



Review Article

# A Review of the Current Status of Japanese Encephalitis in Uttar Pradesh, India

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## I N F O

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## A B S T R A C T

Japanese Encephalitis (JE) is an arboviral disease transmitted by mosquitoes. It is a disease of the poor and young (less than 15 years of age) in rural settings with maximum probabilities of their exposure to mosquitoes that are zoophilic. The disease pattern reflects a large proportion of subclinical cases to a small proportion with disease manifestations. It becomes fatal in U.P. in about 40% of the cases (due to seizures) in the absence of early treatment and leads to sequelae in one-third of the cases. Nearly half of the states of India are endemic for Japanese Encephalitis. Both the Govt of India and the State Govt have taken up the disease seriously and made all possible multi-sectoral approaches/ efforts to contain the menace of the disease. Rehabilitation centres have been established in the affected districts to provide physio and speech therapy. Even National Disaster Management Authority (NDMA) participated to generate awareness among the community against the dreadful disease. With all efforts, a plateau-like situation of the disease has been reached over the years. More coordinated efforts are required in tackling this problem. The environmental conditions will govern the spread of the virus along with the vector. The present article reflects an overview of the problem of JE and efforts made so far to tackle this disease and make the younger generation aware of their contribution through open field of the research in restricting the spread of the disease as well as complete cure of the seizures due to JE.

**Keywords:** Japanese Encephalitis (JE) Outbreak, Surveillance, Intervention Measures, *Culex vishuni gp*, Case Management, JE vaccination

## Background History

Uttar Pradesh is one of the most densely populated states in India with nearly 199.81 million population (2011 census) dispersed in 75 revenue districts and 18 divisions. It contributes to 16.50% of the country population with a

population density of 829 per square kilometre leading to the depravity of basic amenities and health facilities among the majority of them. The literacy rate is about 68%, which is below the national average.

The eastern part of Uttar Pradesh (UP) has been endemic

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for Japanese Encephalitis (JE). The first epidemic of JE was reported from this area in 1978 and recurrent outbreaks have been reported from various districts of eastern UP since then.<sup>1-11,13-14</sup> The disease affected all age groups in the beginning but it has been confined mainly to children below 15 years of age and is a major cause of acute childhood encephalopathy. Various factors may be involved in the transmission of the disease in this part of the state. Japanese Encephalitis (JE) disease is caused by an arbovirus, transmitted by mosquitoes. It is a disease of the poor and young (less than 15 years) in rural settings with maximum probabilities of their exposure to mosquitoes of zoophilic. The disease pattern reflects a large proportion of sub-clinical cases in contrast to a small proportion with disease manifestations. The disease becomes fatal in U.P. in about 40% of the cases (because of seizures) in the absence of early treatment and leads to sequelae in one-third of the cases.

Although various hospital and laboratory-based studies have been conducted on the epidemiology of JE in various parts of India including Uttar Pradesh, still the need for further research, to have a much clear understanding of the disease epidemiology, is beyond any question. Kumari & Joshi<sup>11</sup> had reviewed the epidemiology of JE in the country including Uttar Pradesh since 1978, and had suggested some recommendations for its prevention and control. In the review, it has been reflected that UP contributed one-fifth of the disease burden (20.4% in terms of morbidity and 18.7% in mortality) to the total JE burden of the country from 1978 to 1987. The contribution increased to 24.3% in morbidity and 20.9% in mortality between 1988 and 1997. The morbidity and mortality increased to half of the total JE problem of the country between 1998 and 2009. The proportion of JE cases reported from Uttar Pradesh in 1997 was only 14%, which increased in 1998. The outbreak in UP in 2005 contributed over 90% of JE morbidity and 89% mortality in the country. The case definition of JE revised by the National Vector Borne Disease Control Programme (NVBDCP) in 2006 was followed for epidemiological surveillance for acute encephalitis syndrome (AES) which aimed to undertake JE surveillance and thereafter confirmation of JEV infection using IgM ELISA test. The present document accounts for various efforts made by the state of Uttar Pradesh in strengthening and effecting the diagnostic and treatment facilities, and preventive measures to reduce morbidity and mortality both, in prevailing circumstances of JE virus circulation in domestic and pet animals, in addition to ardeid birds.<sup>5</sup>

### **Data Collection, Compilation, Analysis and Interpretation**

A multipronged approach was planned and implemented as the national strategy for the prevention and control of

Japanese Encephalitis (JE). It includes the following: Early diagnosis and complete case management; Integrated Vector Management and Vector Surveillance; Supervision, monitoring, surveillance and evaluation; Strengthening the capacity of human resource in health; Advocacy, communication and social mobilisation for behavioural impact and inter-sectoral convergence and Programme management. In order to ensure action on different approaches of the disease diagnosis and treatment, prevention and control, inter-sectoral convergence and social awareness with active participation, the Japanese Encephalitis (JE) endemic affected 35 districts were visited during different years. The activities related to different approaches were observed in the districts. The observation made so and data collected from the districts were compiled, analysed and then interpreted, and have been presented in the contribution.

### **Salient Observations and Discussion**

Since there was no identified programme for the prevention and control of the Japanese Encephalitis (JE) disease, data regarding the number of JE cases reported by the state from various treatment hospitals including BRD Medical College, Gorakhpur from 1978, the year of the first epidemic of Japanese Encephalitis (JE) were collected and have been furnished through a graphic presentation in the document (Figure 1a).<sup>1-4,7-10,12-16</sup> In the early years of occurrence of JE, proportionately all age groups of the population were affected but during the end of the 1980s, youngsters aged up to 15 years were more affected by JE. The disease is not reported from all 75 districts of the state but the maximum number of JE reporting districts in the eastern half of the state remained only 40 during the last 42 years, though the number of affected districts never exceeded 20 in any single year till 2000 AD (Figure 1b). District Gorakhpur reported only two cases of JE during 1984 with no mortality. It is worth mentioning here that the maximum cases of JE are reported from Gorakhpur and Basti divisions, which were erstwhile only Gorakhpur division. Hence, the Gorakhpur area, comprising these two divisions and Bahraich and Lakhimpur Kheri districts, is the main contributor to the JE problem. Initially, the problem was not large but over time, Uttar Pradesh accounted for 70% of this national problem. The average case fatality rate (CFR) ranged between 48% in 1979 to 19.10% in 1998 (Figure 1c). However, the number of JE affected districts increased during 2005, when a large epidemic occurred involving 34 districts of eastern Uttar Pradesh with 5581 seizures and 1387 deaths, resulting in 25% case fatality rate (CFR), at the time when medical services have acquired much advanced facilities. The unprecedented occurrence of the disease in 1978 resulted in more than 50% mortality in district Lakhimpur Kheri [38 cases (C)/ 32 Deaths (D)], Pilibhit (28C/ 14D), Gonda (38C/ 18D), Raebareli (11C/ 09D) and Shahjahanpur (21C/

11D). This pattern was seen in district Basti (48C/ 32D), Azamgarh (14C/ 09D), and Ghazipur (16C/ 10D) in 1979; Lakhimpur Kheri (12C/ 07D) and Gonda (30C/ 15D) again in 1980; district Gorakhpur (12C/ 06D) and Deoria (11C/ 06D) in 1981; district Lucknow in 1982 (19C/ 11D); district Deoria (45C/ 23D) and Allahabad (17C/ 12D) in 1983; district Bahraich in 1989 (15C/ 07D); district Mau in 1993 (2C/ 2D); district Ambedkar Nagar in 1999 (2C/ 1D); district Hardoi in 2001 (2C/ 1D); district Balrampur in 2002 (3C/ 2D); district Saharanpur in 2003 (7C/ 4D) and 2004 (2C/ 1D), district Muzaffarnagar (20C/ 19D) and Jaunpur (2C/ 2D) in 2005. It is evident from Figure 1a that peaks of the encephalitis

cases were observed in 1978, 1988, 1998-1999 and 2017-2018 (with less sharpness) but the cycle destined to occur in 2008, was possibly preponed in 2005 with all-time sharp peak of morbidity and mortality. The perusal and analysis of the data revealed that cases of JE start to occur from July every year and end with the end of the calendar year with peak in the month of September (Figure 3a), which coincides with the monsoon period in the state when there is abundant rainwater collection in paddy fields and ponds that provide congenial conditions for the development of JE vectors, *Culex vishnui*, *Culex pseudovishnui*, *Culex tritaeniorhynchus*, and *Culex bitaeniorhynchus*.<sup>6</sup>

