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# Research Article for Special Issue on Public Health and Epidemiology Analysis of Acute Encephalitis Syndrome AES/Japanese Encephalitis Epidemic in Bihar in 2011

*[1]Ragini Mishra, [2]Ganga Kumar, [3]Prashant Soni,*
*[4]Prashant Kumar and [5]Prabhat Pandey*

[1]State Epidemiologist, State Health Society, Govt. of Bihar, India
[2]MD Bihar State Building Construction Corporation-Cum- Special Secretary,
Building Construction Departmen, Govt. of Bihar, India
[3]District Improvement Coordinator (RMNCH+A), Delhi USAID ASSIST Project, Delhi, India
[4]District Epidemiologist, District Health Society, Patna, Govt. of Bihar, India
[5]State Consultant Social Development, NVBDCP, Govt. of Bihar, India

**Abstract:** Japanese Encephalitis (JE) is caused by a virus which is transmitted through the bite of infected mosquitoes (*Culex tritaeniorhyncus and Vishnui*) and is one of the common causes of AES. The main reservoirs of the JE virus are pigs and water birds and in its natural cycle, virus is maintained through certain mosquito species in these animals. Man is accidental host and does not play a role in JE transmission. Epidemiological, Entomological and Environmental studies were carried out. Epidemiological observations showed that the disease outbreak continued till 5 long months when 1071 cases were reported, Case Fatality Rate was 18.95. The incidence of the disease outbreak inorder of severity was Gaya>Patna>Saran (Chapra), Age group 5-9 was the most affected group and in almost all the patients fever and altered sensorium was the most prominent clinical feature. entomological observations included study of vectors prevalent and effect of fogging on vector density,results confirmed the presence of *Culex tritaeniorhynchus* and established that fogging was effective in reducing vector density, environmental and sociological observations results showed that the affected population belonged to lower socio-economic strata, with most of the houses being semi-pucca/kutcha category. Majority of the affected population were illiterate and unaware about the cause of the disease. Awareness regarding disease control and prevention was also very less. The present study based on above findings suggests possible strategies to prevent such future outbreaks in the State. The study would also help us to plan out the strategies for control of the disease and evaluate the success of intervention method (fogging in this case).

**Key words:** Japanese Encephalitis · Epidemic · Culex tritaeniorhyncus and Vishnui

## INTRODUCTION

Japanese Encephalitis (JE) is caused by a virus which is transmitted through the bite of infected mosquitoes (*Culex tritaeniorhyncus and Vishnui*) and is one of the common causes of AES [1]. The main reservoirs of the JE virus are pigs and water birds and in its natural cycle, virus is maintained through certain mosquito species in these animals. Man is accidental host and does not play a role in JE transmission [2-4]. As per WHO, AES is defined as acute onset of fever and a change in mental status including symptoms such as confusion, disorientation, or inability to talk and/or new onset of seizures excluding febrile convulsions in a person of any age at any time of year [5]. Japanese encephalitis (JE) has been prevalent in various countries of East and South-East Asia since long. In India, JE virus activity was, however, first detected in 1952 through sero-epidemiological surveys in Nagpur district of Maharashtra and Chingleput district of Tamil Nadu. Japanese encephalitis as a disease was first reported in 1955 when cases of JE occurred in Vellore and Pondicherry in southern India [6]. Control of JEV is achieved through human and/or swine vaccination,

**Corresponding Author:** Ragini Mishra, State Epidemiologist, State Health Society, Govt. of Bihar, India.

changes in animal husbandry, mosquito control, or a combination of these strategies. This review outlines the ecology of JE vector and examines the recent expansion of Japanese Encephalitis in Bihar [7-8]. The present study was carried out to analyze the epidemic due to AES/JE in Bihar in 2011.Epidemiological, Entomological and Environmental investigations were carried out to ascertain the reasons of this epidemic and to plan out the strategies for its control in future.

