Presentation include:

1. Global distribution of JE and status of JE in India
2. JE transmission - JE vectors, Amplifying Host, Reservoirs
3. JE program-Control Strategy-JE vaccination
4. New Initiatives
5. Surveillance
6. Outbreak investigation
7. Urban JE outbreak investigation
8. JE -3 decades review -Uttar Pradesh
Japanese Encephalitis in India

★ 1952 - First evidence of JE viral activity was recorded by VRC (NIV) during sero-surveys for arbo-viruses.
★ 1955 - First human case of JE in Tamil Nadu.
★ 1973 - First outbreak - Bankura and Burdwan in West Bengal.
★ 1976 - Repeat outbreak in Burdwan.
★ 1978 - Widespread occurrence of suspected JE cases.
   National level monitoring initiated by NMEP in 1978.
★ 2003 - National program for prevention and control of JE
★ 2005 – Major outbreak in Uttar Pradesh.
★ 2011 – First time cases reported from Delhi.
★ 2013 - Tripura and Arunachal Pradesh
The first case of JE viral disease was documented in 1871 in Japan. However, Virus first isolated in Japan in 1935

JEV is the main cause of viral encephalitis in many countries of Asia with an estimated 68,000 clinical cases every year, with approximately 13,600 to 20,400 deaths

24 countries in the WHO South-East Asia and Western Pacific regions have endemic JEV transmission, exposing more than 3 billion people to risks of infection
Japanese Encephalitis

- Japanese encephalitis virus (JEV) is a flavivirus and is spread by mosquitoes.
- The majority of cases occur in children under the age of 15. Most adults in endemic countries have natural immunity through exposure, but individuals of any age may be affected.
- There is no human to human transmission
- Although symptomatic JE is rare (sporadic), the case-fatality rate can be as high as 30%.
- The disease can cause irreversible neurological damage-30%–50%.
- There is no treatment for the disease. Treatment is supportive to relieve symptoms and stabilize the patient.
- Safe and effective vaccines are available to prevent JE.
JE ENDEMIC STATES IN INDIA

Number of endemic districts: 171; Population: 375 million

Source: NVBDCP
Dynamics of JE Transmission

Environment → Vector Mosquito → Host - Amplifying → Host - Carrier → Victim - Accidental

→ Full Recovery
→ Recovery with residual complications → Death
Transmission Dynamics of Japanese Encephalitis

- The virus exists in a transmission cycle between mosquitoes, pigs and/or water birds (enzootic cycle). The disease is predominantly found in rural and peri urban settings, where humans live in closer proximity to these vertebrate hosts.
- Mainly associated in areas with rice field cultivation
- Man is dead end in transmission cycle. Humans, once infected, do not develop sufficient viraemia to infect feeding mosquitoes
- Pig are amplifying hosts
Pig are amplifying hosts because-

- High natural infection rate (98-100%) and high viremia
- Viremia that remains high enough to infect mosquitoes for up to four days
- Feeding preference of vector mosquitoes to feed on swine
- High birth rate providing a source of susceptible pigs every year

Cattle do not circulate virus in their blood but develop antibodies against them; hence they do not act as natural host for the virus.
• Over 90 bird species known to be reservoir hosts of JEV
• Among them Wild wading birds (egrets- Egretta garzetta) and (Heron- Nycticorax nycticorax) are highly susceptible to JEV infection
• species of birds like pond herons, cattle egrets, poultry birds, ducks and sparrows, etc. appear to be involved in natural transmission of JE virus.
• Migratory birds may be involved in the transfer of virus one region to another.
• 27 species of mosquitoes, belonging to five genera have either have been proved or suspected to be vectors of JE.


• *Culex. tritaeniorhynchus*, is the major and incriminated vector of JE in India,

• JE virus has been also detected at National Centre for Disease Control (by Dr Roop Kumari & team) from Cx. *gelidus*, Cx. *pseudovishnui*, Cx. *bitaeniorhynchus*, Cx. *epidesmus*, Cx. *tritaeniorhynchus* in Gorakhpur area.
Isolation of JE virus from mosquitoes in India