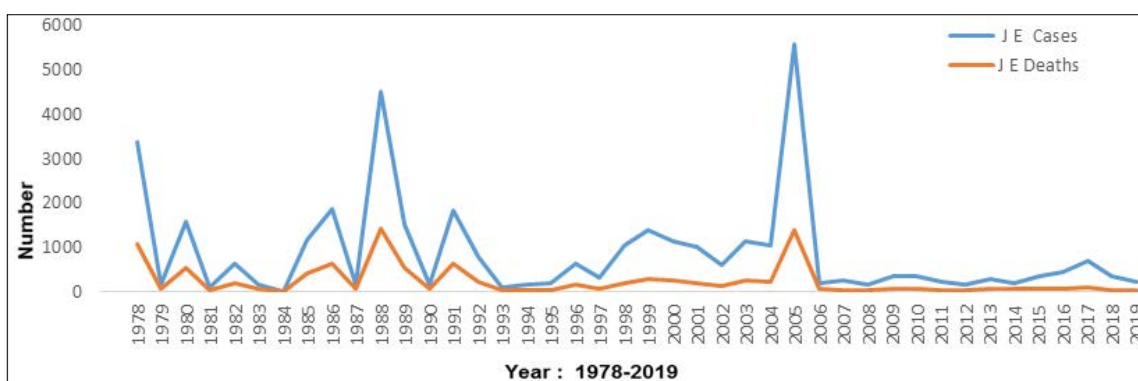


Figure I(a).Yearwise Cases and Deaths due to Japanese Encephalitis (JE) in Uttar Pradesh since 1978

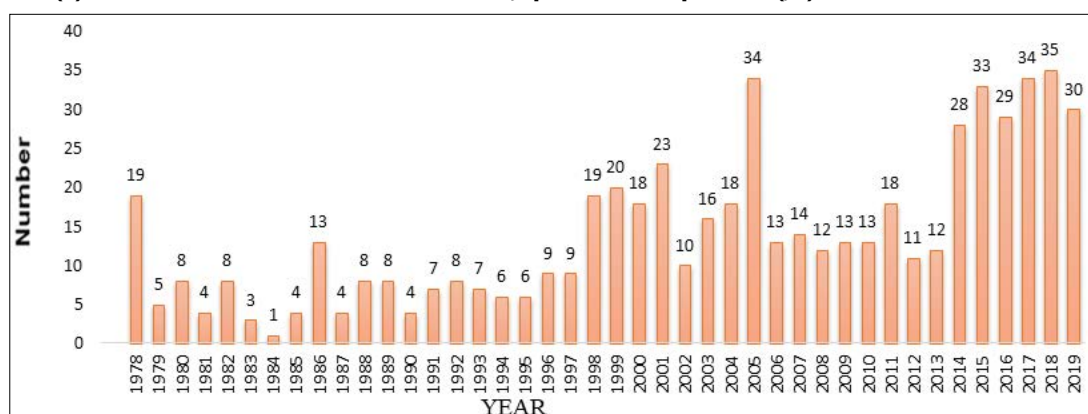


Figure I(b).Yearwise Distribution of the Number of Districts affected by Japanese Encephalitis (JE) in Uttar Pradesh since 1978

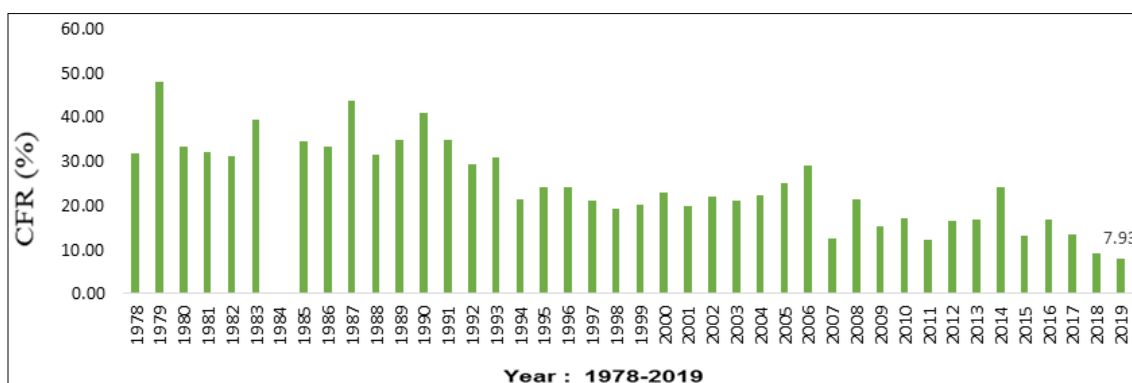


Figure I(c).Case Fatality Rate (CFR) due to JE in Uttar Pradesh (%) since 1978

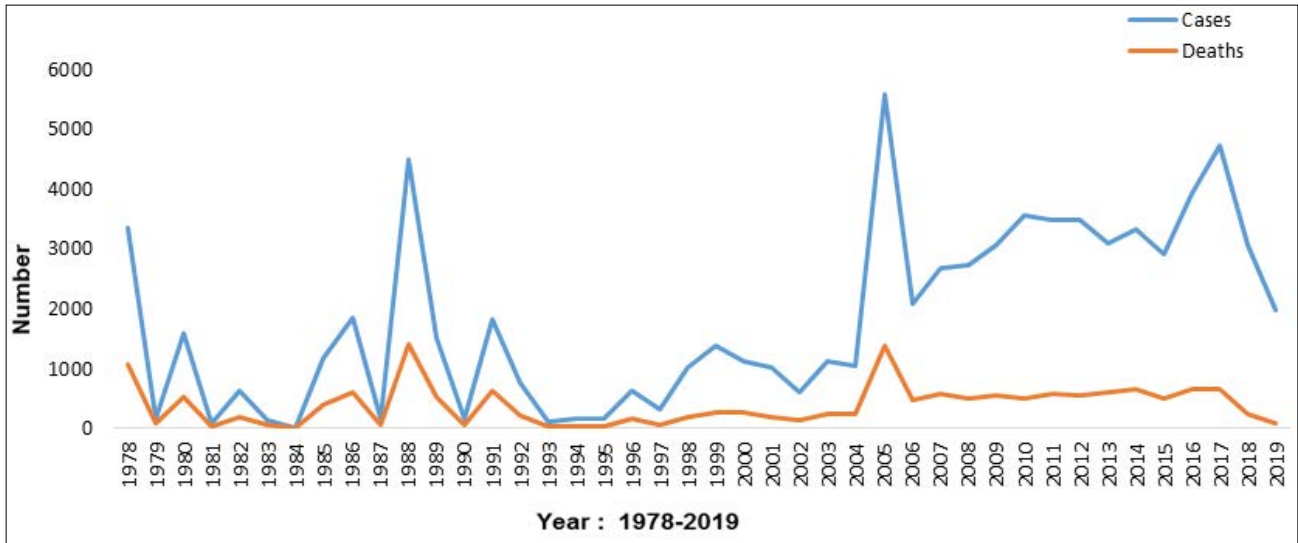


Figure 2(a).Yearwise Distribution of Cases and Deaths due to Acute Encephalitis Syndrome (AES) in Uttar Pradesh since 1978

