CHAPTER 6
Dealing with Biological Outbreaks: A Case Study of the Plague (1994) and Dengue

India has been dealing with biological outbreaks including the plague, dengue and chikungunia; for the purpose of this study, India’s response to dealing the plague outbreak in 1994 and repeated outbreaks of dengue have been taken as case studies.

The rationale for taking these two as a case study include the following: first, though there is not much material available on biological outbreaks in India, there is sufficient literature on these two cases with the information available as to how India handled them. Second, these two are chosen as a case study, for the difference in the places in which they have occurred; plague occurred in a rural and semi urban environment, while dengue outbreak in Delhi is taken for it represents an outbreak in an urban environment. Finally, plague is a bacterial outbreak, while dengue is viral.

The main aim of this chapter is to analyze how the Indian state handled the above two cases of biological emergency? How did various agencies involved in management of biological disaster perform? What were the lessons learnt from the crisis and how the experience gained could be utilized for the management of any similar case of biological emergency in future?

I
Plague in Beed and Surat (1994): A Case Study

India has faced outbreaks of Plague from a very long time. According to V Ramalingswami, India was one of the most severely affected countries of third pandemic

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1 Though doubts have been raised in certain quarters, whether the Surat epidemic is indeed plague, it has been widely agreed by the scientific community that it was indeed plague which hit Surat in 1994. For example, in 1999, Satnam Singh, a former programme director in the WHO office was quoted mentioning that the same disease which occurred in 1994 continues to appear sporadically even now in Surat, following periodical flooding of the Tapti river, an evidence disproving the plague theory. However, Vullimir Ramalingaswami, chairman of the committee that investigated the disease, was quoted refuting the claim and mentioned: “We have isolated the plague bacillus and the cultures are still available in the Gwalior laboratory if anybody wants to test.” See “Surat epidemic was not plague - Ex-WHO official,” *Indian Express*, 20 December 1999. Also see, “Was it really the plague in Surat?,” *The Tribune*, 25 May 2000.

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of plague which spread round the world with more than 12.5 million deaths reported between the years 1886-1950.\textsuperscript{2} However, post 1950, with the increasing availability of DDT and broad spectrum antibiotics, the transmission of plague was greatly curtailed and mortality severely reduced.

It is well known, though, that plague cannot be eradicated just as small pox was and poliomyelitis would hopefully be in the near future. It is disease of the earth, of the creatures that run and burrow the earth and of the fleas. Man is only an accidental victim and need not have plague infection for plague persistence. Between 1967 and 1993, there were reports of two separate outbreaks of plague, though neither of the incidents was confirmed as plague. In recent decades, plague has simply retreated to rural natural foci of infection, involving mostly wild rodents and fleas with occasional spillovers to commensal hosts and humans in villages and towns.

Between August and October 1994, India was struck by two outbreaks of plague in succession- one of suspected bubonic plague in the Beed district of the state of Maharashtra and the other of the suspected pneumonic plague in the Surat city of the state of Gujarat. In the mid August, the first warning signs of ratfall (domestic rats falling from the rafters onto the floors of the dwellings and dying there) and unusually high flea nuisance were reported in Mamla village of Beed district. This was followed by the people turning up to the health centers with tumors in their armpits and groins, a typical symptom of bubonic plague. By mid September, as much as 10% population of the village had developed the symptoms of bubonic plague.\textsuperscript{3}

By mid September 1994, government hospitals and private clinics in the city of Surat, in the neighboring state of Gujarat reported an increasing number of patients with highly fatal illness resembling acute pneumonia. On September 21, 1994, the Deputy Municipal Commissioner of health (DMCH) in Surat received information about the death of a


patient from chest complication that “seemed” to be a case of pneumonic plague. The DMCH immediately shared the information to his superiors and medical community in the area where the suspected plague victim resided was alerted. However, by later in the day, ten more deaths were reported among the residents of Ved Road, the locality in Surat city, from where the disease first surfaced and more than 50 people had been admitted in different hospitals of the city with serious illness.⁴

Once patients were identified, their family members were given prophylactic dose of tetracycline and their homes and surroundings were dusted with pesticide. The local community were explained about the seriousness of the situation with the request to report any case of suspected fever, blood stained sputum, breathlessness, chest pain, sore throat and persistent cough.

