria Programme (NAMP)

2004

- Renaming to **National Vector Borne Disease Control Programme (NVBDGP)**

2005

- Global fund assisted Intensified Malaria Control Project (IMCP)
- Introduction of (monovalent) RDT in the programme

- ACT introduced

2008

- ACT extended
- World Bank supported National Malaria Control Project

2009

- Introduction of Long Lasting Insecticidal Nets (LLIN);
- Oral Artemisinin monotherapy banned

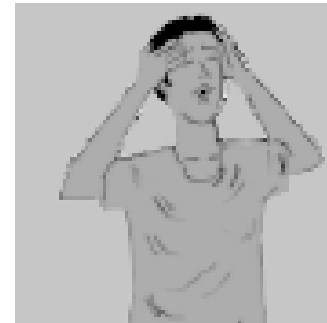
**2010-
2013**

- New drug policy (National Drug Policy on Malaria)

- National Framework for Malaria Elimination in India launched

SYMPTOMS OF MALARIA

- Fever with chills and rigors,
- Headache,
- Vomiting,
- Bodyache,
- Easy fatigue-ability.



SEVERE AND COMPLICATED MALARIA

- History of high fever, plus at least one of the following:-
 - Inability to sit, altered consciousness, lethargy or coma
 - Breathing difficulties
 - Severe anaemia
 - Generalized convulsions/fits
 - Inability to drink
 - Dark and/or limited production of urine

COMPLICATIONS

- Generalized convulsions.
- Normocytic anaemia.
- Renal failure
- Hypoglycaemia.
- Fluid, electrolyte and acid-base disturbances.
- Pulmonary oedema.
- Circulatory collapse and shock
- Spontaneous bleeding (DIC)
- Hyperpyrexia.
- Haemoglobinuria.

Frequent monitoring of laboratory parameters is essential –
blood sugar, SERFT, urine examination, fluid balance, associated infection, etc.

RISK FOR SEVERE COMPLICATIONS

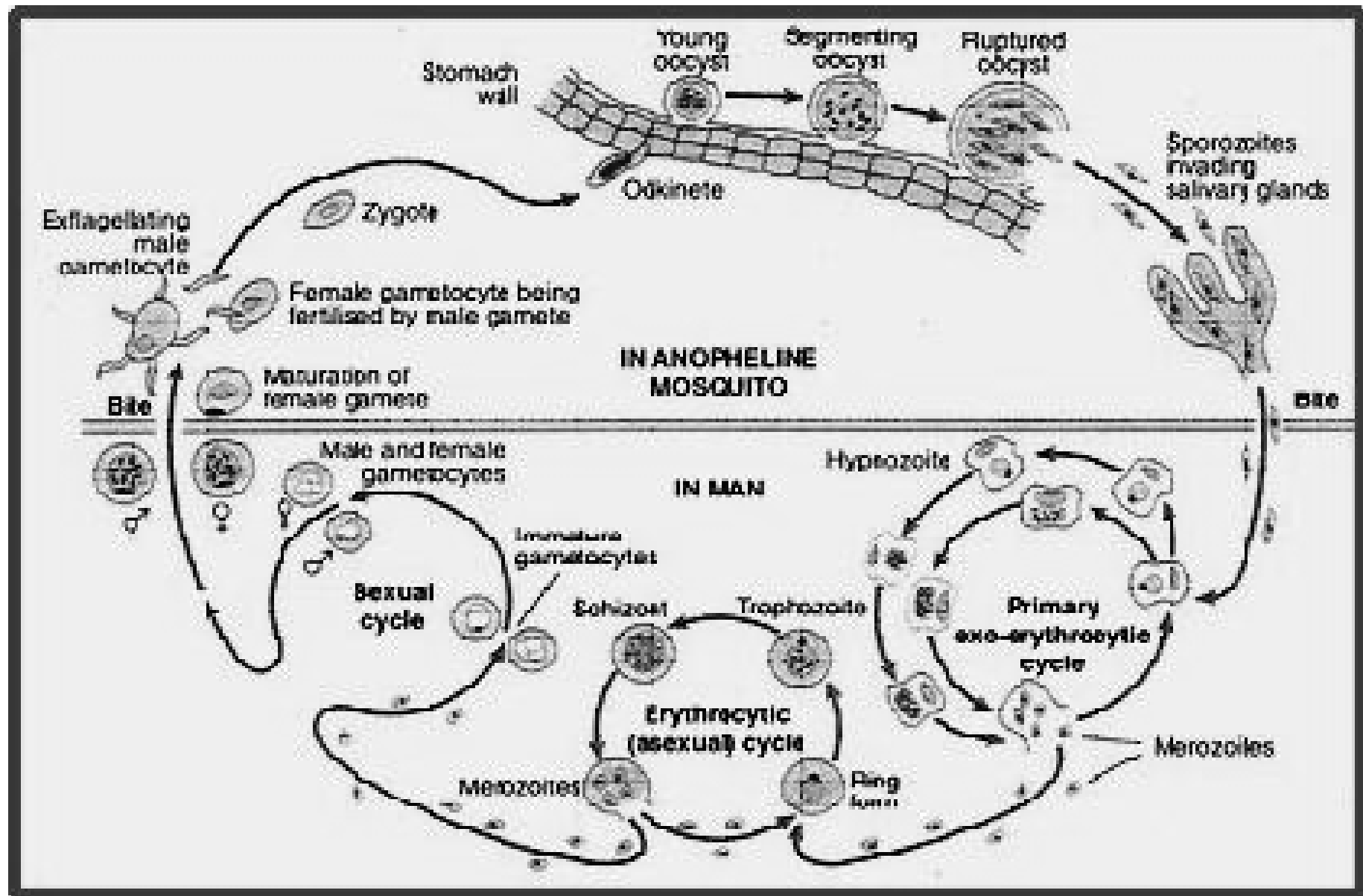
- In areas of low transmission:
 - all age groups are vulnerable but adults develop more severe and multiple complications.
- In areas of high transmission:
 - children below 5 years, visitors, migratory labour.
- Malaria in pregnancy poses a substantial risk to the mother, the foetus and the newborn infant.



IMMUNITY TO MALARIA

- Repeated infections with malaria parasites lead to:
 - the acquisition of antibodies directed against various antigens of various stages of malaria parasites
 - cell-mediated immunity.

LIFE CYCLE OF MALARIA PARASITE IN MAN AND MOSQUITO



Incubation Period

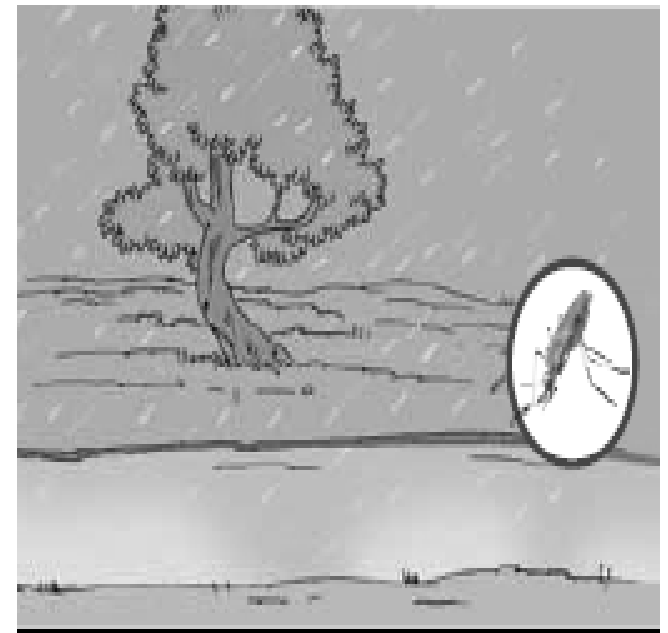
- *P. vivax*: approx. 22 days
- *P. falciparum*: approx. 35 days.
- Fortnightly blood smear collection:
 - surveillance cycle of less than one incubation interval will catch most of the secondary cases before the commencement of next cycle.

Incubation period: It denotes the duration of the full cycle of malaria parasite.

It is the sum of the time taken for the development of the parasite in the mosquito and that in the human being.

VECTORS OF MALARIA

- There are many vectors of malaria
 - *Anopheles culicifacies* is the main vector of malaria
- **Breeding places**
 - Rainwater pools and puddles, borrowpits, river bed pools, irrigation channels, seepages, rice fields, wells, pond margins, sluggish streams with sandy margins.
 - Extensive breeding is generally encountered following monsoon rains.
- **Biting time**
 - Start biting soon after dusk.



Malaria Surveillance

- **Active Case Detection (Fortnightly Domiciliary visits):**
 - search for a fever case or who had fever in between the visits of MPW
 - collection of blood smear from such cases
 - administration of appropriate anti-malarial(s)
- **Passive Case Detection (PCD)**
- **Fever Treatment Depots (FTDs)**
- **Drug Distribution Centre (DDC)**

Measurement of Malaria

Pre-Eradication Era:

- Spleen Rate
- Average Enlarged
- Parasite Rate
- Parasite Density Index
- Infant Parasites
- Proportional Case Rate