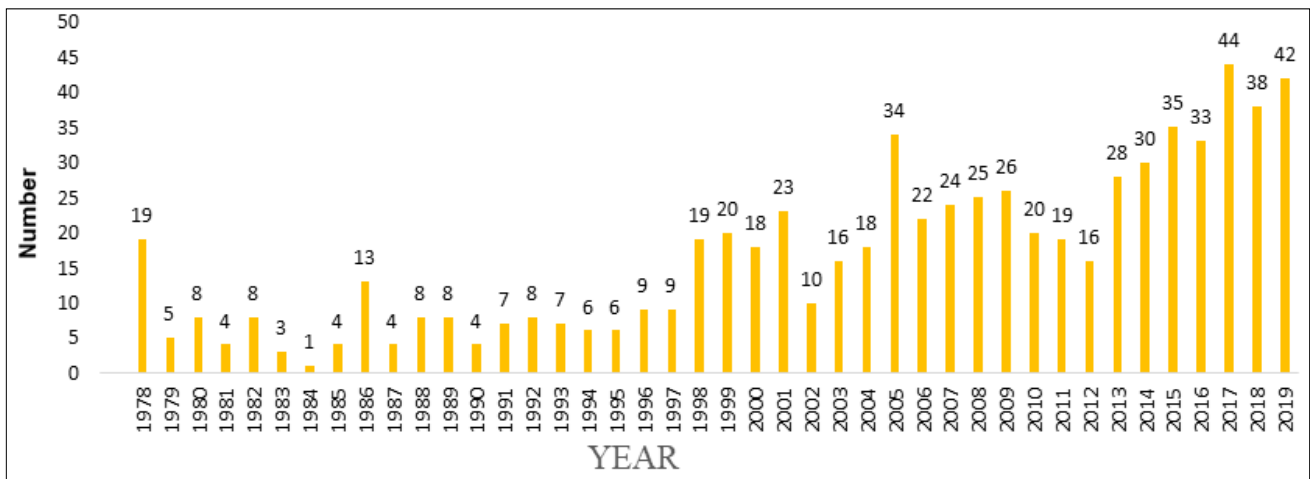


Figure 2(b).Yearwise Distribution of the Number of Districts affected by Acute Encephalitis Syndrome (AES) in Uttar Pradesh since 1978