Rumors spread quickly that the deaths were the result of poisoning of city’s water supply. Citizens became concerned and communication lines were jammed by large number of telephone calls. Though the city administration tried their level best to calm the situation by sending vans fitted with public address system explaining people about the likely cause of deaths due to plague in the city and asking them not to panic and pay no heed to the rumors, there was extreme response from the public at large. Within hours, entire stock of tetracycline in the city and surrounding areas was depleted.⁵

By morning of September 22, 1994, exodus of people from the city had begun. Within two days, more than 300,000 residents deserted the city, which also included several doctors and members of paramedical staff. Check points were established at railway stations and airports in large number of cities across India to monitor incoming Surat inhabitants. Hospitals in various cities and towns were also alerted to receive plague infected patients, just in case the disease spread to new areas. In many cities, people

rushed to buy surgical masks, tetracycline and other drugs. As a precautionary measure, schools and places of public entertainment were closed by the administration. The incident of plague caused a huge financial loss to the economy of India. In Surat city alone the loss was estimated to be to the tune of US$ 260 million. In addition, various countries like UAE decided to stop agricultural import from India. This was a major setback to country’s export as UAE alone imported 500,000 tons of fresh fruit from India. The incident also resulted in loss of business sentiment in the country and also investor confidence from foreign investors. In London, Global Depository receipts (GDRs) crashed after BBC and CNN media agencies reported plague outbreak in India. Foreign travelers and tourists also suspended their visit to India, which hit tourism industry badly. Official tour of Mauritian minister for tourism to India was postponed. Though government offered foreign journalists and tour operators free travel and hospitality to assess the situation themselves, only very few responded. Plague related restrictions were imposed on Indian travelers by many countries. For example, Indians traveling to US from plague affected areas had to fill special forms upon arrival. Aircrafts were fumigated in many European countries like Italy and passengers were subjected to special health checks. In Moscow, authorities ordered six days quarantine for passengers from India. Advisory was issued by several countries against traveling to India whereas flights to India were banned by several airlines.

While anxiety was being displayed by the international community, the authorities in India did pretty little to calm the situation. There was clear confusion and lack of communication between the agencies involved in crisis management like health agencies, political leadership, bureaucracy and media. Health officials in Surat city declared plague epidemic before it was known that the plague was pneumonic one and the first isolates of plague pathogen were characterized by the experts. Daily statistics about suspected cases provided by the health agencies added to a mountain of information. Press statements by

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local politicians also added to the confusion. For example, the chief minister of Gujarat, at the time when the plague was considered to be at its peak, claimed that the plague in Surat was pneumonic and not bubonic, little realizing that the pneumonic plague is more infectious than the bubonic plague. The Union Health Ministry also did not do enough to calm the country’s or international community’s anxieties.

The local and international media also resorted to sensationalism and irresponsible reporting while covering the incidence. The number of people killed or sick due to plague were highly exaggerated. Many hearsay accounts and rumors were also carried in the media which only added to the anxiety among the people.

Plague in Beed and Surat, 1994: Understanding the Conditions leading to the Outbreak

Studies conducted in Mamla village of Beed district of Maharashtra, where Plague was first reported in August 1994, showed that after the earthquake of September 1993 in neighboring Latur and Osmanabad districts, the ecological conditions led to an outbreak of Plague.

In India, the pathogen bacteria *Yersinia pestis* survives in wild rat populations of *Tatera indica* and field rodent like *Bandicota bengalensis*, who act as natural hosts of the bacteria. The pathogen is transmitted by fleas which act as ectoparasites of the rodent. Among 76 species of flea recorded in India, the role of only three species viz. *Xenopsylla astia*, *X. brasiliensis* and *X. cheopis* is well recorded in plague transmission. The rodent-flea borne infections may remain in enzootic form with rare or accidental human transmission depending upon the extent of man-flea contact. Common domestic rat *Rattus rattus* is generally free from the pathogen and the only possibility of its becoming infected with the pathogen occurs when there is substantial contact of the domestic rat

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9 Ibid.
with the feral or field rodent or because of an ecological change, there is shift of one population of rats into another or intermixing of different rat populations is possible.\textsuperscript{10}

In Mamla village, it was found that the domestic biotope (\textit{R. rattus}) had direct ecological linkage with agro-climatic zone (\textit{B. bengalensis}) and feral (\textit{T. indica}). The chances of intermixing of rat populations became even greater after a large part of the village was abandoned after September earthquake and most of the village population relocated to new place outside the village in tin shelters. Another possible route of spillover of rodent-borne flea mediated infection from wild (feral) directly into the domestic biotope was by passive transmission of wild fleas (\textit{X. astia}) through grazing goats and cattle.\textsuperscript{11} According to another report, the outbreak of plague that occurred in Surat was pneumonic plague -- a highly contagious form of the disease that kills 100 percent of its victims if left untreated. Pneumonic plague is caused by the same disease organism that causes bubonic plague, but it infects the lungs rather than the lymph system. Since the disease invades the lungs, it can be transmitted to others in close physical contact through exhaled sputum droplets. Crowding and poor sanitation can provide ideal conditions for the spread of this type of plague.\textsuperscript{12}