<table>
<thead>
<tr>
<th>Species</th>
<th>No. of isolations</th>
<th>State*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cx. tritaeniorhynchus</td>
<td>79</td>
<td>TN, KA, KL</td>
</tr>
<tr>
<td>Cx. vishnui</td>
<td>30</td>
<td>TN, KA, WB</td>
</tr>
<tr>
<td>Cx. pseudovishnui</td>
<td>8</td>
<td>KA, GOA</td>
</tr>
<tr>
<td>Cx. bitaeniorhynchus</td>
<td>3</td>
<td>KA, WB</td>
</tr>
<tr>
<td>Cx. epidesmus</td>
<td>1</td>
<td>WB</td>
</tr>
<tr>
<td>Cx. fuscocephala</td>
<td>7</td>
<td>TN, KA</td>
</tr>
<tr>
<td>Cx. gelidus</td>
<td>8</td>
<td>TN, KA</td>
</tr>
<tr>
<td>Cx. quinquefasciatus</td>
<td>1</td>
<td>KA</td>
</tr>
<tr>
<td>Cx. whitmorei</td>
<td>4</td>
<td>TN, KA, AP, WB</td>
</tr>
<tr>
<td>An. barbirostris</td>
<td>1</td>
<td>WB</td>
</tr>
<tr>
<td>An. paeditaeniatius</td>
<td>1</td>
<td>KA</td>
</tr>
<tr>
<td>An. subpictus</td>
<td>9</td>
<td>TN, KA, KL</td>
</tr>
<tr>
<td>Ma. annulifera</td>
<td>2</td>
<td>KL, ASSAM</td>
</tr>
<tr>
<td>Ma. indiana</td>
<td>3</td>
<td>KL</td>
</tr>
<tr>
<td>Ma. uniformis</td>
<td>4</td>
<td>KA, KL</td>
</tr>
</tbody>
</table>

* AP= Andhra Pradesh; TN= Tamil Nadu; KA= Karnataka; KL= Kerala; WB=West Bengal

Virus isolation done from 17 mosquito species; major role by Culex vishnui group.
Vector Bionomics

Breeding Habits

• Primarily breed in rice fields, swamps, ponds, ditches, ground pool, irrigation channels – associated with aquatic vegetations i.e. grass, paddy crops, water hyacinth, water lily etc.

• Culex vishnui subgroup is very common, widespread and breed in water with luxuriant vegetation mainly in paddy fields and the abundance is related to rice cultivation, shallow ditches and pools.

Resting and Biting Behavior

• primarily outdoor resting in vegetation and other shaded places but in summer may also rest in indoors.

• They are in principally zoophagic/cattle feeders, though human and pig feeding are also recorded.
Cx. tritaeniorhynchus
The breeding places of *C. vishnui* are almost same as those of *C. tritaeniorhynchus*, both the species often occurring together.
Culex pseudoovishnui

The breeding places are similar to those of *Cx. tritaeniorhynchus* and *Cx. vishnui*
Seasonal Prevalence of JE Vectors

- Seasonality varies in different areas
- Is determined by the availability of breeding sites, temperature, monsoon and humidity, the cropping pattern and the agricultural practice in an area.
- Epidemic usually coincide with the monsoons and post monsoon period when the vector density is high.
SEASONAL VARIATIONS IN JE INCIDENCE

SEASONAL VARIATION OF JE IN UTTAR PRADESH

SEASONAL VARIATION OF JE IN ASSAM

SEASONAL VARIATION OF JE IN WEST BENGAL

SEASONAL VARIATION OF JE IN MAHARASTRA

Dr Roop Kumari, 2005-NVBDCP
Existing Strategies for prevention and control of JE in India

AES/ JE surveillance Guidelines-NVBDCP

Operational Guidelines AES/JE NVBDCP
https://nvbdcp.gov.in/WriteReadData/l892s/JE-AES-Prevention-Control(NPPCJA).pdf
Programme Strategy

- Effective Surveillance and monitoring system - sentinel sites
- Vector control-Integrated Vector Management (VM)
- Health education/Behaviour Change Communication (BCC) to promote early case reporting, Referral of cases & for Personal Protection
- Safe and effective JE vaccines are available to prevent disease - Vaccination of children in JE endemic areas
- Early diagnosis and proper management of JE cases to reduce case fatality.
GUIDELINES FOR SURVEILLANCE OF ACUTE ENCEPHALITIS SYNDROME (WITH SPECIAL REFERENCE TO JAPANESE ENCEPHALITIS)

Directorate of National Vector Borne Diseases Control Programme
Directorate General of Health Services,
Ministry of Health and Family Welfare

November 2006

Contributed By Dr Roop Kumari, 2006-NVBDCP
JE Vaccination in India

JE vaccination campaign launched in 2006 where in 11 most sensitive district in Assam, Uttar Pradesh and Karnataka covered 1-15 years children in campaign mode using SA14-14-2 vaccine
JE vaccination Program

Over the past years, the live attenuated SA14-14-2 vaccine manufactured in China has become the most widely used vaccine in endemic countries, and it was prequalified by WHO in October 2013.