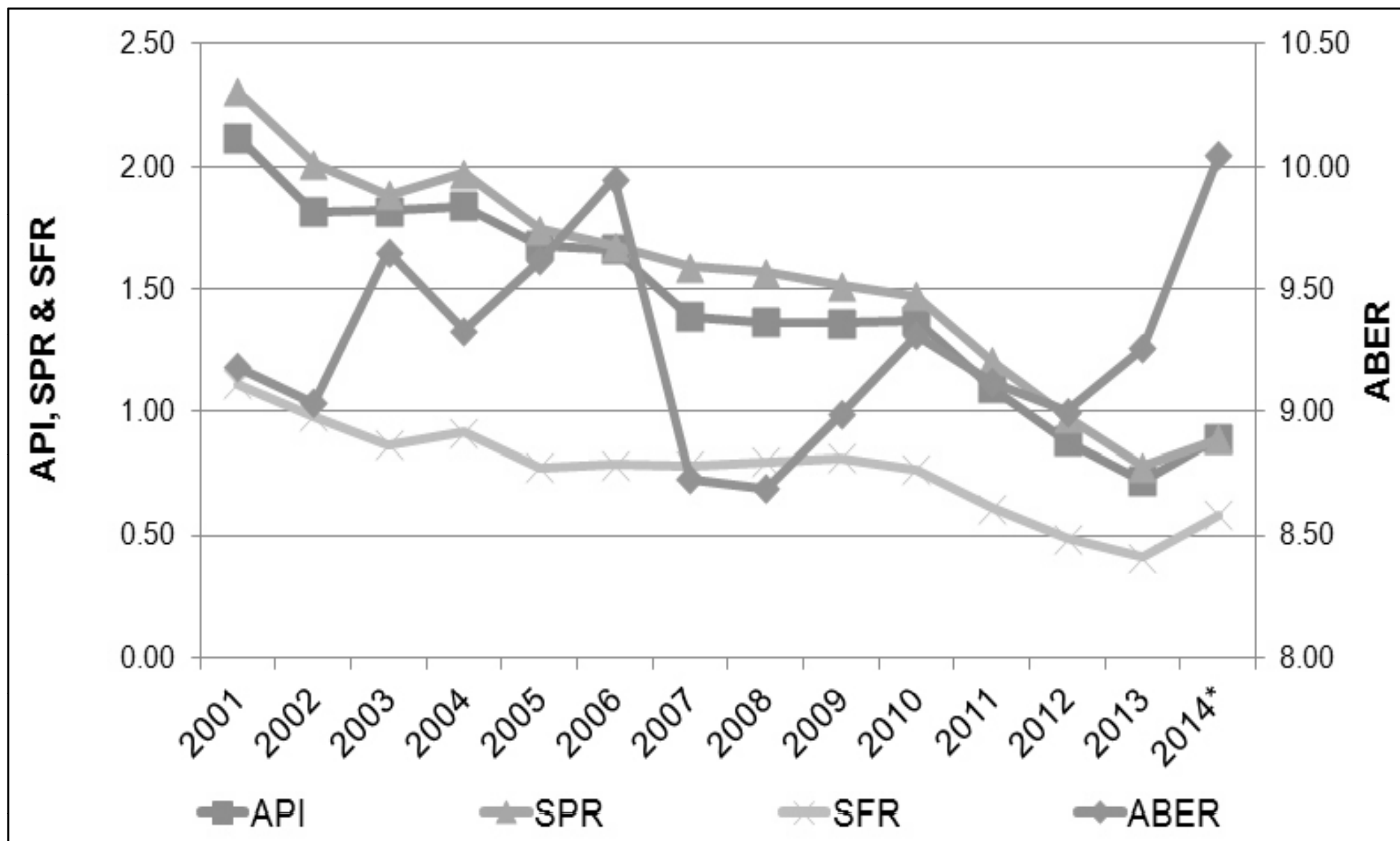
Vector Indices:

- Human blood index
- Sporozoite rate
- Mosquito density
- Man-biting rate
- Inoculation rate

Malaria Indices

- **Annual Blood Examination Rate**
 - Smears examined in a year $\times 100$ / Total population
- **Annual Parasite Incidence**
 - Total no. of positive slides for parasite in a year $\times 1000$ / Total population
- **Slide Positivity Rate**
 - Total positive $\times 100$ / Total slides examined
- **Slide Falciparum Rate**
 - Total positive PF $\times 100$ / Slides examined.

Trend of Malaria Parameters (2001-2014)



Geographical patterns of transmission

Classification of Areas	EIR	Spleno- megaly	Parasit- aemia
Holoendemic: intense transmission where virtually everyone is infected all the time.	50- 2000+	> 75%	> 75%
Hyperendemic: regular, often seasonal, transmission but the immunity in some of the population does not confer protection all the times.	10-50	50-75%	50-75%
Mesoendemic: transmission fairly regularly but at much lower levels	<10 and variable	10-50%	10-50%
Hypoendemic: little transmission and the population will have little or no immunity	Not measure- able	<10%	<10%

Focal nature of Malaria

- Malaria is a focal disease.
- Its transmission is a dynamic process influenced by the changes in ecological conditions, agricultural practices, urbanization, socio-economical factors, meteorological conditions, etc.
- Urban conditions: transmission associated with focal breeding sites.
- Rural conditions: transmission associated with proximity of mosquito breeding sites.
- Rice paddies, river systems, ponds, and stable water bodies.

Control strategy developed for one type of setting may not be applicable to or sustainable in other eco-epidemiological settings.

Mosquito Inspection Techniques

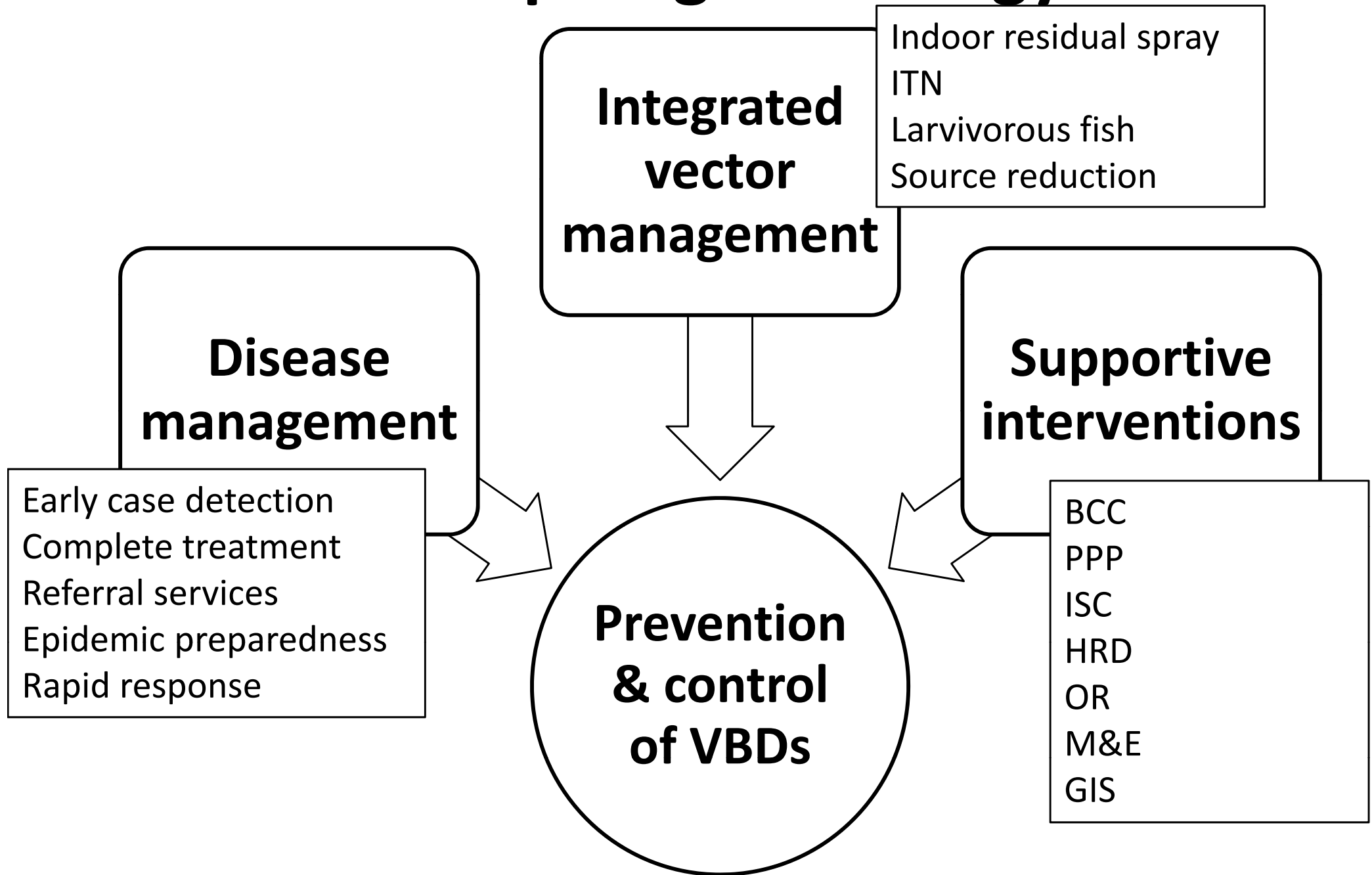
Adult mosquito	<ul style="list-style-type: none">•Landing Rate Count•Light Trap•Truck Trap•Animal-Baited Trap•Resting Station
Breeding site	<ul style="list-style-type: none">•By dipping a drinking dipper•With a large syringe (in case of tree holes)•Poured out from containers
Egg Survey	<ul style="list-style-type: none">•Retrieving eggs from soil•Ovitrap
GPS (Global Positioning System)	

MALARIA CONTROL STRATEGIES

1. Early case Detection and Prompt Treatment (EDPT)
2. Vector Control
3. Environmental Management & Source Reduction Methods
4. Community Participation.