## MATERIALS AND METHODS

Standardized clinical case definition for AES and case records of these patients were analyzed in detail and data recorded for history, examination and investigation. Lab confirmation of JE IgM antibodies done in acute stages of AES patients either in serum or serum and CSF samples was also analyzed. Number of LAMA (Leaving against Medical Advice) patients was also analyzed. Data of last 6 years was used to compare the disease with present year to estimate the disease burden. Descriptive analysis on the basis of Time, Place and Person was done to understand the details of affected population. Entomological investigations based on adult and larval survey was done to understand the vector species prevalent in the area and their density as well as potential breeding sites. Post fogging, vector density was also assessed. 3 PHCs with 1 village/place each, where fogging was done (experimental) and other places/tolas in the same or adjacent village where fogging was not done (control) was surveyed for vector presence and density and determine the impact of fogging. PHC Manpur, Wazirganz and Tankuppa, (Gaya district) were selected for this survey. Environmental investigation, knowledge, attitude and practices of the community were analyzed as per pre-planned questionnaire. Epidemiological studies are based on data collected from Patna Medical college and Hospital (PMCH, Patna) and Anugrah Narayan Medical College and Hospital (ANMCH, Gaya), detailed analysis as well as questionnaire on clinical signs and symptoms with the patients and their relatives admitted in the above hospitals. Entomological studies are based on mosquitoes collected by Hand collection, Suction Tube method and aspirator torch in indoors and outdoors in Cattle shed, Mixed Dwellings and Human Dwellings during dusk hours. Larval density was calculated by using sauce pan and density calculated as per dip. The objective before the pre spray (fogging) was to ascertain different vectors prevalent in the areas affected and post spray (fogging) was to measure the efficacy of fogging (in terms of Per Man Hour Density). Per Man Hour Density was calculated by formula: PMHD=Nx60/TxP, where N=No. of mosquitoes collected; T=Time spent in min; P=No. of persons involved in collection. Environmental and sociological studies are based on standard pre- planned questionnaire and interview with the patients and their relatives admitted in PMCH, Patna and ANMCH, Gaya as well as community members residing in affected villages.

## RESULTS AND DISCUSSION

Data of past 5 years of AES/JE was also collected and analyzed for Gaya district and Bihar state. The outbreak of AES/JE continued till 5 long months. The index case was recorded on 27$^{th}$ July and disease outbreak was over by 31$^{st}$ December 2011. The disease spread its foci to 31 districts in Bihar. The disease has been prevalent in Gaya since past 4 years except in 2010 in which no single of AES/JE was recorded. (Table1). Status of AES/JE in Bihar is given in (Table 2). Town Block/Gaya Sadar (42 cases) was most affected followed by Barachatti (21 cases) and Wazirganj PHC (20 cases) in Gaya. From Gaya district alone 307 cases and 64 deaths were recorded. Overall, 1071 cases (including cases from other states Jharkhand (48), Orissa (1), MP (1) and UP (2) and 203 deaths were reported from 27th July to 31st Dec 2011 from various districts of Bihar. Case Fatality Rate/100 during the outbreak period from Bihar was 18.95 Clinical profiles of the affected patients showed that fever and altered sensorium was present in 1005 of the cases while 90% had seizures (Figure 1). Serological results showed that total 18% of the Suspected JE/AES cases were IgM positive for JE in Bihar. Out of this, 18% of the Suspected JE/AES cases were IgM positive for JE in PMCH, Patna while it was 16.82% in ANMCH, Gaya (Table 3). Specific age group who suffered most from the disease are as follows: 5-9> 10-14>0-4 and males were slightly more affected with the disease than females (Table 4). Highest incidence of AES/JE in order of severity in different districts of Bihar are as follows: Gaya>Patna>Saran (Chapra)>Aurangabad>Jahanabad>Nalanda>Nawada.map wise distribution of the cases have been represented in (Figure 2). Peak of the outbreak occurred b/w 25$^{th}$ September to 4$^{th}$ October 2011 when 226 cases were reported from various districts of Bihar. Total 78 LAMA patients (approx) could be traced. One LAMA patient from PMCH, Patna was traced for outcomes during which it was found that he died while way back to Jamui. Many 1others, as per information, who were treated for AES/JE

Table 1: AES/JE cases and deaths in Bihar, 2005-2011 (upto 8 November 2011)

| Year | Cases | Deaths | CFR (%) |
|---|---|---|---|
| 2005 | 192 | 64 | 33.3 |
| 2006 | 21 | 3 | 14.3 |
| 2007 | 336 | 164 | 48.8 |
| 2008 | 198 | 46 | 23.2 |
| 2009 | 363 | 99 | 27.3 |
| 2010 | 97 | 17 | 17.5 |
| 2011 | 794 | 168 | 21.2 |
| Total | 2001 | 561 | 28.0 |