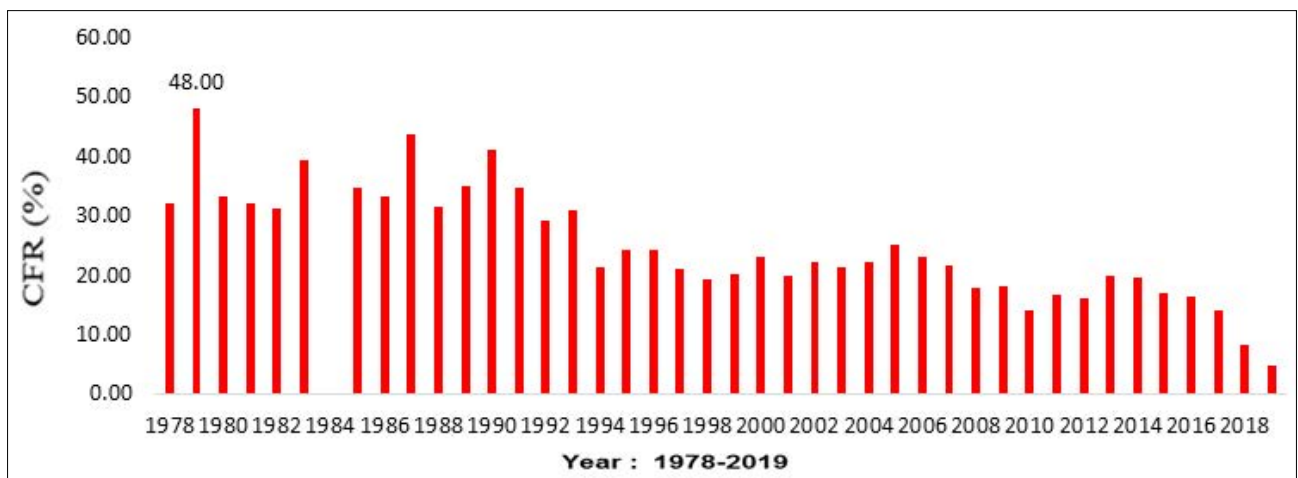


Figure 2(c).Case Fatality Rate (CFR) due to AES in Uttar Pradesh (%) since 1978

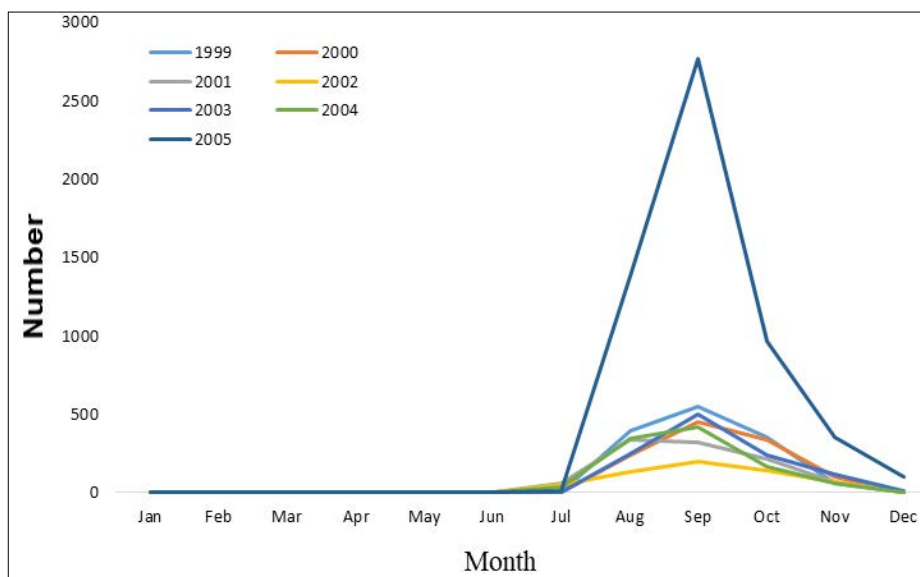


Figure 3(a).Monthwise Occurrence of JE cases from 1999-2005 in Uttar Pradesh

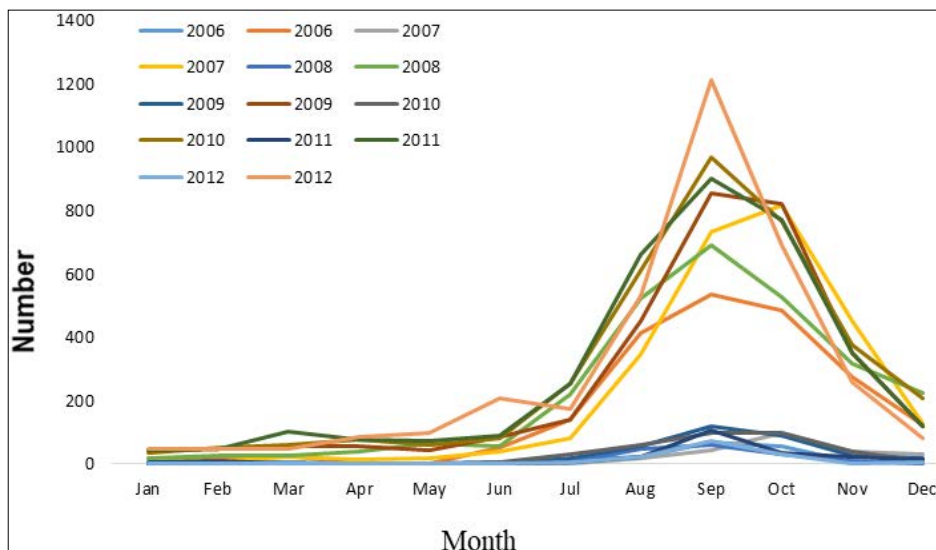


Figure 3(b).Monthwise Occurrence of AES cases from 2006-2012 in Uttar Pradesh

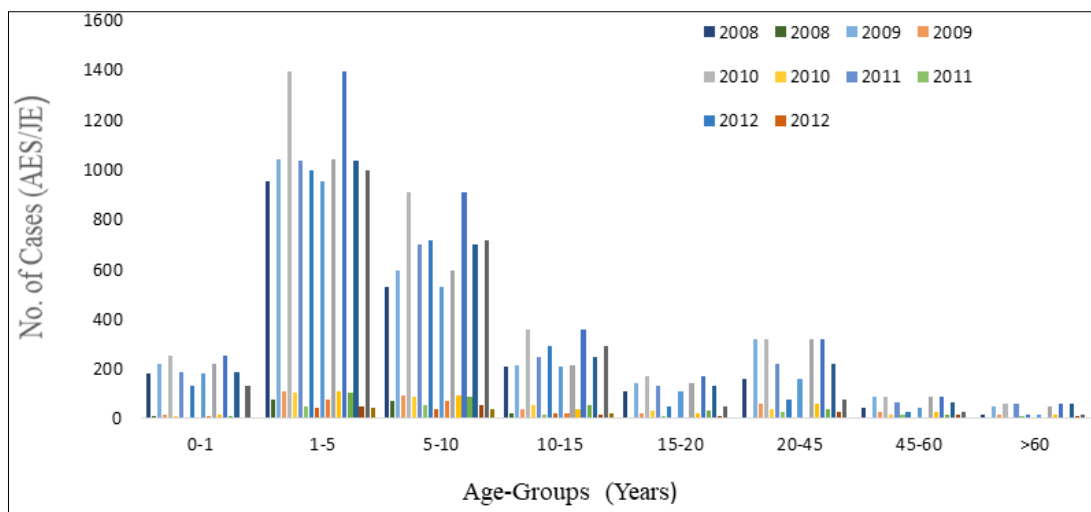


Figure 4.Occurrence of AES/ JE cases in Various Age Groups in Uttar Pradesh



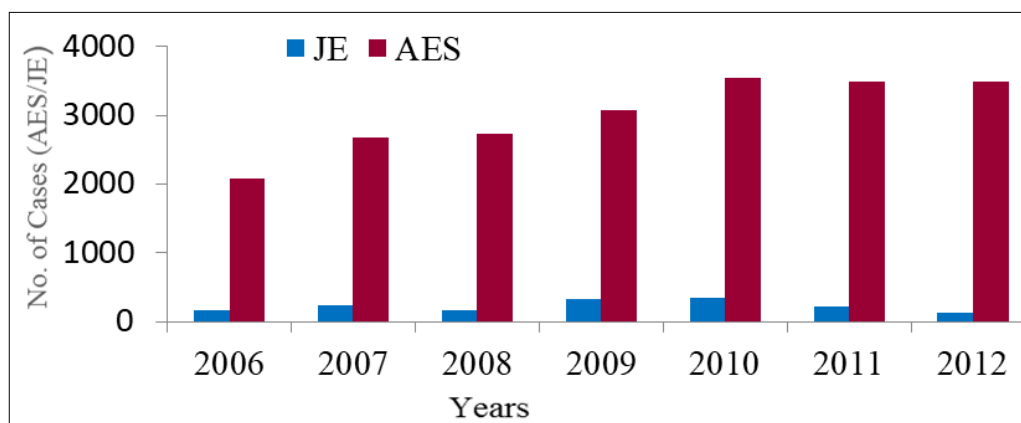


Figure 5. Prevalence of JE and AES after Institution of Intensified Diagnostic, Treatment, Preventive Intervention Measures through Inter-sectoral Coordination

Table I. Occurrence of AES/ JE Cases among Various Age Groups in Uttar Pradesh from 2008 to 2012

S. No.	Age Group (Years)	2008		2009		2010		2011		2012	
		AES	JE	AES	JE	AES	JE	AES	JE	AES	JE
1	0-1	181	8	217	16	253	10	186	4	133	2
2	1-5	954	76	1041	109	1395	102	1038	50	997	41
3	5-10	526	72	592	93	908	87	700	54	714	38
4	10-15	208	20	214	35	360	55	246	16	294	21
5	15-20	111	0	141	20	168	33	130	10	46	4
6	20-45	157	0	321	58	317	38	220	27	76	7
7	45-60	44	0	87	28	88	14	66	16	25	7
8	> 60	13	0	50	16	59	5	60	11	18	1
9	<b>Total</b>	<b>2194</b>	<b>176</b>	<b>2663</b>	<b>375</b>	<b>3548</b>	<b>344</b>	<b>2646</b>	<b>188</b>	<b>2303</b>	<b>121</b>
<b>Proportion of 1-15 years age group to total cases</b>		<b>76.93</b>	<b>95.45</b>	<b>69.35</b>	<b>63.20</b>	<b>75.05</b>	<b>70.93</b>	<b>74.98</b>	<b>63.83</b>	<b>87.06</b>	<b>82.64</b>

### Surveillance of Japanese Encephalitis (JE) Cases

The initial surveillance of Japanese Encephalitis (JE) was hospital-based when the cases of JE that approached treatment facilities available in the districts accounted to the credit of the disease. Since the epicentre of the disease was Gorakhpur, the cases of JE belonging to the neighbouring districts including Bihar and Nepal, were mainly treated at BRD Medical College, Gorakhpur. The persons reporting for treatment with suspected symptoms of JE were subjected to serological or CSF or both examinations. The samples collected from the patients were sent to the National Institute of Virology (NIV), Pune or National Centre for Disease Control (NCDC), erstwhile National Institute of Communicable Diseases (NICD), Delhi for confirmation of JE as the state did not have any JE testing facility. The reports of the samples were received from the respective institutes (NCDC & NIV) after a couple of weeks and based on the samples' positivity for JE, the persons related to the whole lot of samples were considered to be positive for JE

and it was presumed that the persons resembling such JE suspect persons will be considered and accounted for JE. However, more samples were sent for confirmation of JE during the transmission period of the disease. The death audit of JE patients had to be carried out by the state on the instructions of higher authorities. While making the death audit of the persons or seizures of JE for undertaking preventive intervention measures, it was noticed that JE seizures or victims history did not coincide with the typical symptoms of JE and the districts raised this objection before the authorities of BRD Medical College, Gorakhpur through state higher authorities.

As per the prevailing strategy and available medical and diagnostic resources, approximately 50% of the sera samples of 5581 seizure cases in 2005 were subjected for confirmation of JE MAC-ELISA test and out of these samples, only 1042 persons (36.99%) confirmed the presence of JE virus, which reflects that a major proportion of the cases are not due to JE but some other aetiological agents that

are causing encephalopathy among the community. This interpretation may stand true to the preceding years' cases too. The definition derived for AES holds appropriate to ensure the treatment of the seizures with encephalopathy manifestations, which are not attributable to JE. Thus, the definition of AES and availability of diagnostic tools together with institution of preventive and control facilities has led to a considerable decrease in the JE seizures, as is evident from Figures 1(a) and 5 but has widened the gap between AES & JE cases, as the number of AES cases has considerably increased and that of JE cases has declined (Figures 2(a) and 5). The observations also revealed that the seasonality of the occurrence of AES cases (Figures 3(a) and 3b) and the age groups affected (Table 1 and Figure 4) are similar to that of JE except for the occurrence of a few AES cases during the rest of the lean months of the year (January-June). Although the number of AES cases and the number of districts affected by it have increased (Figure 2(b)), but the mortality has come down to > 10% (4.72%) in 2019 (Figure 2(c)) and is less than the mortality due to JE (7.93%) during 2019 (Figure 1(c)). However, the proportion of JE to total AES has come down to 11.34%. The decline in mortality of AES cases is a great achievement of the state, when the aetiology of 60% AES cases is yet to be determined (Table 2) and efforts are being made in this direction. This decline in mortality, in AES as well as JE cases, has been possible due to the efforts of the state in coordinating the activities of different departments related to reducing the possible causes of encephalopathy, strengthening the diagnostic and treatment facilities and timely implementation of preventive measures, which are accounted as:

**Table 2. List of Aetiology found in AES Cases of Uttar Pradesh during 2019**

S. No.	List of Aetiology and related Data	No. of Cases
1.	Aetiology	
	Japanese Encephalitis	198
	Scrub Typhus	285
	Dengue	64
	Chikungunya	39
	Measles	3
	Varicella Zoster Virus (VZV)	2
	Herpes Simplex Virus (HSV)	1
	Mumps	1
	Typhoid	17
	Leptospirosis	1
	Multiple Causative Organism	86
2.	Total AES Cases	1746

3.	Total known aetiology	697
4.	Percentage of known aetiology in total AES cases	39.91
5.	Cases of unknown aetiology	1049
6.	Percentage of unknown aetiology in total AES cases	60.09

### Laboratory Diagnosis of AES/ JE Cases

In the early years of JE occurrence, the state lacked JE testing facilities. The persons reporting for treatment with suspected symptoms of JE were subjected to serological or CSF or both examinations. The samples collected from the patients were sent to the National Institute of Virology (NIV), Pune or National Centre for Disease Control (NCDC), erstwhile National Institute of Communicable Diseases (NICD), Delhi for confirmation of JE disease. A few weeks' time was required to receive the results from the respective laboratories. Now the state has strengthened its diagnostic facility by establishing JE sentinel laboratories (Table 3) in JE endemic district hospitals. This has enabled the state to take early decisions and actions towards the treatment line, which is of course symptomatic in both cases. On strengthening the diagnostic laboratories, 68%, 73%, 82.70%, and 90.82% sera samples of AES persons were tested in 2006, 2007, 2008 and 2009, respectively, out of which only 8.19%, 8.79%, 6.15% and 10.67% reflected positivity for JE in respective years. The JE prevalence to total AES cases from 2006 to 2019 has been depicted in Figure 6, which remains around deca (around 10) figure. The JE Kits for performing tests are supplied by the National Vector Borne Disease Control Programme (NVBDCP), Delhi (Government of India) on the demand of the state.

**Table 3. Updated List of JE Diagnostic Sentinel Laboratories in Uttar Pradesh**

S. No.	Name of the JE Sentinel Laboratory
<b>A.</b>	<b>Apex Laboratories</b>
1.	Grade-1 Virology Laboratory, KGMU Lucknow
2.	Microbiology Laboratory, SGPGL, Lucknow
3.	Field Unit of NIV Pune (now Regional Medical Research Institute) located at BRD Medical College, Gorakhpur
<b>B.</b>	<b>Regional Laboratory</b>
1.	Regional Laboratory, Swasthya Bhawan, Lucknow
<b>C.</b>	<b>Sentinel Laboratories</b>
1.	District Hospital, Balrampur
2.	District Hospital, Sitapur
3.	District Hospital, Lakhimpur Kheri

4.	District Hospital, Raebareli
5.	District Hospital, Basti
6.	District Hospital, Siddharthnagar
7.	District Hospital, Gorakhpur
8.	District Hospital, Deoria
9.	District Hospital, Mahrajganj
10.	District Hospital, Kushinagar
11.	District Hospital, Gonda
12.	District Hospital, Bahraich
13.	District Hospital, Faizabad
14.	District Hospital, Azamgarh
15.	District Hospital, Sant Kabirnagar
16.	District Hospital, Shravasti
17.	District Hospital, Hardoi
18.	District Hospital, Ballia
19.	District Hospital, Mau

### Treatment of AES/ JE Cases

In the early years of Japanese Encephalitis (JE) epidemics from 1978, JE cases were treated in the district hospitals and BRD Medical College, Gorakhpur. The cases were mainly brought to BRD Medical College, Gorakhpur. Limited treatment resources in the medical college and influx of a large number of cases from adjoining districts, states (Bihar) and countries (Nepal), sometimes resulted in overloading of the bed occupancy and unavailability of medical care provider staff. Keeping in view the transmission season of JE disease, the district hospitals and Community Health Centres (CHCs) were strengthened for the availability of beds, medicines, and medical care staff. CHCs were to work as Special JE treatment centres and Primary Health Centres (PHCs) had to provide first aid facility to the JE

patients until the end of the 2000AD and beginning of 2001. The state had established Encephalitis Treatment Centres (ETCs) in all the CHCs of AES/ JE affected districts. Paediatric Intensive Care Units (PICUs) and mini PICUs (Table 4) had been established and made functional with the availability of a working strength of ventilators in the hospitals/ CHCs of districts highly affected by AES/ JE in order to ensure early treatment of seizures at their doorstep.

Early diagnosis and prompt treatment have resulted in bringing down mortality in AES cases to 4.72% and in JE cases to 7.93%, which is very less in comparison to the prevailing average mortality due to AES and is a matter of credit to the state. The districts have also been provided with rehabilitation centres for physically impaired children with sequelae after treatment of AES/ JE cases.

### Preventive Intervention Measures

#### Anti-vector Measures

The occurrence of seizures with encephalopathy were all considered to be due to JE, which necessitated anti-vector measures and as such with the opinion of higher-level experts, two rounds of Indoor Residual Spray (IRS) with B.H.C.50% wdp at an interval of 60 days each, outdoor space spray with Malathion Technical (5.0%) and indoor space spray with pyrethrum (0.1%) along with personal protective measures were recommended. As a result of programme experts recommendation, the whole population of the highly affected districts, Gorakhpur, Maharajganj, Deoria, and Kushinagar was sprayed with B.H.C.50% wdp (active ingredient dose 0.2 g/metre<sup>2</sup>) in two rounds of 60 days each, which required a large quantity of the insecticide and other finances for equipment used in spray and payment of wages. The districts were also provided with vehicle-mounted and portable thermal fogging machines for outdoor space spray and atomisers or motorised machines for indoor space spray. Other less affected districts were also provided resources for IRS and space spray but not for the whole district.

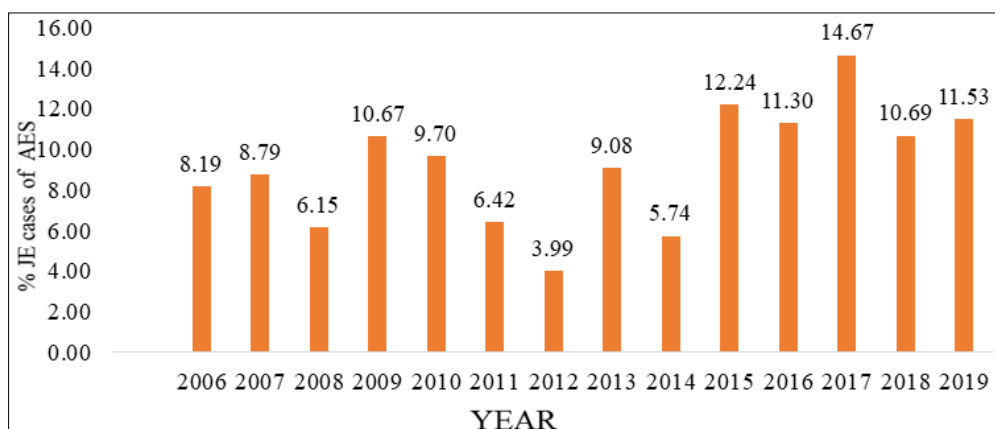


Figure 6. Proportion of JE Cases to AES Cases after Strengthening of Diagnostic Medical Care Facilities in Uttar Pradesh