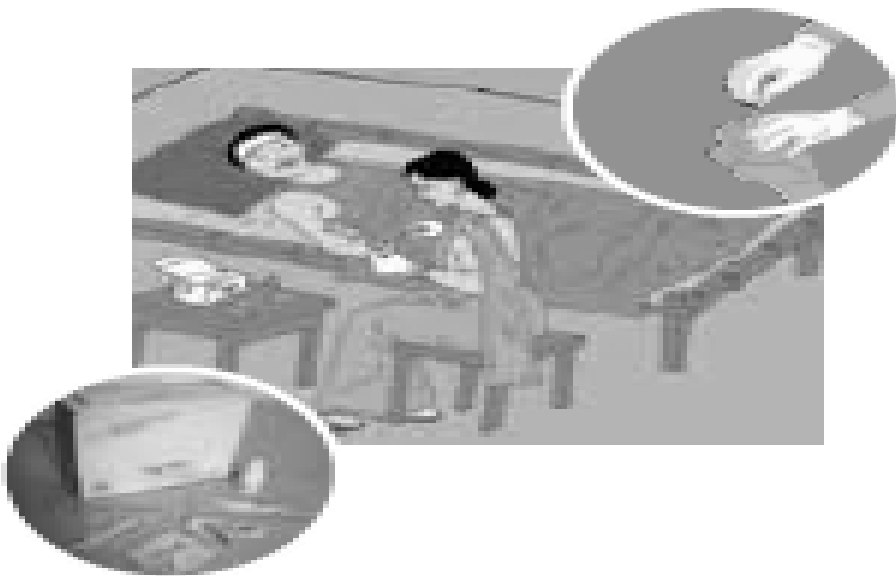
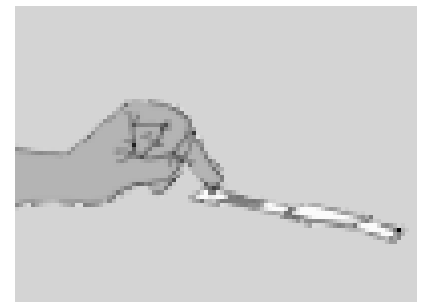
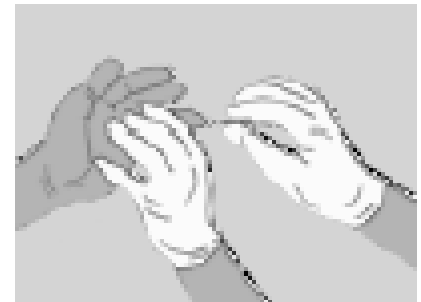
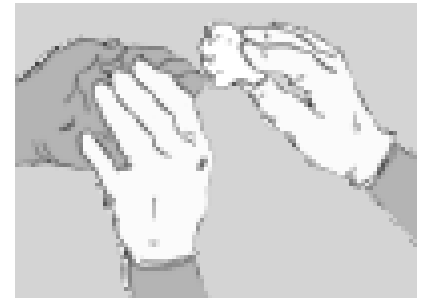
MALARIA CONTROL STRATEGY

Three pronged strategy



Early case Detection and Prompt Treatment (EDPT)

- The main thrust of the NVBDCP for malaria control.
- Malaria Diagnosis:
 - Microscopic examination of blood film
 - Rapid diagnostic test (RDT) kits:
 - Pf specific and Bivalent.



Early case Detection and Prompt Treatment (EDPT)

- EDPT is the main strategy of malaria control - radical treatment is necessary for all the cases of malaria to prevent transmission of malaria.
- Chloroquine is the main anti-malaria drug for uncomplicated
- Drug Distribution Centres (DDCs) and Fever Treatment Depots (FTDs) have been established in the rural areas for providing easy access to anti-malarial drugs to the community.
- Alternative drugs for chloroquine resistant malaria are recommended as per the drug policy of malaria.

Algorithm for diagnosis & treatment of Malaria

Where microscopy result is available within 24 hours

Clinically suspected malaria case



Take slide for microscopy



P. vivax

CQ 3 days +
PQ 14 days

P. falciparum

ACT 3 days + PQ single dose

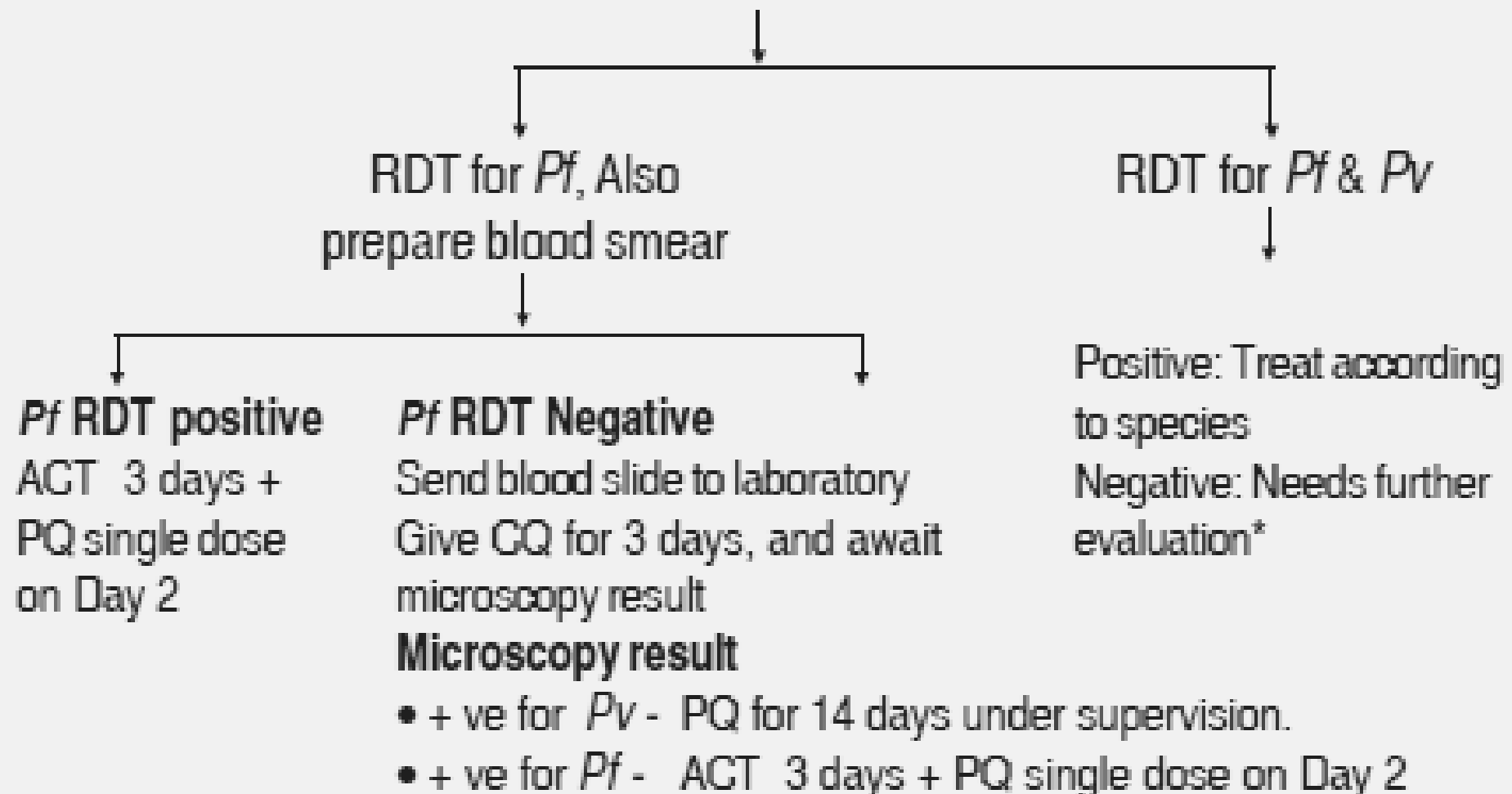
Negative

Needs further
evaluation*

Where microscopy result is not available within 24 hours

Clinical suspected malaria case

Perform RDT



ACT: Artesunate, Sulfadoxine & Pyrimethamine

Treatment of *Vivax Malaria*

- **Chloroquine:**
 - 25 mg/kg body weight divided over three days i.e.
10 mg/kg on day 1, 10 mg/kg on day 2 and 5 mg/kg on day 3.
- **Primaquine:**
 - 0.25 mg/kg body weight daily for 14 days.

Primaquine is contraindicated in infants, pregnant women and individuals with G6PD deficiency.

Dosage Chart for Treatment of *Vivax Malaria*

Age	Day 1		Day 2		Day 3		Day 4 to 14
	CQ (150 mg base)	PQ (2.5 mg)	CQ (150 mg base)	PQ (2.5 mg)	CQ (150 mg base)	PQ (2.5 mg)	PQ (2.5 mg)
Less than 1 yr	½	0	½	0	¼	0	0
1-4 years	1	1	1	1	½	1	1
5-8 years	2	2	2	2	1	2	2
9-14 years	3	4	3	4	1½	4	4
15 yrs or more*	4	6	4	6	2	6	6
Pregnancy	4	0	4	0	2	0	0

Note: CQ 250mg tablet is having 150 mg base

Treatment of *Falciparum Malaria*

- In States other than North-Eastern States
- In North-Eastern States

In States other than North-Eastern States

- **Artemisinin based Combination Therapy (ACT-SP)**
 - Artesunate 4 mg/kg body weight daily **for 3 days**
 - Plus
 - Sulfadoxine (25 mg/kg body weight) &
 - Pyrimethamine (1.25 mg/kg body weight) **on first day.**
- **Primaquine**
 - 0.75 mg/kg body weight **on day 2**

ACT is not to be given in 1st trimester of pregnancy.

Dosage Chart for Treatment of *falciparum* Malaria with ACT-SP

Age Group (Years)	1 st day		2 nd day		3 rd day
	AS	SP	AS	PQ	AS
0-1* Pink Blister	1 (25 mg)	1 (250 +12.5 mg)	1 (25 mg)	Nil	1 (25 mg)
1-4 Yellow Blister	1 (50 mg)	1 (500+25 mg each)	1 (50 mg)	1 (7.5 mg base)	1 (50 mg)
5-8 Green Blister	1 (100 mg)	1 (750+37.5 mg each)	1 (100 mg)	2 (7.5 mg base each)	1 (100 mg)
9-14 Red Blister	1 (150 mg)	2 (500+25 mg each)	1 (150mg)	4 (7.5 mg base each)	1 (150 mg)
15 & Above White Blister	1 (200 mg)	2 (750+37.5 mg each)	1 (200 mg)	6 (7.5 mg base each)	1 (200 mg)

* SP is not to be prescribed for children <5 months of age and should be treated with alternate ACT

In North-Eastern States

- **ACT-AL Co-formulated tablet *twice daily for 3 days***
(ARTEMETHER – LUMEFANTRINE)

Weight (Age)	5 14 kg (> 5 months to < 3 years)	15 24 kg (≥ 3 to 8 years)	25 34 kg (≥ 9 to 14 years)	>34 kg (>14 years)
Total Dose of ACT-AL	20 mg/ 120 mg	40 mg/ 240 mg	60 mg/ 360 mg	80 mg/ 480 mg

- **Tab Primaquine: 0.75 mg/kg body weight on day 2**

ACT-AL Not recommended during 1st trimester of pregnancy and for children weighing < 5 kg.