Table 2: AES/JE cases and deaths in Gaya district, 2007-2011

| Year | Cases | Deaths | CFR (%) |
|---|---|---|---|
| 2007 | 134 | 10 | 7.5 |
| 2008 | 141 | 23 | 16.3 |
| 2009 | 112 | 33 | 29.5 |
| 2010 | 0 | 0 | 0 |
| 2011 (upto 22 Nov) * | 271 | 58 | 21.4 |
| Total | 658 | 124 | 18.8 |

Table 3: AES cases according to Serology for JE IgM (from 23 July 2011 to 31st Dec 2011)

| Name of Hospital | JE IgM Positive | JE IgM Negative | Total Suspected JE/AES | No. of LAMA Patients | Total death due to JE | Total death due to AES/Suspected JE(negative death) |
|---|---|---|---|---|---|---|
| PMCH,Patna (till 31st Dec 2011) | 120(18%) | 529(82%) | 649 | 46 | 12 | 110 |
| ANMCH,Gaya (till 31st Dec 2011) | 71(16.82%) | 351 (83%) | 422 | 32 | 9 | 93 |
| Total | 191(18%) | 730 | 1071 | 78 | 21 | 203 |

Table 4: Table showing Age group and Sex most affected with AES/JE during outbreak period (27th July-31st Dec ) in 2011

| | | Sex | |
|---|---|---|---|
| Age group | Frequency | | |
| 0-4 | 280 | Male | Female |
| *5-9 | 445 | 612 | 454 |
| *10-14 | 310 | | |
| *15-19 | 10 | | |
| *20 and above | 14 | | |

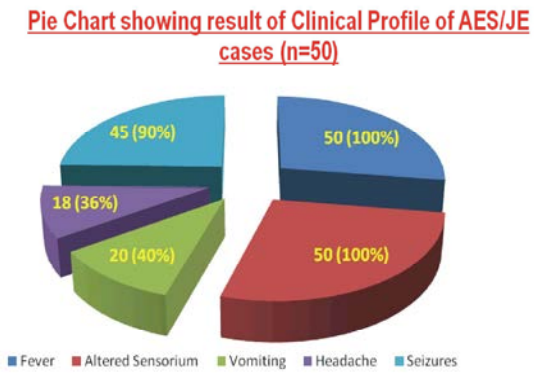



Fig. 1: Clinical Profile of AES/JE patients from PMCH, Patna & ANMCH, Gaya

suffered from several types of neurological derangement. In almost all the patients, fever and altered sensorium was the most prominent clinical feature Most of the villages visited were rural agricultural areas. Paddy fields were present in majority. Most of the Paddy fields had dried during second visit in November. Pig and cattle population was also high in the areas affected. Different species of mosquitoes were collected from above indoor habitats during dusk hours. Pre-Spray per man hour density of Culex, Anopheles and Aedes was: 28, 19 and 15 respectively. So, the overall Per Man Hour Density in order of prevalence are: Culex>Anopheles> Aedes (Table 5). Maximum number of collection was found in the following sites: Cattle shed >Mixed dwellings>Human dwellings. For larval survey, collection from breeding


Fig. 2: Map: Case distribution of AES/JE in various districts during outbreak period in 2011 in Bihar

Table 5: Results of Entomological survey for adult mosquito species prevalent in the affected villages and their Per Man Hour Density. (Pre-spray) during the epidemic.

| | Indoor | | | | Outdoor |
|---|---|---|---|---|---|
| Name of the species | HD | CS | MD | PMHD | PMHD |
| Culex | 4 | 12 | 12 | 0.47 | * No collection could be done |
| Anopheles | 5 | 8 | 6 | 0.32 | |
| Aedes | 8 | 2 | 5 | 0.25 | |