**Table 4. Paediatric Intensive Care Units (PICUs) Established/ Functional with Number of Ventilators in the Hospitals of AES/ JE Affected Districts**

S. No.	Name of the District Hospital with PICU	No. of Functional Ventilators	
		PICU	Mini PICU
1.	Gorakhpur	17	03 in Chauri Chaura, 03 in Piprauli, and 03 in Gagaha
2.	Mahrajganj	15	03 in Nichloul and 03 in Ratanpur
3.	Deoria	15	03 in Rudrapur
4.	Kushinagar	10	03 in Captainganj and 03 in Hata
5.	Basti	15	03 in Haraiya, 03 in Gaur, and 03 in Kudraha
6.	OPEC Hospital, Basti	10	00
7.	Sant Kabirnagar	10	03 in Hainsar Bazar and 03 in Menhdawal
8.	Siddharthnagar	15	03 in Dumariyaganj and 03 in Bansi
9.	Bahraich	10	00
10.	Azamgarh	5	00
11.	Mau	5	00
12.	Gonda	5	00
13.	Hardoi	5	00
14.	Lakhimpur Kheri	10	00
15.	Raebareli	5	00
16.	Sitapur	5	00
	<b>Total</b>	<b>157</b>	<b>45</b>

Keeping in view the exophilic and exophagic nature of the JE vector belonging to the *Culex vishnui* group, it was considered to stop the use of IRS against the JE vector and undertake only focal spray in and around 50 houses, from where JE cases had been reported. The action was executed in 1995 as is evident from Table 5. The focal spray was performed with Malathion 25% wdp as the use of BHC 50% wdp was banned and provision for focal spray in the JE affected district was made accordingly. However, thrust was given for outdoor space spray (thermal fogging) with 5% solution Malathion Technical at fortnightly intervals during JE transmission season, for which 72 vehicle-mounted fogging machines were provided to the districts. After this, portable thermal fogging machines were arranged by the state and also supplied by NVBDC (erstwhile NAMP). The vector intervention measures are of utmost importance as the JE virus is found circulating in the environment reflecting > 10% JE seropositivity in the sera samples of 11 states collected from equines of 13 North Indian States. The stopping of IRS in the JE affected districts reflected no consequential adverse impact on the occurrence of the disease, thus saving huge resources to be utilised for other activities related to vector-borne diseases. Many districts have constructed fish hatcheries with the help of the fisheries department for the development of mosquito larvivorous fish, which are made available to the public for releasing them in water bodies in the vicinity of the human dwelling.

#### JE Vaccination

While preparing the action plan for prevention and control of JE in 1993, it was observed that children who are less than 15 years of age are more affected by JE. Thus, it was decided to saturate this age group by JE vaccination with inactivated mouse brain-derived vaccine manufactured by Central Research Institute (CRI), a prestigious institute of the Govt of India located at Kasauli (Himachal Pradesh), India. In a meeting of technical experts convened at Delhi on 19th April, 1993, it was decided to vaccinate the children of the age group of 5-10 years of districts highly affected by JE, Gorakhpur, Mahrajganj, and Deoria

**Table 5. Population of JE added Districts of Gorakhpur Division Sprayed with BHC 50% WDP in Two Rounds of 60 Days Each up to 1994 and thereafter with Malathion 25% wdp**

S. No.	District Sprayed	Population (in million) Sprayed								
		1993	1994	1995	1996	1997	1998	2000	2001	2006
1.	Gorakhpur	2.30	2.30	0.30	0.30	0.30	0.31	0.10	0.10	0.15
2.	Mahrajganj	1.50	1.50	0.30	0.34	0.34	0.32	0.10	0.10	0.15
3.	Deoria	4.00	4.00	0.50	0.41	0.20	0.20	0.10	0.10	0.15
4.	Kushinagar	With Deoria	With Deoria	With Deoria	With Deoria	0.20	0.30	0.10	0.02	0.15

(included district Kushinagar as it was undivided) keeping in view the availability of the vaccine in limited quantity. As per the schedule, the vaccine was to be administered to the children in two doses (each dose of 1.0 ml) at an interval of 7-14 days with a third booster dose after four weeks but within a year of the first dose. The vaccination was to be performed during inter-transmission period of JE and must be completed one month prior to the ensuing JE transmission period.

With the available quantity of the vaccine from CRI, Kasauli, the vaccination of children of the age group of 5-10 years was performed from 1993 to 1996 (Table 6). As is evident from Table 6, the available JE vaccine was quite inadequate in respect of the children belonging to 5-10 years of age group. Moreover, the vaccine was not provided timely to the state, as a result of which the vaccination performed was not expected to provide a positive epidemiological impact on the occurrence of JE cases. Though some children were protected from it despite being untimely vaccinated, others suffered from JE post-vaccination. CRI, Kasauli in later years could not supply the vaccine, as the vaccine was not manufactured and supplied due to administrative, technical

and financial issues, and consequently, vaccination of the children with this vaccine came to an end.

After the occurrence of the JE epidemic during 2005, the Govt of India and the State Govt decided to vaccinate children of the age group of 1-15 years highly affected by JE, with live attenuated JE vaccine SA-14-14-2 manufactured in China with the supply and administration support of PATH. All 34 districts affected during 2005 were considered for undertaking vaccination of children of the age group of 1-15 years in a phased manner from 2006 to 2009. Administration of the vaccine subcutaneously with a single dose was ensured and overall 95.55% coverage was achieved (Table 7).

Later on, both the Govt of India and the State Govt together decided to vaccinate the children of age group of 1-15 years of the highly affected by JE districts of Gorakhpur and Basti division with the IInd dose of this vaccine, SA-14-14-2, and accordingly, the vaccination was effected during 2010 and overall 99.03% coverage was achieved (Table 8). The technical aspect regarding the impact of administering the IInd dose of vaccine in 2010 at varied time intervals from the 1st dose from 2006 to 2009 yet needs to be ascertained.

**Table 6. JE Vaccination in Gorakhpur Division with Inactivated Mouse Brain-derived Vaccine**

S. No.	District	Year	No. of Children who were administered Vaccine			
			Ist Dose	IInd Dose	IIIrd Dose	Total
1.	Gorakhpur	1993	17512	8245	0	25757
		1994	7016	6360	3914	17290
		1995	38293	29306	10493	78092
		1996	29139	23214	6223	58576
	<b>Sub-Total (A)</b>		<b>91960</b>	<b>67125</b>	<b>20630</b>	<b>179715</b>
2.	Deoria (with Kushinagar)	1993	183809	135623	9014	328446
		1994	271059	251023	195300	717382
		1995	7669	6842	6441	20952
		1996	22118	19829	17187	59134
	<b>Sub-Total (B)</b>		<b>484655</b>	<b>413317</b>	<b>227942</b>	<b>1125914</b>
3.	Mahrajganj	1993	77629	71259	35102	183990
		1994	28897	25479	18742	73118
		1995	40215	33012	25629	98856
		1996	30100	24570	11491	66161
	<b>Sub-Total (C)</b>		<b>176841</b>	<b>154320</b>	<b>90964</b>	<b>422125</b>
4.	Total	1993	278950	215127	44116	538193
		1994	306972	282862	217956	807790
		1995	86177	69160	42563	197900
		1996	81357	67613	34901	183871
	<b>GRAND TOTAL (A + B + C)</b>		<b>753456</b>	<b>634762</b>	<b>339536</b>	<b>1727754</b>

Table 7. JE Vaccination in Gorakhpur Division with Live Attenuated JE Vaccine SA 14-14-2