Recommended regimen by weight and age group

Co-formulated tablet ACT-AL	5–14 kg (> 5 months to < 3 years)	15–24 kg (≥ 3 to 8 years)	25–34 kg (≥ 9 to 14 years)	> 34 kg (> 14 years)
Total Dose of ACT-AL	20 mg/ 120 mg twice daily for 3 days	40 mg /240 mg twice daily for 3 days	60 mg /360 mg twice daily for 3 days	80 mg /480 mg twice daily for 3 days
	Pack size			
No. of tablets in the Packing	6	12	18	24
Give	1 Tablet twice daily for 3 days	2 Tablets twice daily for 3 days	3 Tablets Twice daily for 3 days	4 Tablets Twice daily for 3 days
Colour of the pack	Yellow	Green	Red	White

* ACT-AL is not to be prescribed for children weighting less than 5 kg.

Treatment of uncomplicated *P.falciparum* cases in pregnancy

- **1st Trimester :**
 - Quinine salt 10mg/kg 3 times daily for 7 days.
- **2nd and 3rd trimester:**
 - Area-specific ACT as per dosage schedule given above.
 - i.e. ACT-AL in North Eastern States /ACT-SP in Other States

Quinine may induce hypoglycemia; pregnant women should not start taking quinine on an empty stomach and should eat regularly.

Treatment of mixed infections (*P.vivax* + *P.falciparum*) cases

- All mixed infections should be treated with full course of **ACT and Primaquine** 0.25 mg per kg body weight daily for 14 days.
 - In North-Eastern States: Treat with: Age-specific ACT-AL for 3 days + Primaquine 0.25 mg per kg body weight daily for 14 days.
 - In Other States: SP-ACT 3 days + Primaquine 0.25 mg per kg body wt. daily for 14 days.

Dosage Chart for Treatment of mixed (*vivax* *and falciparum*) Malaria with ACT-SP

Age	Day 1			Day 2		Day 3		Days 4-14
	AS tablet (50 mg)	SP tablet	PQ (2.5 mg)	AS tablet (50 mg)	PQ (2.5 mg)	AS tablet (50 mg)	PQ (2.5 mg)	PQ (2.5 mg)
Less than 1 yr	½	½	0	½	0	½	0	0
1-4 years	1	1	1	1	1	1	1	1
5-8 years	2	1 ½	2	2	2	2	2	2
9-14 years	3	2	4	3	4	3	4	4
15 yrs or more	4	3	6	4	6	4	6	6

Treatment of *P. ovale* and *P. malariae*

- In India these species are very rarely found.
 - *P. ovale* should be treated as *P. vivax*
 - *P. malariae* should be treated as *P. falciparum*.

Treatment of severe malaria cases

- Severe malaria is an emergency and treatment should be given as per severity and associated complications.
- Parenteral artemisinin derivatives or quinine should

- **Initial parenteral treatment for at least 48 hours:**
- **Quinine:**
 - 20mg quinine salt/kg body weight on admission (IV infusion or divided IM injection) followed by maintenance dose of 10 mg/kg 8 hourly.
 - infusion rate should not exceed 5 mg/kg per hour. Loading dose of 20mg/kg should not be given, if the patient has already received quinine.

Follow-up treatment, when patient can take oral medication

- **Quinine** 10 mg/kg three times a day with:
- Doxycycline 100 mg once a day or
- Clindamycin in pregnant women and children under 8 years of age,
to complete 7 days of treatment

- **Initial parenteral treatment for at least 48 hours:**
 - **Artesunate:** 2.4 mg/kg i.v. or i.m. given on admission, then at 12 h and 24 h, then once a day. **OR**
 - **Artemether:** 3.2 mg/kg bw i.m. given on admission then 1.6 mg/kg per day. **OR**
 - **Arteether:** 150 mg daily i.m for 3 days in adults only (not recommended for children).
- **Follow-up treatment, when patient can take oral medication**
 - Full oral course of Area-specific ACT

Use of Paracetamol

- Brings down fever from any cause.
- Does not cure the disease that is causing the fever.
 - The fever remains low for about 4-6 hours, and then the fever can rise again.
- It can be safely given at any age and even during pregnancy.
- If the fever is not very high, and the patient is able to tolerate the fever, there is no need to give paracetamol.

Dosage chart for use of Paracetamol

Age (Years)	No. of Tab. PCM (500 mg)
Less than 1	$\frac{1}{4}$
1-4	$\frac{1}{2}$
5-8	$\frac{3}{4}$
9-14	1
15 or more	1 or 2

It can be given 3-4 times a day if needed.

Chemoprophylaxis

Short term chemoprophylaxis (up to 6 weeks)

- Doxycycline:
 - 100 mg once daily for adults and 1.5 mg/kg once daily for children
 - It should be started 2 days before travel and continued for 4 weeks after leaving the malarious area.

Chemoprophylaxis for longer stay (more than 6 weeks)

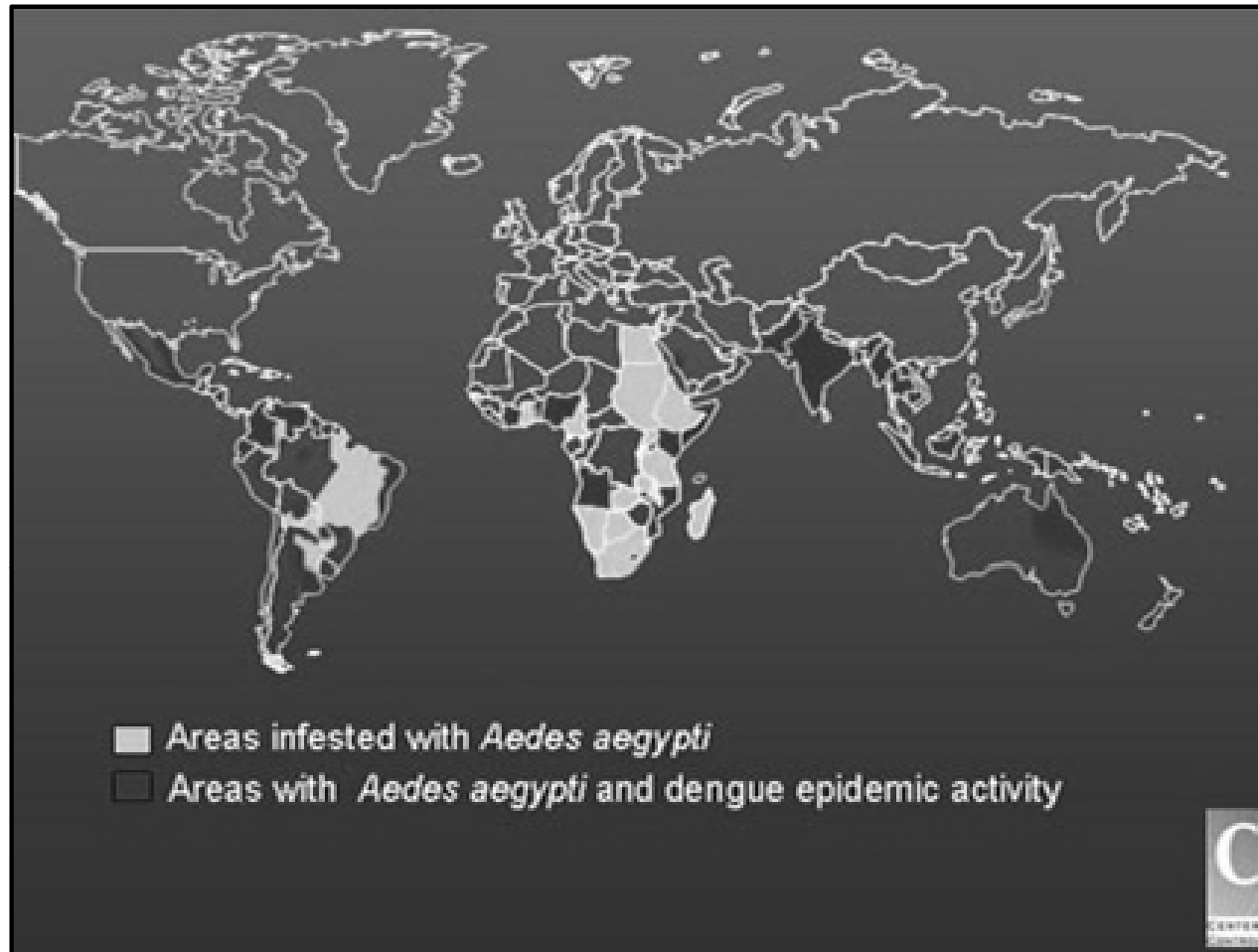
- Mefloquine:
 - 250 mg weekly for adults
 - It should be administered two weeks before, during and four weeks after exposure.