The abandoned houses had substantial quantities of stored food grains, on which the domestic rats fed without human disturbance. The result was that there was gradual but persistent growth of \textit{R. rattus} population in the subsequent 8-10 months quiescent period as also \textit{X. cheopis}, their ectoparasite. It is because of this unrestricted growth of domestic rat and its flea, that unusual flea nuisance was seen in early August 1994. It is probable that the rat population growth which overshot its upper asymptote level sometimes in July-August 1994 resulted in shortage of space and at this juncture density dependent population controls, of which disease is an important component, operated on the rat population, leading to a rodent epizootic, mediated by the flea \textit{X. cheopis}. This resulted in


\textsuperscript{12} “The Black Death revisited: India's 1994 plague epidemic,” http://archive.wri.org/page.cfm?id=941&z=?
death of large number of susceptible individuals of the rat population, forcing their fleas to venture for alternate hosts, including humans.$^{13}$

In case of Surat, poor sanitation conditions in the town were believed to be the main reason which led to the outbreak of suspected plague during September-October 1994. Surat's sanitation problems then helped the rat population grow dramatically. Surat, a city of 2.2 million, generates close to 1,250 metric tons of garbage each day, 250 metric tons of which remain uncollected. To make matters worse, floodwaters inundated the city during the 1994 monsoon, particularly in low-lying slum areas near the river. Surat residents complain that nothing was done to remove the great piles of rubbish that remained after the floodwaters receded, offering an ideal habitat for rats.$^{14}$

Over the years, hundreds of thousands of poor people from surrounding rural areas has migrated to Surat city, which is a main centre for Silk, Diamond cutting and polishing, Chemicals and metal related industries. Most of the city’s 1.5 million work force inhabits just outside city limits, in squalid shanty towns and slums which usually have open sewers, tightly clustered shelters made of cement or plastic sheets.$^{15}$

It is not uncommon to find heaps of garbage including animal carcasses in these slums as well as pools of stagnant water which fills the alleys. The situation worsened in the first week of September 1994, when an unusually high Monsoon rains, which was a record in the past 25 years flooded the city and flood water remained stagnant for 5 days in most parts of Surat city. A large number of dead animals were found after the flood water receded.$^{16}$

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Such a setting is ideal for outbreak of an epidemic. Also the timing coincided with Ganpati festival which involves close intermingling of huge crowds of people. It is highly probable that workers from Maharashtra state who came to Surat for work or devotees celebrating Ganpati festival had already become infected with bubonic plague before they reached Surat. Living in crowded conditions in the slums of the city or huge numbers of people celebrating festival, without medical care or without the money to pay for medical treatment, untreated bubonic plague infections progressed systemically to plague pneumonia, resulting in rapid spread of person to person transmitted pneumonic plague.¹⁷

### 1994 Plague in India: How did the Government handle it?

The outbreak of plague in July–August 1994 led to the constituting a Technical Advisory Committee (TAC) by The Government of India on Plague on Oct 9, 1994, at a time when the outbreak had already been subsided.¹⁸ The main aim of the TAC was to elucidate factors responsible for the current outbreak of plague and its spread, to advise the strategies, policies and programmes for the control of plague and to recommend steps for prevention of such outbreaks in future.

As TAC initiated its work, it first tried to address the ongoing controversy in the media and professional circles as to whether the epidemic was infect Plague. Since the outbreak had subsided by the time TAC was formed and no fresh study material was available from the field, TAC had to have recourse to original clinical specimens stored in Civil Hospital, Surat and National Institute of Communicable Diseases (NICD), Delhi. These clinical samples were put to extensive analysis in which various laboratories and scientific institution played their part.¹⁹


¹⁸ The TAC consisted of following: Sh. V. Ramalingaswamy of AIIMS, New Delhi, Chairman; Sh. G. V. Satyavati of ICMR, New Delhi, Member; Sh. N. K. Ganguly of PGIMER, Chandigarh, Member; Sh. Kalyan Banerjee, of NIV, Pune, Member; Sh. K.K.Datta of NICD Delhi, Member; Sh. S. Sehgal of NICD, Delhi, Member; Sh. H. Sharat Chandra of IISc Bangalore, Member; Sh. R.V. Swamy of DRDE, Gwalior, Member; Sh. D. K. Biswal of CPCB, Shahadra, Member; V. K. Vinayak of DBT, New Delhi, Member; T. Verghese, DG Health Service, New Delhi, Member-Secretary.