Table 6: Results of Entomological survey for Larval species prevalent in the affected villages, their breeding habitats and their density per dip. (Pre-spray)

| Details of Mosquito Breeding sites | No. Checked | No. found positive | Density/Dip(3 dips done) | Name of the species identified |
|---|---|---|---|---|
| Paddy field | 4 | 3 | 8 | Culex Anopheles |
| Cattle feeding containers | 5 | 5 | 16 | Aedes Culex |
| Household water containers | 10 | 4 | 6 | Aedes Anopheles |
| Pots/vases | 5 | 1 | 3 | Aedes |
| Coconut/Palm Shells | 10 | 4 | 2 | Aedes |

Table 7: Assessment of Fogging in terms of Per Man Hour Density of mosquitoes from affected/experimental (where fogging done) and control (where fogging not done)

| Per man hour density | | | | | | Per man hour density | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Experimental | | | | | | Control | | | | | |
| Places where fogging done | PHC Manpur, Place: Masautha Kurd | | | | | Place where fogging not done | PHC Manpur, Place: Masautha Kala | | | | |
| | Indoor | | | | Outdoor | | Indoor | | | | Outdoor |
| Mosquito species | HD | CS | MD | PMHD | PMHD | Mosquito species | HD | CS | MD | PMHD | PMHD |
| Culex | 0 | 2 | 1 | 3 | 2 | Culex | 5 | 6 | 8 | 19 | 6 |
| Anopheles | 0 | 1 | 1 | 2 | 0 | Anopheles | 3 | 5 | 2 | 10 | 2 |
| Aedes | 0 | 0 | 0 | 0 | 0 | Aedes | 0 | 0 | 0 | 0 | 0 |

Table 7: Continue

| Per man hour density — Experimental | | | | | | Per man hour density — Control | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Places where fogging done | PHC Wazirganz, Place: Punama | | | | | Places where fogging not done | PHC Wazirganz, Place: Punama (certain harijan tolas/place) | | | | |
| | Indoor | | | | Outdoor | | Indoor | | | | Outdoor |
| Mosquito species | HD | CS | MD | PMHD | PMHD | Mosquito species | HD | CS | MD | PMHD | PMHD |
| Culex | 0 | 2 | 2 | 4 | 2 | Culex | 4 | 5 | 8 | 17 | 8 |
| Anopheles | 1 | 1 | 0 | 2 | 2 | Anopheles | 5 | 4 | 1 | 10 | 3 |
| Aedes | 1 | 0 | 0 | 1 | 0 | Aedes | 0 | 0 | 0 | 0 | 0 |
| Per man hour density — Experimental | | | | | | Per man hour density — Control | | | | | |
| Places where fogging done | PHC Tankuppa, Place: Ramanpur | | | | | Places where fogging not done | PHC Tankuppa, Place: Ramanpur (certain interior tola/place) | | | | |
| | Indoor | | | | Outdoor | | Indoor | | | | Outdoor |
| Mosquito species | HD | CS | MD | PMHD | PMHD | Mosquito species | HD | CS | MD | PMHD | PMHD |
| Culex | 0 | 1 | 1 | 2 | 1 | Culex | 3 | 5 | 7 | 15 | 5 |
| Anopheles | 0 | 0 | 1 | 1 | 0 | Anopheles | 5 | 3 | 3 | 11 | 3 |
| Aedes | 0 | 0 | 0 | 0 | 0 | Aedes | 0 | 0 | 0 | 0 | 0 |

Table 8: Results of Environmental and Social Awareness, Knowledge, Attitude and Practice