Dengue

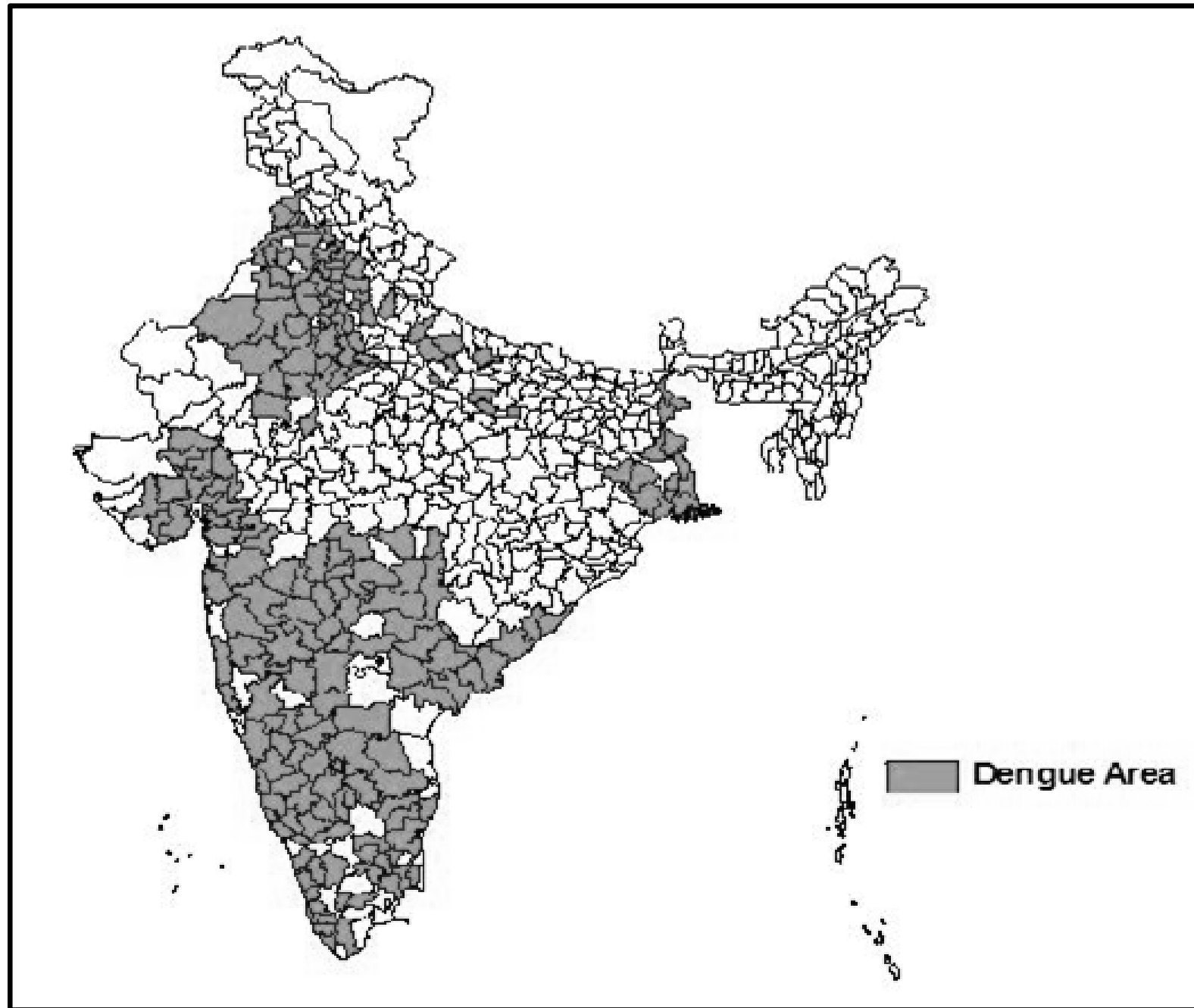
Disease Burden

- *Mosquito-borne viral disease*
- Dengue fever (DF) and its severe forms dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS)
- Endemic in 112 countries of the world putting at *risk to 2.5 to 3 billion people*
- Estimates suggest that 100 million cases of DF occur every year and *half a million cases of DHF require hospitalization, i.e. one DHF case every minute*

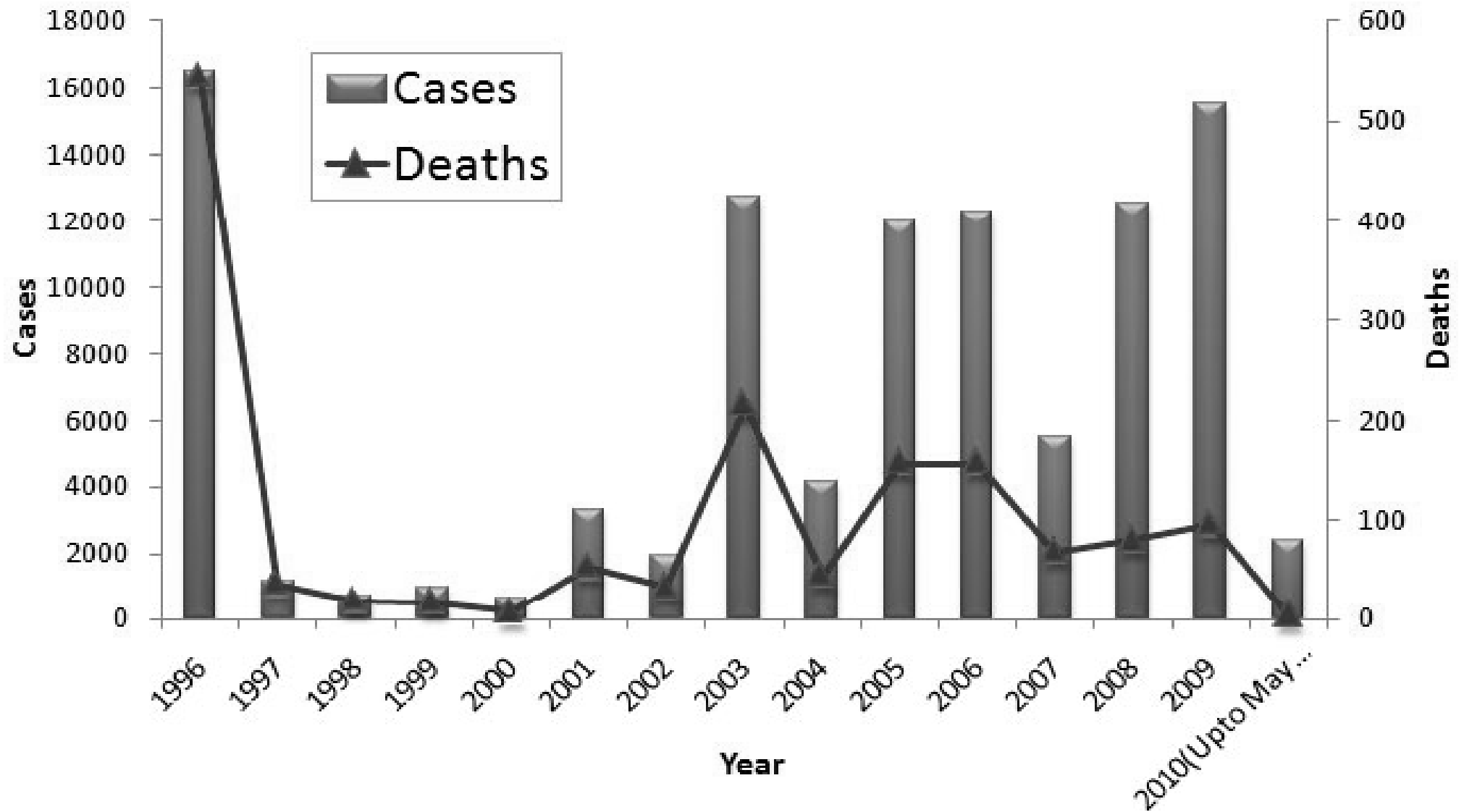
- About 21,000 deaths occur due to DHF every year – mostly among children – i.e. one young life lost to DHF *every 20 minutes*
- In SEA countries, 1.3 billion people out of 1.5 billion at risk of DHF in urban centres – i.e. *87% of population at risk of acquiring DHF during their life time*
- DHF -a global emerging disease of 21st century. Economic impact -similar to that of *malaria and tuberculosis*



Distribution Of Dengue In India



Trends of DENGUE cases & deaths (1996-2010)



Dengue Situation in India (2015-16)

	2015		Up to April 2016	
	India	Chandigarh	India	Chandigarh
Cases	99913	966	3962	02
Deaths	220	01	05	00

Epidemiological Features of Dengue

Infectious Agent

- DF – 4 distinct but *closely-related dengue viruses called serotypes* (DEN-1, DEN-2, DEN-3 and DEN-4) -family Flaviviridae (*Flavivirus*)
- Same viruses-responsible for DHF/DSS
- All 4-serotypes in circulation in the country

Incubation period

- usually 5-6 days but may vary from 3 to 10 days.

Period of communicability

- Infected person with Dengue becomes infective to mosquitoes 6 to 12 hours before the onset of the disease and remains so upto 3 to 5 days

Reservoir of infection

- Evolved from mosquitoes, adapted to monkeys and later to humans during their evolutionary process
- Maintains in urban in a human (*Aedes aegypti* mosquito cycle)
- In forests of South-East Asia and the Indian sub-continent in a monkey (*Ae. albopictus* mosquito cycle)
- ***Both monkeys and humans are amplifying hosts***, while virus is maintained ***by mosquitoes transovarially*** via eggs

Transmission

- By the infective bite of mosquitoes principally *Ae. aegypti* and to a lesser extent *Ae. albopictus*
- *Aedes* mosquitoes are ***day-biters with two biting peaks*** – *two hours after sunrise and again before dusk*
- Mosquito pick up virus from the blood of viraemic patients which builds up 1-2 days before the onset of fever and 4-5 days thereafter
- ***Extrinsic incubation period*** lasts about 6-7 days and mosquito ***remains infective for rest of its life***

Risk factors for geographic spread

- **Unprecedented human population growth**
 - permit continuous circulation of virus and maintain endemicity by regular addition of newborns as susceptible hosts
- **Unplanned/uncontrolled urbanization-**
 - **high vector breeding potential** in peri-urban areas (used tyres, trash, solid waste holding rainwater)
- **Increased national / international travel**
 - introduction of **new serotypes** resulting in build-up of epidemics
- **Poor health infrastructure**

Microevolution of viruses:

- Nucleotide sequencing studies revealed existence of genotypes under each serotype.
- So far, **5 genotypes each** for DEN-1 and DEN-2, **3 for** DEN-3 and **2** for DEN-4 have been identified
- Some of these genotypes - more virulent virus and replacing the less virulent *strains with increasing severity of epidemics*
- **DEN-1 and DEN-2** cause problems of *plasma leakage*
- *DEN-3 and DEN-4* are associated with *hepatic dysfunction*

Variable endemicity of DF/DHF in India

- India recorded first outbreak of DF/DHF in Kolkata in 1963
- Since then **over 60 outbreaks** have been reported from all over the country.
 - A major outbreak of DHF struck Delhi in 1996 when >10,000 people were hospitalized and 425 died of infection
- **Infection rates of DF/DHF** to total population varies from 20 to 50% in a defined large epidemic
- An analysis of these outbreaks has shown **close relationship with climatic zone** which governs the distribution of vector species

In arid, deciduous, dry and wet zones

- It is endemic in urban centres and to a lesser
- *Ae. aegypti* is the only vector;
- Epidemics have *cyclic periodicity*
- In urban cycles, Iceberg phenomenon characterizes dengue virus infection
 - symptomless cases, followed in increasing rarity by undifferentiated fever, DF, DHF, DSS and deaths;
- *clustering of cases* is yet another feature