**Strategy**

One time campaign, as mass vaccination drive covering children aged 1-15 years over three weeks period followed by integration of JE vaccine into UIP, after a period of 6 months to cover new cohort

**The Multi Year Plan**

All JE endemic districts to be covered with JE mass vaccination campaigns in a phase wise manner
New Initiative has been undertaken for prevention and control of JE/AES in India

- Government of India has formulated a multipronged strategy to reduce morbidity, mortality and disability in children due to JE/AES.
- This strategy will be implemented only with the active engagement of the Ministries/Departments of
  - Ministry of Health & FW
  - Ministry of Drinking Water Supply & Sanitation
  - Ministry of Women & Child Development
  - Ministry of Social Justice & Empowerment
  - Ministry of Rural Development
  - Ministry of Urban Development
- Interventions will be focused during Phase–I of the programme in 60 districts in 5 states (Assam, Bihar, Tamil Nadu, Uttar Pradesh & West Bengal)

Source: NVBDCP
JE/AES 60 High Priority Districts

Uttar Pradesh 20 Districts

Bihar 15 Districts

Assam 10 Districts

West Bengal 10 Districts

Tamil Nadu 5 Districts

Source: NVBDCP
JE Surveillance
What is the definition of surveillance?

- the continuous and systematic collection, analysis and interpretation of disease-specific data
- the use of that data in the planning, implementation and evaluation of public health practice

The objectives of JE surveillance are to

- Detect early warning signals for an impending outbreak by using clinic epidemiological, environmental and/or entomological parameters.
- Strengthen laboratory services for sero diagnosis.
- Assess the impact of vaccination as well as to guide future strategies.
Approaches for JE surveillance

1. Epidemiological surveillance (human)
2. Entomological surveillance
3. Veterinary based surveillance

• **Entomological Surveillance** - to monitor JE vector density (Hop Cage Method-exophilic mosquitoes) - appropriate vector control measures, prediction of outbreaks, undertake entomological investigations during epidemics and evaluate the impact of control measures.

• **Veterinary surveillance**: By identifying the prevalence & density of pigs, ducks, and ardeid birds and detecting viral activity in susceptible hosts-animal husbandry department- Sera sample -to ascertain transmission of JE virus.
Epidemiological surveillance for Acute Encephalitis Syndrome

- Infection with Japanese Encephalitis virus may be asymptomatic, or may cause febrile illness, meningitis, or encephalitis.
- Encephalitis is the most commonly recognized presentation of JE and is clinically indistinguishable from other causes of an acute encephalitis syndrome (AES).
- JE surveillance therefore, aims to identify patients with AES followed by serologically confirming JE viral infection using standardized laboratory techniques.
For surveillance purposes, WHO defines a case of acute encephalitis by:

- An acute febrile illness, AND
- A change in mental status (such as confusion, disorientation, inability to talk, coma) AND/OR
- New onset seizures, excluding simple febrile seizures*

* Simple febrile seizure: a single seizure lasting < 15 minutes with recovery of consciousness within 60 minutes, in a child aged 6 months to 6 years.
Partial Differential Diagnosis

- Japanese encephalitis
- Some seizures
- Cerebrospinal meningitis
- Viral meningitis
- Meningococcal or epidemic meningitis
- TB, Hib or St pn meningitis
- Viral encephalitis
- Encephalitis
- TB meningoencephalitis
- Pyogenic or purulent meningitis
- Other suspect meningitis or encephalitis
- Meningitis
- Meningococcal or epidemic meningitis
- Viral meningitis
- AES
AES Syndromic Surveillance Strategy

Probable cases

Hospitals

Case Investigation and Lab Analysis

JE

Hib

Sp

Nm

Other

Negative
AES Case classification

- Adequate blood/CSF specimen
  - IgM -ve
    - Other diagnostic tests
    - AES- unknown
  - IgM +ve
    - Lab confirmed JE
    - Probable JE
- No adequate blood/CSF specimen
  - Geographic/temporal link to a lab confirmed JE during an outbreak
    - No geographic/temporal link to a lab confirmed JE
      - AES Unknown
  - AES Unknown
Outbreak Detection and Response Without Preparedness: Normal Sequence of events in the Absence of Rapid response

First Case

Late Detection

Delayed Response

Implementation of prevention & control activities

Opportunity for control
Outbreak Detection and Response
With Preparedness-RRT

Early Detection
Rapid Response

Potential Cases Prevented/outbreak averted
JE Outbreak investigation

Delhi-Urban area
JE outbreak investigation in Delhi

First time, 4 JE cases were reported in Delhi in Sept. 2011, detailed investigations were carried out to rule out whether this case is ‘imported’ or ‘indigenous’. ????