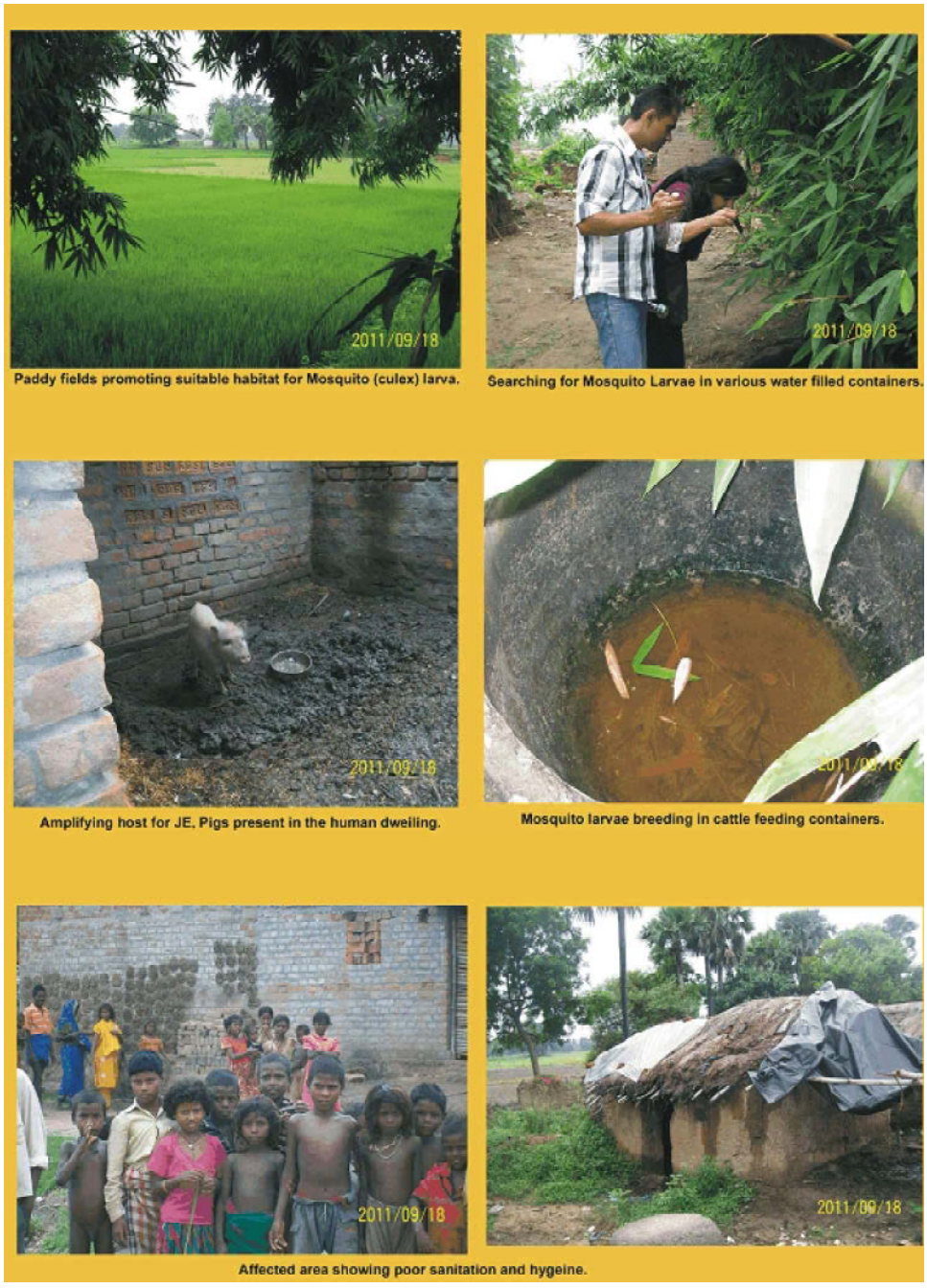
| Socio-demographic characteristics of respondents (100approx) | | |
|---|---|---|
| Characteristics | Male n=40 | Female n=60 |
| Age (years) | | |
| 18-30 | 15 | 25 |
| >30 | 25 | 35 |
| Educational status | | |
| Literate | 12 | 5 |
| Illiterate | 28 | 55 |
| Occupation | | |
| Working | 30 | 10 |
| Non working | 10 | 50 |
| Family Type | | |
| Nuclear | 25 | 50 |
| Joint | 15 | 10 |
| Type of House | | |
| Pucca | 10 | 10 |
| Semi-Pucca/Kutcha | 30 | 50 |
| Water Supply | | |
| Safe | 5 | 15 |
| Unsafe | 35 | 45 |
| Waste disposal | | |
| Compost pits | 10 | 25 |
| Covered pits | 0 | 0 |
| Throwing discriminately | 30 | 35 |
| Drainage | | |
| Open | 35 | 55 |
| Underground | 0 | 0 |
| Soakage pits | 5 | 5 |