In monsoon climatic zones (north-eastern region and Western Ghats of south India)

- North-eastern India has **not reported any outbreak**, except Nagaland, which was not validated serologically or virologically.
- *Ae. aegypti* has not gained foothold in urban centres in this region and *Ae. albopictus* is a poor vector for urban cycle

Bio-ecology of *Ae. aegypti*

Adults

- *Highly domesticated*; breeds in essentially stored water meant for human consumption
- Rests inside/outside of breeding containers or dark, humid, obscure places; thus making *sampling/control difficult*
- Flight range-limited 20 to 30 metres. Disease thus distributes **in clusters**
- *Strong preference for human blood*

Larval Habitats

- **Domiciliary habitats**

- *Domestic*: Key containers include overhead tanks, underground storage tanks, cement tanks, metal drums, earthen jars, rainwater harvesting tanks (arid zone) and evaporation coolers (hot & dry areas)
- *Peridomestic*: Unused household materials stacked in open, trash, etc. holding rainwater
- *High-rise buildings*: Essential fire-fighting waters. Construction of water tanks – one at top and other at ground level

- Exteriors of buildings: Roof gutters, sunshades, porticos & other projections capable of holding rainwater
- Construction sites: Various types of curing tanks, abandoned cellars, construction material holding water

- **Extradomiciliary habitats**

- Commercial/public sector organizations: used tyre dumps on vacant plots, building material stacked in the open, heavy machinery, scrap material, ornamental tanks, poorly maintained sanitary fittings in schools, colleges, shopping complexes, hospitals and other places of public utility

Clinical Forms of the Disease

Dengue occurs in *3 main clinical forms*:

- **Dengue fever (DF)**
 - Primary infection with a flu-like illness that affects infants, young children and adults
 - “*breakbone fever*” because of severe muscular pains
 - Infection with dengue confers immunity to infection with the same serotype, but *does not prevent infection with other serotypes*

Dengue fever

- **An acute febrile illness of 2-7 days duration with two or more of the following:**
 - Headache
 - Retro-orbital pain
 - Myalgia
 - Arthralgia
 - Rash
 - Hemorrhagic manifestations.

Dengue haemorrhagic fever (DHF)

- An acute onset of fever followed by haemorrhagic phenomenon
- Affects all age groups, but occurs most in children <15 years.
- Fatality can exceed 20% but with *supportive therapy can be reduced to <1%*

Dengue Hemorrhagic Fever

- A case with clinical criteria for Dengue Fever **PLUS**
- Hemorrhagic tendencies evidenced by one or more of the following:
 - Positive tourniquet test
 - Petechiae, ecchymosis or purpura
 - Bleeding from mucosa, GIT, injection sites or other sites

PLUS

- Thrombocytopenia ($< 1,00,000$ cells per cumm)

PLUS

- Evidence of plasma leakage manifested by one or more of the following:
 - Rise in average hematocrit for age and sex by more than or equal to 20%
 - More than 20% drop in hematocrit following volume replacement
 - Signs of plasma leakage (pleural effusion, ascities)

Dengue shock syndrome (DSS)

- Small proportion of DHF cases progress to shock
- Severe hypotension develops requiring urgent replacement therapy
- Case-fatality can *go up to 50%*

Dengue Shock Syndrome

- All the criteria for DHF with
- Evidence of **circulatory failure**
 - manifested by rapid and weak pulse and narrow pulse pressure (less than or equal to 20 mmHg) or hypotension for age, cold and clammy skin and restlessness.

Probable DF/DHF

- A case compatible with clinical description of Dengue Fever during outbreak

OR

- Non-ELISA based NS1 antigen/IgM positive
- A positive test by RDT will be considered as probable due to poor sensitivity and specificity of currently available RDTs.

Confirmed Dengue Fever

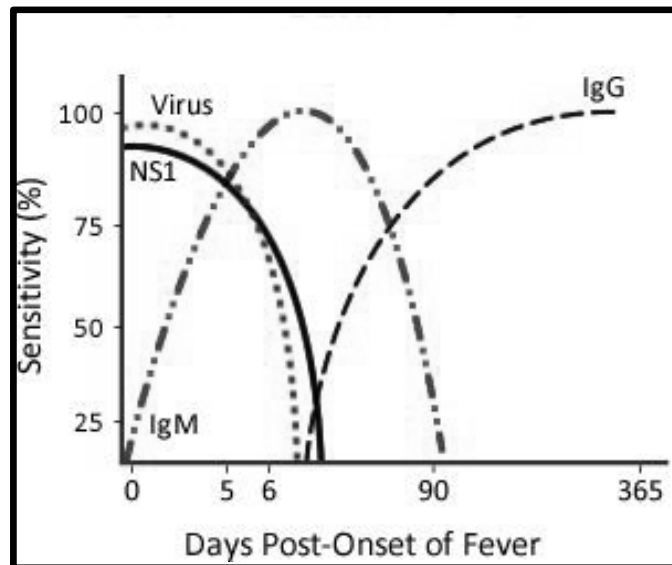
- A case compatible with clinical description of Dengue Fever with **at least one** of the following:
 - Isolation of the dengue virus
 - Demonstration of IgM antibody titer by ELISA positive in single serum sample
 - Demonstration of dengue virus Ag in serum sample by NS1-ELISA
 - IgG seroconversion in paired sera after two weeks with four fold increase of IgG titer
 - Detection of viral nucleic acid by PCR

Laboratory Tests

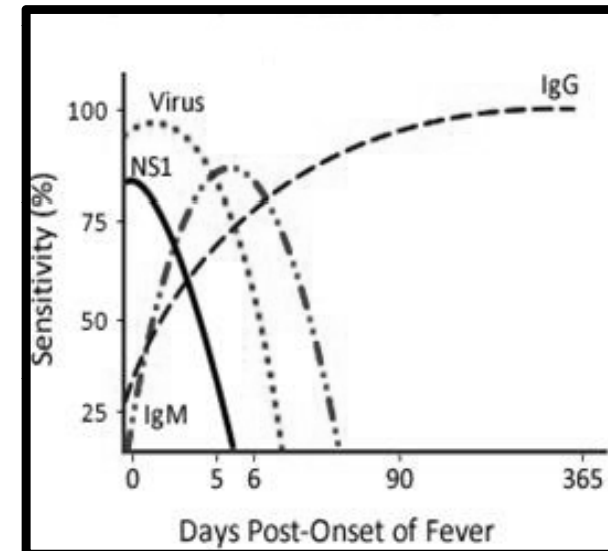
- ELISA-based NS1 (non-structural protein 1) antigen tests
- IgM-capture ELISA (MAC-ELISA)
- Isolation of dengue virus
- Polymerase Chain Reaction
- IgG-ELISA
- Other serological tests
- Rapid diagnostic tests (RDTs)

Immunological Response to Dengue Infection

Primary DENV Infection



Secondary DENV Infection



Clinical support system

Essential facilities at Treatment Centers

Drugs

- Syrup & Inj. Paracetamol
- ORS
- IV fluids (isotonic saline/ compound solution of sodium lactate/ dextrose saline)
- Blood bank facilities
- Plasma, Dextran 40

Equipments

- Syringes and needles.
- Thermometer
- Sphygmomanometer
- Adhesive tape
- IV cannula, 22, 24
- Ambu Bag

Laboratory facilities

- Complete haemogram
- Absolute platelet count
- Haematocrit estimation
- Serum electrolytes
- Renal function tests
- Liver function tests
- Blood gas analysis

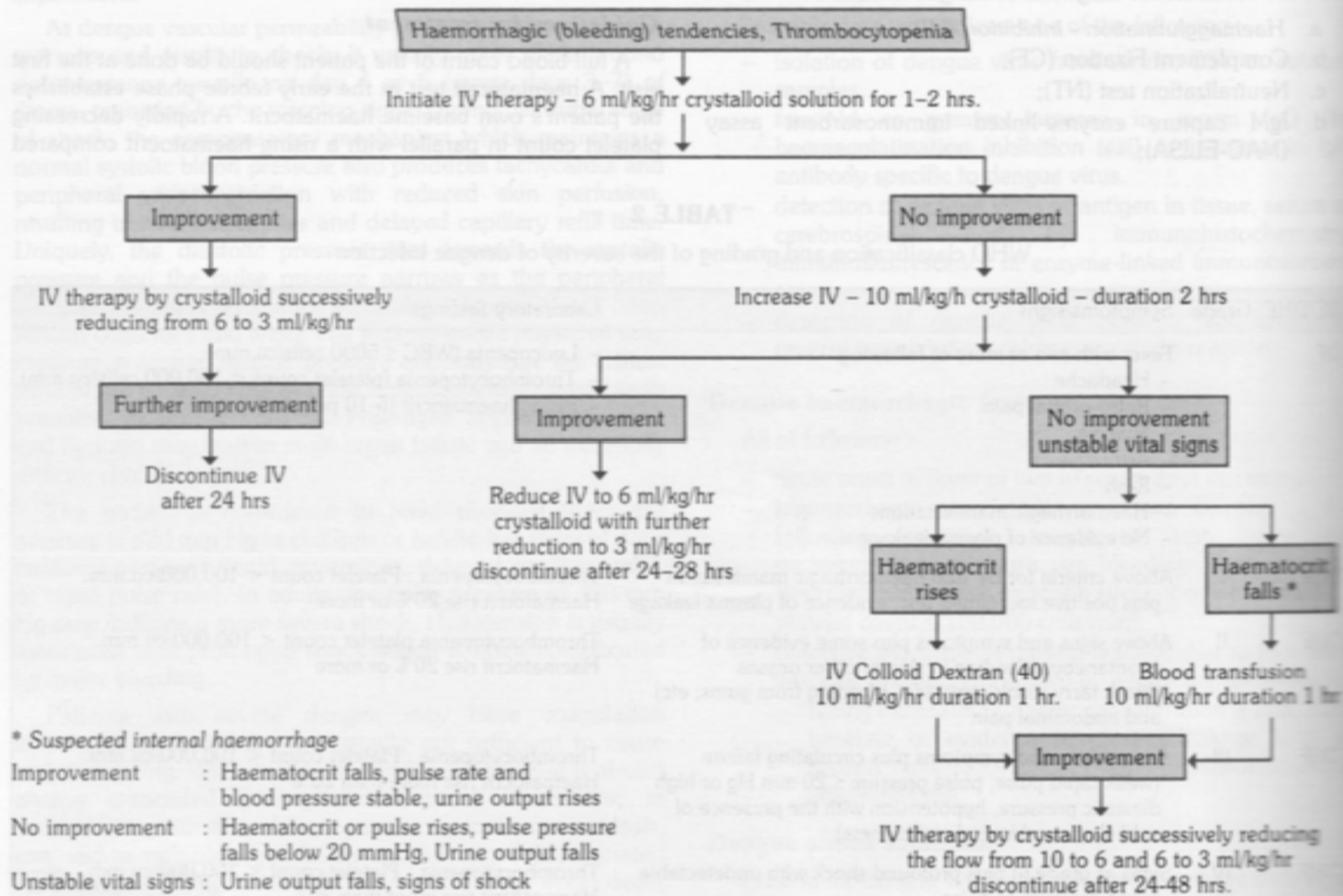


FIG. 3

UNSTABLE VITAL SIGNS
Urine output falls, signs of shock

Immediate rapid volume replacement : initiate IV therapy
10–20 ml/kg/hr crystalloid solution for 1 hour