S. No.	Districts	Year of Vaccination	Targeted Children (1-15 years)	Total Vaccinated Children	Total Coverage (%)
1.	Lakhimpur Kheri	2006	1183481	1218364	102.95
2.	Deoria	2006	1074219	1072683	99.86
3.	Gorakhpur	2006	1390307	1349047	97.03
4.	Kushinagar	2006	1095877	1085055	99.01
5.	Maharajganj	2006	778600	806996	103.65
6.	Sant Kabir Nagar	2006	542062	511417	94.35
7.	Siddharthnagar	2006	775934	792944	102.19
	<b>Sub-Total</b>	2006	<b>6840480</b>	<b>6836506</b>	<b>99.94</b>
8.	Ambedkarnagar	2007	764068	741354	97.03
9.	Bahraich	2007	990327	992254	100.19
10.	Balrampur	2007	623020	622963	99.99
11.	Barabanki	2007	1074154	1063815	99.04
12.	Basti	2007	774322	750262	96.89
13.	Gonda	2007	1040501	1045957	100.52
14.	Mau	2007	719800	691341	96.05
15.	Raebareli	2007	1058987	1029154	97.18
16.	Saharanpur	2007	1056185	923246	87.41
17.	Sitapur	2007	1385606	1312326	94.71
18.	Shravasti	2007	331903	326485	98.37
	<b>Sub-Total</b>	2007	<b>9818873</b>	<b>9499157</b>	<b>96.74</b>
19.	Azamgarh	2008	1400000	1402631	100.19
20.	Ballia	2008	1067337	1074655	100.69
21.	Faizabad	2008	649634	646847	99.57
22.	Sultanpur	2008	1234068	1230527	99.71
23.	Lucknow	2008	1506695	1479660	98.21
24.	Hardoi	2008	1270372	1297733	102.15
25.	Unnao	2008	1030843	1049428	101.80
26.	Bareilly	2008	1337392	1410208	105.44
27.	Muzaffarnagar	2008	1340236	1348320	100.60
	<b>Sub-Total</b>	2008	<b>10836577</b>	<b>10940009</b>	<b>100.95</b>
28.	Allahabad	2009	1948804	1684826	86.45
29.	Fatehpur	2009	913749	680895	74.52
30.	Pratapgarh	2009	1028331	974161	94.73
31.	Ghazipur	2009	1202355	1007125	83.76
32.	Jaunpur	2009	1546931	1376128	88.96
33.	Kanpur Nagar	2009	1660500	1227209	73.91
34.	Shahjahanpur	2009	953078	887219	93.09
	<b>Sub-Total</b>	2009	<b>9253748</b>	<b>7837563</b>	<b>84.70</b>
	<b>Grand Total</b>		<b>36749678</b>	<b>35113235</b>	<b>95.55</b>

**Table 8. Special JE Vaccination Drive in Gorakhpur Division with Live Attenuated JE Vaccine SA 14-14-2**

S. No.	District	Year of Vaccination	Targeted Children (1-15 years)	Total Vaccinated Children	Total Coverage (%)
1.	Basti	2010	807199	800812	99.21
2.	Deoria	2010	1074533	1076237	100.16
3.	Gorakhpur	2010	1458276	1451883	99.56
4.	Kushinagar	2010	1170549	1158539	98.97
5.	Maharajganj	2010	901624	878546	97.44
6.	Sant Kabir Nagar	2010	549482	529304	96.33
7.	Siddharthnagar	2010	829157	829411	100.03
	<b>Sub-Total</b>	<b>2010</b>	<b>6790820</b>	<b>6724732</b>	<b>99.03</b>

For protection from JE, the children less than 1 year of age were not vaccinated from JE vaccination since they were under maternal care, and later on, when they were between 1 and 2 years of age, they were covered for vaccination under routine universal immunization programme (UIP). Under this set-up, two doses of vaccine are being administered to children on fixed immunization days, 1st dose of vaccine at the age of 9 months and 2nd dose between the age of 16 and 24 months from April 2013 vide Ministry of Health & Family Welfare (Govt of India), Nirman Bhawan, New Delhi letter No. dated 26th March, 2013.

#### Social Mobilization of Community

In order to ensure public support in the execution of various activities, treatment, prevention and control of not only JE but AES too, various practices like inter-personal communication of health workers with community, drum beating, loudspeaker, posters, hoardings, handbills, and newspaper insertions were exercised with available limited resources in order to change and ensure the treatment-seeking behaviour of the public for their sufferings at the earliest and the nearest treatment centres/ hospitals to prevent mortality or sequelae due to AES/ JE.

National Disaster Management Authority (NDMA) took a serious note of the lack of awareness and participation of the community in reporting to nearby treatment centres for their suffering due to JE. The need of other public related departments like education, rural development, and panchayat raj institutions was felt important in addition to the medical and health department and as such NDMA with the support of state developed health education material (booklets, handbills, posters etc.). NDMA with the support of the Government of India and state government organised training of trainers (ToT) at the district level related to medical and health, education, rural development, panchayat raj institutions, civil defence etc

(Table 9), who in turn, trained the community at village level for mobilisation in order to ensure the earliest treatment at the nearest treatment centres/ hospitals to prevent mortality or sequelae due to AES/ JE, along with maintaining personal hygiene by ensuring proper hand wash prior to feeding and after defecation, only using deep bore water for drinking and stopping the use of shallow water hand pumps, keeping proper sanitation and not allowing stagnation of undue water collection in and around their dwellings, practising personal protective measures and using mosquito nets at the time of sleep to prevent mosquito bites.

Hon'ble Chief Minister of Uttar Pradesh is much devoted to the above acts through the dream project drive "DASTAK" carried out 2-3 times in a year for a fortnight or complete month in inter-transmission period. All the public representatives (MPs, MLAs and other local leaders) are expected to ensure participation in such drives in their own areas. This social mobilisation, collectively with other efforts, has paid a dividend in bringing down the mortality of AES as well as JE (< 10%).

#### Intersectoral Co-ordination

As discussed above, the personnel of other departments, education, rural development, panchayat raj institutions (PRI) and civil defence were involved in social mobilisation of the community. The fisheries department was involved in the development of rearing of mosquito larvivorous fish (*Gambusia affinis* or other indigenous fish) to prevent the breeding of JE vector mosquitoes.

The rural development and panchayat raj department supported in ensuring the availability of safe drinking water and construction of latrines to prevent open defecation, which consequently prevents the spread of infection. The work done by these departments has been furnished in Tables 10 and 11.

**Table 9. Training of Trainers for Social Mobilisation/ Awareness among Community against AES/ JE with the Support of NDMA, NVBDCP (Govt of India and State Government) Conducted during 2011-13**

S. No	Name of District	No. of Participants				Remarks
		Medical	Paramedical	Other Departments	Total	
1.	Gorakhpur	95	33	291	419	Nov. 2011
2.	Mahrajganj	90	135	118	343	May, 2012
3.	Deoria	87	146	124	357	May, 2012
4.	Kushinagar	70	140	129	339	May, 2012
5.	Basti	52	19	352	423	May, 2012
6.	Sant Kabir Nagar	69	53	93	215	May, 2012
7.	Siddharthnagar	21	21	138	180	May, 2012
8.	Bahraich	80	146	145	371	May, 2012
9.	Shravasti	75	163	148	386	May, 2012
10.	Gonda	70	155	139	364	May, 2012
11.	Balrampur	45	80	96	221	May, 2012
12.	Azamgarh	9	112	368	489	May, 2012
13.	Ballia	63	150	120	333	May, 2012
14.	Mau	47	130	159	336	May, 2012
15.	Lakhimpur Kheri	85	155	162	402	June, 2012
16.	Raebareli	96	161	138	395	March, 2013
17.	Sitapur	28	60	89	177	March, 2013
18.	Hardoi	30	43	37	110	March, 2013
19.	Kanpur Dehat	18	43	40	101	March, 2013
20.	Saharanpur	39	80	186	305	March, 2013
21.	Muzaffarnagar	43	78	82	203	March, 2013
22.	Barabanki	32	86	87	205	March, 2013
<b>Total</b>					<b>6674</b>	