Table 9: Table showing Awareness and knowledge regarding selected mosquito borne diseases

| Characteristics | No. of respondents (n=100 approx) |
|---|---|
| Sources of information | |
| TV | 20 |
| Radio | 30 |
| Newspapers | 5 |
| Health Care Providers | 10 |
| Others | 35 |
| Serious problem in area | |
| Yes | 95 |
| No | 5 |
| Breeding places | |
| Ditches | 40 |
| Ponds | 2 |
| Vehicle tyres | 0 |
| Stagnant Water | 50 |
| Coconut shells | 0 |
| Others | 8 |
| Causative agents | |
| Mosquito bite | 70 |
| Drinking dirty water | 8 |
| Overwork/sun exposure | 6 |
| Food | 0 |
| Others | 6 |
| Don't know | 10 |
| Disease transmitted by mosquitoes | |
| Malaria | 65 |
| Dengue | 15 |
| Chikungunya | 3 |
| Filaria | 10 |
| Others | 4 |
| Don't know | 3 |
| Control measures | |
| Environmental | 15 |
| Chemical | 75 |
| Biological | 5 |
| Integrated | 0 |
| Don't know | 5 |

areas like Paddy field, cattle feeding containers, other water containers and pots were searched. Both Culicine as well as Aedine larvae could be identified. Density per dip was maximum in cattle feeding containers > paddy field> other water containers > pots (Table 6). The PMHD of mosquitoes, post fogging decreased significantly when compared with places/tolas which did not undergo fogging. (Table 7). Most of the affected population belonged to low socio-economic strata, with most of the houses being Semi -Pucca/Kutcha category (Table 8). In Gaya, majority belonged to Mushar community. Majority of them were illiterate and unaware of the cause of the disease. Awareness regarding disease control and prevention was also very less (Table 9).

Pictures of field visit



## CONCLUSION

Overall, 1071 cases and 203 deaths were reported from 27th July to 31st Dec 2011 from various districts of Bihar. Overall Case Fatality Rate/100 from Bihar due to AES/JE was 18.95. Highest incidence (per 1000 population) of AES/JE in order of severity in different districts are as follows: Gaya>Patna> Saran (Chappra) > Aurangabad > Jehanabad>Nalanda>Nawada. Culex tritaeniorhynchus (vector of JE) was identified in the affected area and the serological results confirmed the Japanese Encephalitis outbreak in the region. Fogging was found to be effective. Information, Education and Communication (IEC) and Behaviour Change Communication (BCC) activities along with increased surveillance, proper case management and inter-sectoral coordination would prove fruitful to prevent such future outbreaks.

**Recommendations:**

- Since outbreak due to Vector Borne Diseases including new ones like Dengue in (2010) and Chikungunya (2011) are increasingly becoming common in Bihar, anticipatory preparations should be made for timely availability of medicines, equipments etc.
- More number of Health Facilities should be identified for clinical management of AES/JE cases which should ensure the availability of necessary drugs, IV fluids and equipments before the onset of JE transmission season.
- District and Block Rapid Response Team (RRT) should be activated for investigation and containment of the outbreak. This should include the Animal Husbandry Department as well.
- Primary Health Centres (PHCs) should also be made well equipped to manage any outbreak. For this Technical Malathion, fogging machines, health education materials, preliminary lab investigation and transportation of cases to referral centres should be made available before the transmission season.
- Vector and larval surveillance should be carried out throughout the year to map the vector density and larval breeding sites.
- Case management through early diagnosis and prompt treatment must be done. Camp based approach for active case search of AES/JE must be undertaken.
- Vaccination of susceptible population should be carried out on urgent basis at least before the transmission season (post monsoon) in this case.
- Awareness of Community through IEC, IPC and BCC must be done for success of intervention methods.
- Surveillance system must be strengthened and data analysis work should be carried out on regular basis to generate the Early Warning Signals of diseases. Coordination and data sharing between District Surveillance Unit and District Programme officers of Disease Control Programmes must be done on regular basis to contain outbreaks. Every single case of AES/JE should be reported immediately to the higher authority to prevent outbreak.
- All districts adjoining the districts where a case of JE/AES has been recorded should be made alert and an eye on all the AES cases should be kept for timely referral and cases management.
- Fogging should be carried on a regular basis to reduce vector density which in turn would automatically reduce the appearance of cases.

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