Improvement

IV therapy by crystalloid
successively reducing from 20 to 10,
10 to 6 and 6 to 3

Further improvement

Discontinue IV
after 24 hrs

No improvement

Oxygen

**Haematocrit
rises**

IV colloid (dextran (40) or
plasma 10 ml/kg/hr
as intravenous bolus
(repeat if necessary)

**Haematocrit falls rapidly
(due to haemorrhage)**

Blood transfusion
(10 ml/kg/hr)

Improvement

IV therapy by crystalloid successively reducing
the flow from 10 to 6 and 6 to 3 ml/kg/hr.
Discontinue after 24–48 hrs.

- Serial platelet and haematocrit determinations : drop in platelets and rise in haematocrit are essential for early diagnosis of DHF.
- Cases of DHF should be observed every hour for vital signs and urinary output.

FIG. 4

Volume replacement flow chart for patients with DHF Grades III & IV

- A comprehensive surveillance system for DF/DHF should comprise of following components:
 - **Epidemiological surveillance**
 - **Entomological surveillance**
 - **Laboratory based surveillance**

Epidemiological interpretation of various entomological indices

Entomological index	High risk of transmission	Low risk of transmission
Breteau index	>50	<5
House index	>10%	<1%

House index (HI): % houses infected with larvae and/or pupae

- $\text{Number of Houses infected} / \text{Number of Houses inspected} \times 100$

Container Index (CI): % water holding containers infected with larvae or pupae.

- $\text{Number of positive containers} / \text{Number of containers inspected} \times 100$

Breteau Index (BI): number of positive containers per 100 houses inspected

- $\text{Number of positive containers} / \text{Number of houses inspected}$

Pupae Index (PI): number of pupae per 100 houses

- $\text{Number of pupae} / \text{Number of houses inspected} \times 100$

Adult Surveys

- i) Landing/biting collection: Landing/biting collection of humans is a sensitive means of detecting low level infestations of *Ae aegypti*, but are very labour intensive. Because adult males have low dispersal rates, their presence can be a reliable indicator of clear proximity to hidden larvae habitats. It is usually expressed in terms of landing/biting counts per man hour.
- ii) Resting collection: During periods of inactivity, adult mosquitoes typically rest indoors, especially in bedrooms and mostly in dark places, such as cloth closets and other sheltered sites. Resting collection requires systematic searching of these sites for adult mosquitoes with the aid of flashlight. Following a standard timed collection routine in selected rooms of each house, densities are recorded as the number of adults per house or number of adults per man hour of human efforts.
- iii) Oviposition traps: Ovitrap are devices used to detect the presence of *Ae aegypti* where the population density is low and larval surveys are largely unproductive (when the Breteau index is less than 5) as well as normal conditions. The ovitrap is used for *Ae aegypti* surveillance in urban areas to evaluate the impact of adulticidal space spraying on adult female population.

Laboratory surveillance

- Presently, laboratory based surveillance for DF/DHF is very poor/ non-existent.
- Serological surveillance through rapid diagnostic kits can provide more accurate estimation of
 - the extent of dengue virus
 - serotypes circulating in the community.

Prevention and Control of DF/DHF

- Mortality control

- *No treatment. No drugs to kill virus*
- Case management through symptomatic treatment and supportive therapy
- *Early admissions* in a hospital increases the chances of recovery
- Peripheral health centres / small hospitals- *poorly equipped* in respect of case management skills, equipment and material.

Dengue virus infection

Asymptomatic

Symptomatic

Undifferentiated
fever
(viral syndrome)

Dengue fever
(DF)

Dengue haemorrhagic
fever (DHF)
(with plasma leakage)

Expanded dengue syndrome/
Isolated organopathy
(unusual manifestation)

Without
haemorrhage

With unusual
haemorrhage

DHF
non-shock

DHF with shock
Dengue shock
syndrome (DSS)

FIG. 1

Manifestations of the dengue virus infection

Source : (2)

TABLE 2

WHO classification and grading of the severity of dengue infection

DF/DHF	Grade	Symptoms/signs	Laboratory findings
DF		Fever with two or more of following <ul style="list-style-type: none"> - Headache - Retro-orbital pain - Myalgia - Arthralgia - Rash - Haemorrhagic manifestations - No evidence of plasma leakage 	<ul style="list-style-type: none"> - Leucopenia (WBC \leq 5000 cells/cu.mm), - Thrombocytopenia (platelet count $<$ 150,000 cells/cu.mm), - Rising haematocrit (5-10 per cent)
DHF	I	Above criteria for DF and haemorrhagic manifestaion plus positive tourniquet test, evidence of plasma leakage	Thrombocytopenia : Platelet count $<$ 100,000/cu.mm. Haematorcit rise 20% or more
DHF	II	Above signs and symptoms plus some evidence of spontaneous bleeding in skin or other organs (black tarry stools, epistaxis, bleeding from gums, etc) and abdominal pain	Thrombocytopenia platelet count $<$ 100,000/cu.mm. Haematocrit rise 20% or more
DHF	III	Above signs and symptoms plus circulating failure (weak rapid pulse, pulse pressure \leq 20 mm Hg or high diastolic pressure, hypotension with the presence of cold clammy skin and restlessness)	Thrombocytopenia : Platelet count $<$ 100,000/cu.mm. Haematocrit rise more than 20%
DHF	IV	Signs as grade III plus profound shock with undetectable blood pressure or pulse	Thrombocytopenia : Platelet count $<$ 100,000/cu.mm. Haemotocrit rise more than 20%
DHF III and IV are Dengue Shock Syndrome			

- **Morbidity control**

- *No Vaccination*

- *Disease surveillance non-existent*, although essential for early warning and predictive capability

- *National-level dengue control programs non-existent*

- Ad hoc arrangements put under the responsibility of NVBDC/Health infrastructure of municipal corporations inadequate to meet the challenges

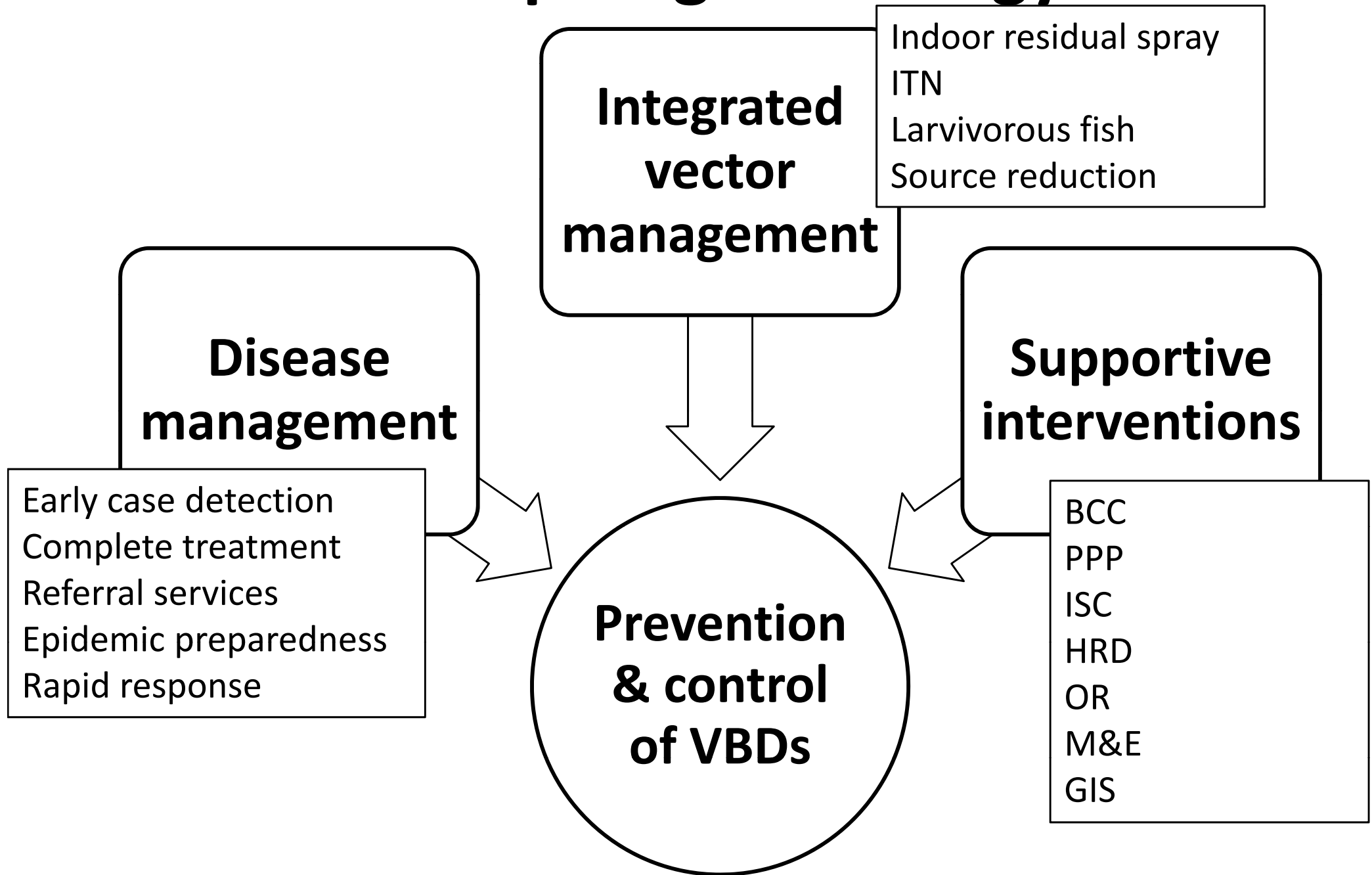
- *Notifiable status of DHF*

Integrated Vector Management

Prof., & Head Department of Community Medicine
Govt. Medical College & Hospital, Chandigarh