**Table 10. India Mark II Hand Pumps installed in AES/ JE affected Districts by Jal Nigam**

S. No.	Name of District	No. of places provided for India Mark II pump installation	No. of places installed with India Mark II pump	No. of places left for installation of India Mark II pump
1.	Gorakhpur	593	593	0
2.	Mahrajganj	271	271	0
3.	Deoria	341	341	0
4.	Kushinagar	720	720	0
5.	Basti	109	109	0
6.	Sant Kabir Nagar	276	276	0
7.	Siddharthnagar	110	110	0
8.	Azamgarh	108	108	0
9.	Mau	174	174	0
10.	Ballia	175	175	0
11.	Gonda	84	84	0



12.	Balrampur	138	138	0
13.	Bahraich	173	173	0
14.	Shravasti	69	69	0
	<b>Total</b>	<b>3341</b>	<b>3341</b>	<b>0</b>

### Summary and Conclusion

An in-depth review of the situation of Japanese Encephalitis (JE) disease in Uttar Pradesh revealed that the disease is prevalent in the state since 1978, cases of which occur every year from July onwards coinciding with the monsoon period in the state, when the increase in water bodies provide congenial conditions for JE vectors. The epidemics have been observed at an interval of 10 years but the epidemic that occurred in 2005 was preponed (the estimated time was 2008). Until this time, all the cases with encephalopathy were treated due to JE on the basis of the test results of representative sera samples of patients positive for JE in some samples only but after the epidemic of 2005, clinical features and laboratory diagnosis of sera samples of 50% cases reflected only 37% positivity for JE. JE surveillance, therefore, aims to identify patients with AES and thereafter confirm JEV infection using IgM ELISA test. The state has fared well in the direction of strengthening the diagnostic and treatment facilities at the patient doorstep, establishment

of PICUs and mini PICUs with functional ventilator facility up to CHC level in JE affected districts, ensuring JE vaccination of children of 1-15 years age group with single-dose JE vaccine SA-14-14-2, manufactured in China and IIInd dose administered in 7 highly JE affected districts of Gorakhpur and Basti division after ample time lag. The JE vaccination of children of 1-2 years age group has been incorporated in the UIP programme. The anti-vector intervention measures are being conducted effectively and support from other departments is also being received. The collective efforts of all these departments have resulted in the reduction of 100% JE cases of AES till 2005 (lab. confirmed 36.99%) to 11.53% in 2019 (Figure 6) and subsequent reduction in mortality due to JE from 31.82% in 1978 and 48% in 1979 to 7.93% in 2019, which is a matter of credit to the state. Though the number of AES seizures and the number of affected districts have increased yet the mortality due to AES seizures has been brought down to 4.72% by performing aforesaid activities.

**Table II. Construction of Latrines/ Toilets in AES/ JE affected Districts by Panchayat Raj Department under Total Sanitation Programme**

S. No.	Name of District	Individual House Hold Latrines (IHHL)								
		BPL Families (A)			APL Families (B)			Total Families (A + B)		
		Targeted No.	Constructed	% Achievement	Targeted No.	Constructed	% Achievement	Targeted No.	Constructed	% Achievement
1.	Gorakhpur	211033	210993	99.98	280101	202339	72.24	491134	413332	84.16
2.	Mahrajganj	145090	144753	99.77	111256	90142	81.02	256346	234895	91.63
3.	Deoria	181225	171213	94.48	198893	165696	83.31	380118	336909	88.63
4.	Kushinagar	287089	234042	81.52	160033	145406	90.86	447122	379448	84.86
5.	Basti	160480	128134	79.84	120653	82793	68.62	281133	210927	75.03
6.	Sant Kabirnagar	121112	90642	74.84	227284	104716	46.07	348396	195358	56.07
7.	Siddharthnagar	139597	123643	88.57	133650	111651	83.54	273247	235294	86.11
8.	Azamgarh	186141	158907	85.37	466925	245710	52.62	653066	404616	61.96
9.	Mau	133766	108377	81.02	73752	57985	78.62	207518	166362	80.17
10.	Ballia	172179	167490	97.28	138937	124522	89.62	311116	292012	93.86
11.	Gonda	138500	117865	85.10	198080	140587	70.97	336580	258452	76.79
12.	Balrampur	65273	63529	97.33	136410	84121	61.67	201683	147650	73.21

13.	Bahraich	284073	226430	79.71	174857	165679	94.75	458930	392109	85.44
14.	Shravasti	104902	97449	92.90	54772	41761	76.25	159674	139210	87.18
15.	Raebareli	190306	190430	100.07	135862	124312	91.50	326168	314742	96.50
16.	Sitapur	305299	273463	89.57	255574	185138	72.44	560873	458601	81.77
17.	Lakhimpur Kheri	73000	93314	127.83	124463	124463	100.00	197463	217777	110.29
18.	Hardoi	199989	199989	100.00	231215	211279	91.38	431204	411268	95.38
19.	Kanpur Dehat	126650	121150	95.66	117436	86598	73.74	244086	207748	85.11
20.	Saharanpur	49458	49458	100.00	192771	184011	95.46	242229	233469	96.38
	<b>TOTAL</b>	<b>3275162</b>	<b>2971271</b>	<b>90.72</b>	<b>3532924</b>	<b>2678909</b>	<b>75.83</b>	<b>6808086</b>	<b>5650179</b>	<b>82.99</b>

S. No.	Name of District	Sanitary Complex for Women (SCW)			School Toilets			Anganwadi Toilets		
		Targeted No.	Constructed	% Achievement	Targeted No.	Constructed	% Achievement	Targeted No.	Constructed	% Achievement
1.	Gorakhpur	121	121	100.00	6036	6036	100.00	1823	1823	100.00
2.	Mahrajganj	55	55	100.00	2956	2956	100.00	1461	1461	100.00
3.	Deoria	39	31	79.49	4696	4696	100.00	1461	1461	100.00
4.	Kushinagar	25	25	100.00	5120	5120	100.00	2133	2133	100.00
5.	Basti	40	26	65.00	3695	3695	100.00	2223	2223	100.00
6.	Sant Kabirnagar	35	35	100.00	2368	2368	100.00	991	991	100.00
7.	Siddharthnagar	50	50	100.00	4128	4128	100.00	1481	1481	100.00
8.	Azamgarh	87	87	100.00	4888	4888	100.00	4101	4101	100.00
9.	Mau	13	13	100.00	2494	2494	100.00	1090	1090	100.00
10.	Ballia	115	120	104.35	4636	4636	100.00	1888	1888	100.00
11.	Gonda	16	16	100.00	4298	4298	100.00	2031	2031	100.00
12.	Balrampur	18	18	100.00	2948	2948	100.00	1215	1215	100.00
13.	Bahraich	10	10	100.00	6100	6100	100.00	1802	1802	100.00
14.	Shravasti	10	10	100.00	1838	1838	100.00	650	650	100.00
15.	Raebareli	25	25	100.00	5809	5809	100.00	1860	1860	100.00
16.	Sitapur	25	25	100.00	7397	7397	100.00	2307	2307	100.00
17.	Lakhimpur Kheri	20	20	100.00	8355	8355	100.00	1930	1930	100.00
18.	Hardoi	5	5	100.00	8478	8478	100.00	1978	1978	100.00
19.	Kanpur Dehat	60	60	100.00	3536	3536	100.00	1149	1149	100.00
20.	Saharanpur	25	25	100.00	3766	3766	100.00	1720	1720	100.00
	<b>Total</b>	<b>794</b>	<b>777</b>	<b>97.86</b>	<b>93542</b>	<b>93542</b>	<b>100.00</b>	<b>35294</b>	<b>35294</b>	<b>100.00</b>

Proper sanitation, avoidance of open-air defecation and safe drinking water supply are being ensured from other departments' support and the aetiology of 60% AES is

undetermined, which will be worked out in forthcoming time.

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**Conflict of Interest:** None

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