Do we need surveillance of JE in urban areas?

First time, indigenous cases of Japanese Encephalitis reported from urban areas of National Capital Territory of Delhi, India (first 4 cases).
JE outbreak investigation in Delhi

- JE is mainly known as rural disease; found associated with rice field in rural areas.
- Entomological surveys
- Human serology: Blood were tested by IgM Capture ELISA method for detection of JE virus - NCDC.
- Pig’s serology: Pig’s blood samples were tested by haemagglutination inhibition (HAI) through MCD.
- JE virus in vector mosquitoes were tested by Antigen-Capture ELISA technique for the detection of JE virus – NCDC.
- Demography and epidemiological investigations: Door to door surveys to collect information - number of fever cases, history of patient movement, domestic pig population etc.
- In urban localities JE vectors breed in small water bodies like ponds, ditches particularly with the presence of water hyacinth/aquatic plants.
- Also rural areas during non-transmission period restricted to limited breeding sites.
JE investigation in Delhi

Breeding site of JE vector near patient’s house where water bird and pigs were also seen in Jahangirpur, Delhi

Investigated by Dr Roop Kumari & Team of NCDC
Indigenous JE cases in Urban areas*

- JE virus antigen was detected in *Cx. tritaeniorhynchus* and *Cx. vishnui* with high infection rate (125.00).
- There is possibility to get infection in pigs reared in Delhi from water birds, JE virus might be spilled through water birds (reservoir) in amplifier host (pigs) in mosquito breeding sites through mosquito bites, where pigs, water birds and infected mosquitoes were found together.
- Total of first four reported JE cases; three were confirmed 'indigenous', indicating that "virus is multiplying in the city".
- JE is not only restricted to rural areas; associated with paddy cultivation but it may spread in urban localities in suitable ecological conditions.

*Kumari et al 2013*
Japanese Encephalitis in Uttar Pradesh

Three Decades - Review of JE in Uttar Pradesh since 1978 onward

Percent contribution of JE cases by Uttar Pradesh in national figures

Kumari and Joshi, 2012
Percent contribution of JE deaths by Uttar Pradesh in national figures

1978-1987: 81.30%
1988-1997: 79.14%
1998-2009: 46.25%

Kumari and Joshi, 2012
Figure 6 showing the districts with repeated number of times JE cases occurred in 30 years from 1978 to 2007.

Kumari and Joshi, 2012
Figure 8 A. Map showing District wise disease burden of reported JE cases in Uttar Pradesh from 1978 to 1987.

Figure 8 B. Map showing District wise disease burden of reported JE cases in Uttar Pradesh from 1988 to 1997.

Figure 8 C. Map showing District wise disease burden of reported JE cases in Uttar Pradesh from 1998 to 2007.

Kumari and Joshi, 2012
Figure-12 Correlation of Monthly rainfall and JE cases

Monthly JE cases and average rainfall in Uttar Pradesh

Kumari and Joshi, 2012
Epidemic peaks

- Analysis of epidemic peaks of various outbreaks reported from Uttar Pradesh shows that during early outbreaks, **epidemic peak was short**.
- In 2005 outbreak, duration of epidemic was about 17 weeks. However, in 1970s and 1980s, duration of epidemic was about 6-9 weeks\(^\text{17}\) (Chakrabarrty et al 1986).
- It is reported* over those 3 decades, in Uttar Pradesh the peak of the epidemic season shifted forward by **approximately one month** from October to September and seasonality of the disease started in the month of July instead of September.

*Kumari and Joshi, 2012*
Conclusion

- Continuous surveillance & monitoring of vector populations along with JE virus infection rates in vector mosquitoes in relation to climate factors will help in predicting an outbreak & taking an effective intervention measures.
- In conclusion with proper health education, early diagnosis and treatment, environmental sanitation, surveillance, proper planning and implementation of an effective integrated vector control approach and vaccination, JE problem can be controlled.