MALARIA CONTROL STRATEGY

Three pronged strategy



Integrated Vector Management

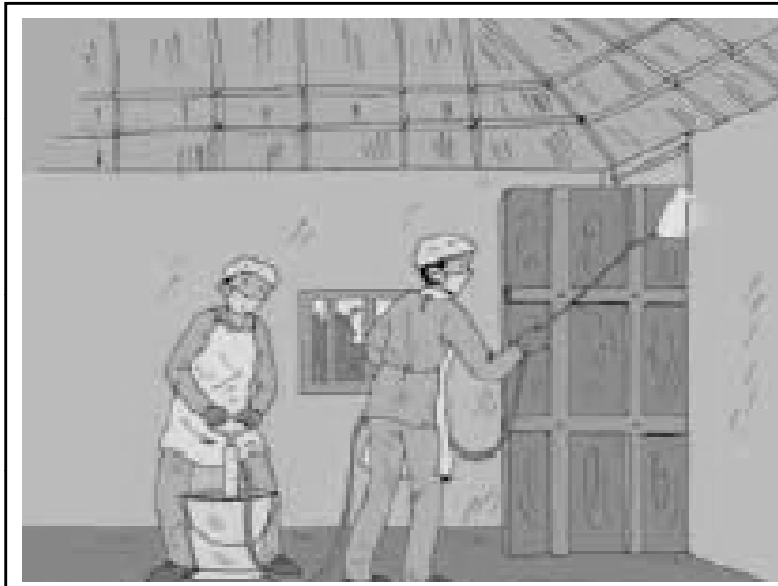
- Environmental Management & Source Reduction Methods
- Chemical Control
- Biological Control
- Personal Prophylactic Measures

Environmental Management & Source Reduction Methods

- Source reduction i.e. filling of the breeding places
- Proper covering of stored water
- Channelization of breeding source
- Avoid artificial collection of water

Chemical Control

- Use of Indoor Residual Spray (IRS) with insecticides recommended under the programme
- Use of chemical larvicides like Abate in potable water
- Aerosol space spray during day time
- Malathion fogging during outbreaks



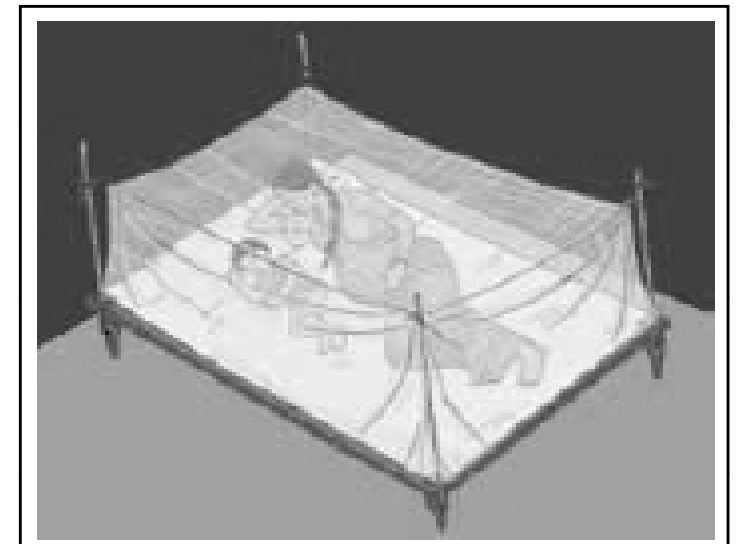
Biological Control

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



Personal Prophylactic Measures

- Use of mosquito repellent creams, liquids, coils, mats etc.
- Screening of the houses with wire mesh
- Use of bednets treated with insecticide (ITN)
- Wearing clothes that cover maximum surface area of the body.



Synthetic Pyrethroids are used for treatment of Bed Nets: Deltamethrin, Cyfluthrin

Vector control Measures

Action	For Individual & Family Protection	For Community Protection
Reduction of human-mosquito contact	ITN, Repellants, Protective clothing, Screening of houses	ITN, Zoo-prophylaxis
Destruction of adult mosquitoes		ITN, indoor space spraying, ULV spray
Destruction of mosquito larvae	Peri-domestic sanitation	Larviciding of water surface, intermittent irrigation, Biological control
Source reduction	Small scale drainage	Environmental sanitation, water management, drainage
Social Participation	Motivation for personal & family protection	Health education, community participation

Integrated Vector Management

- **Environmental Management & Source Reduction Methods**

Source reduction i.e. filling of the breeding places

- Proper covering of stored water
- Channelization of breeding source

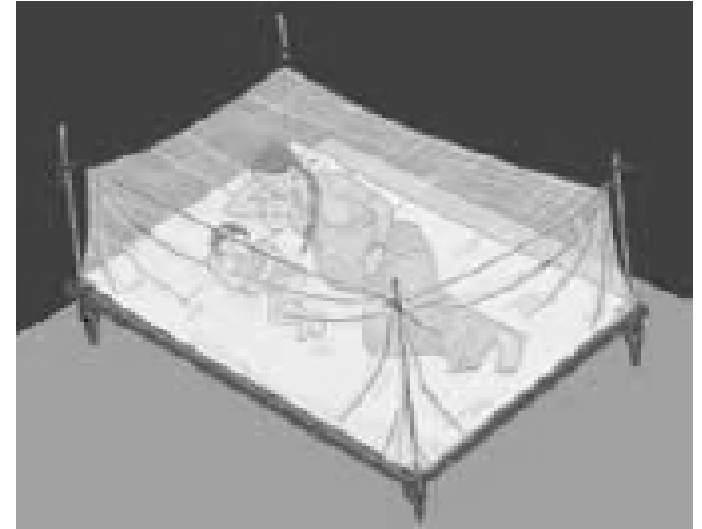
- **Chemical Control**

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Synthetic Pyrethroids are used for treatment of Bed Nets: Deltamethrin, Cyfluthrin

Transmission Control

Vector interventions – available options

- **Adult control**
 - *Indoor residual spray* – Neither technically feasible nor practical; >90% adults rest on non-sprayable surfaces
 - Thermal fogging – Space spray (Malathion):
 - *Not effective for lack of air current* in the houses to reach the targeted sites

Larval Control Only Option

- **Two approaches**
- **Top-down approach:**
 - Govt. vertical program – require large staff, budget – **Not sustainable – Unsuccessful**
American programme of 1950s and 60s for eradication of Ae. aegypti is classic example
- **Bottom-up approach:**
 - Community-based integrated approach with intersectoral linkages – require extensive social marketing of dengue prevention, health education of communities for ownership – **very slow process**

Community participation

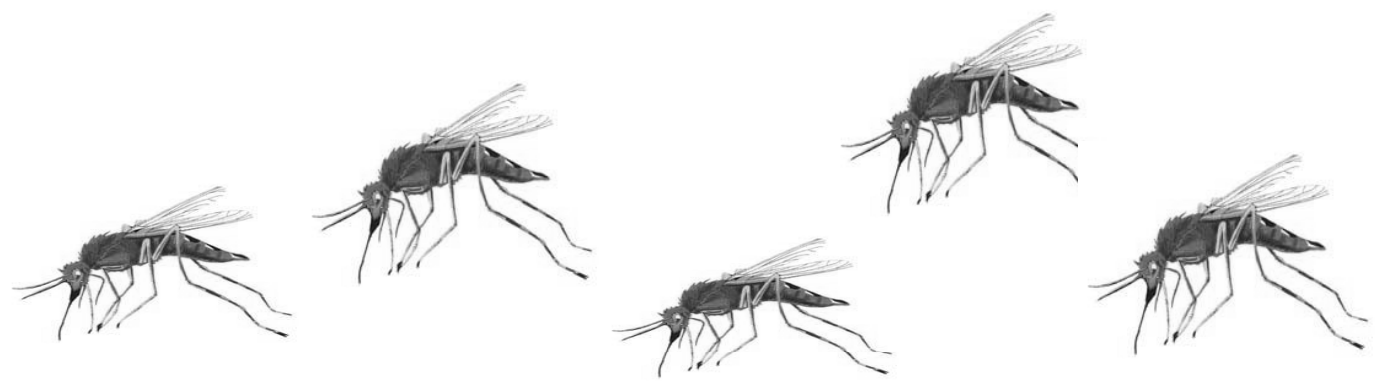
- Essential for the prevention and control.
- The community must be educated and encouraged to:
 - Eliminating mosquito breeding sites
 - Take personal protection measures to prevent mosquito bite
 - Co-operate during the periodic insecticide spray
 - Report cases to the health authorities and seek early treatment

GIS & Malaria Control

- Data-driven decision-making was one of the essential factors commonly observed in four countries where malaria burden was successfully reduced.*
- Approximately 80% of the information needs of the local government decision-makers relate to geographical locations.**
- *When feeding back the results of a field survey to the decision-makers and local health workers, **visually-indicated GIS maps could be much more effective** for communicating the main findings, rather than tables of statistical results alone.*

*Barat LM: **Four malaria success stories: how malaria burden was successfully reduced in Brazil, Eritrea, India, and Vietnam.** *Am J Trop Med Hyg* 2006, **74:12-16.**

Williams RE: **Selling a geographical information system to government policy makers. *URISA* 1987, **3:150-156.**



MDG Target 6C.

- **Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases**



Thanks.....