¹⁹ “An overview of the work carried out by the technical advisory committee on plague,” Current Science, November 1996, Vol 71, no. 10.
The main task of isolation and characterization of the casual organism was carried out at Defence Research and Development Establishment (DRDE), Gwalior, whereas the molecular characterization of the isolates was carried out by scientists in a network of Laboratories. The main among them were All India Institute of Medical Sciences (AIIMS); the Post Graduate Institute of Medical Education and Research (PGIMER), Chandigarh; the Institute of Microbial Technology (IMTECH), Chandigarh; and the Centre for Cellular and Microbial Biology (CCMB), Hyderabad. In addition to the clinical material from Humans, specimens of original rodent material and of fleas from Surat and Beed collected by the NICD during and after the outbreak were analyzed. As a result of extensive and systematic analysis of the samples, $Y. \text{pestis}$ was isolated from 11 out of 82 clinical samples in Surat. $Y. \text{pestis}$ was also reported from 6 isolates drawn from different batches of trapped rodents from Beed and a single rodent isolate from Surat city.\(^{20}\)

After the outbreak of the plague, India has taken steps to prepare for future plague incidents. In response to the outbreak, medical school course work has been revised to address plague in greater detail. The National Institute for Communicable Disease's plague research unit has been modernized to make diagnosis easier. In addition to activating plague control units all over the country, the national government plans to set up a more sophisticated national surveillance system.\(^{21}\)

However, a critical analysis of the Government response during the outbreak of plague in India would reveal the confusion and mismanagement at various levels. First and foremost, various procedures which need to be followed as per World Health Organisation’s plague manual were ignored.\(^{22}\)

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\(^{20}\)“An overview of the work carried out by the technical advisory committee on plague,” Current Science, November 1996, Vol 71, no. 10.

\(^{21}\)Government of India, Report of the Technical Advisory Committee on Plague (Government of India, Delhi, India, 1995).

Second, the remoteness of regions plays an important role, in creating awareness amongst the people, and in turn the government understanding the extent of the threat. Since the outbreak took place in a community of rural poor living in a far flung village in an impoverished part of the state (Mamla village in district Beed) or in crowded, shanty slums (as in Surat Plague), the disease was not given due importance in its initial period.

Third, the plague outbreak in 1994 exposed vulnerability of the country in terms of epidemiological monitoring and supportive laboratory services, the essential pre-requisite for rapid response. While the epidemic was raging, investigating laboratories were still struggling to differentiate real cases of plague from a huge background load of a variety of infectious diseases which also cause epidemics with similar clinical and epidemiological features. Worst still, many hospitals in India lacked basic diagnostic laboratory service and as such no definite lab diagnosis was made and patients were simply treated on the basis of presumption of plague.

Fourth, quarantine remained the biggest problem during plague crisis. The most important step, which is, establishing quarantine or setting up of cordon sanitaire around infected neighborhood and/or the field hospitals where sick patients are brought for treatment within the restricted area was not followed in Surat and Beed. Isolation wards were not set up in even in major hospitals until days after confirmation of the epidemic. In many cases, family members of the seriously sick and dying patients simply removed their patients from the hospital against the medical advice. This not only led to rapid spread of the disease in many areas but also made the exact count of the dead impossible as many dead were simply cremated/buried, without sharing the information to the authorities. So much so, many doctors and paramedical staff left the city in panic, thereby adversely affecting the healthcare service for the general public.

23 John, T. J. “Learning from Plague in India,” Lancet, 344, 972
Fifth, proper availability of antibiotics to treat the sick and administration of preventive antibiotics to the close relatives and healthcare providers could not be achieved. In case of plague epidemic in Surat and Beed, though sufficient antibiotics were available in the market, the over-the-counter nature of sale of the antibiotics resulted in some people buying large quantities of the antibiotics for their families out of sheer panic, resulting in scarcity of the medicine for the patients for whom it was actually needed. Furthermore, many physicians and pharmacists bought large stocks of these antibiotics and simply left the city. Raids were conducted by government officials in different parts of the country to check black marketing of the essential antibiotics.

Sixth, maintaining sanitation standard is a problem all over the country. Elimination of fleas and rats is also an important step towards controlling plague epidemic but these steps help only in case of bubonic plague, the kind of cases reported from Beed. Here too, it is to be borne in mind that the interventions to kill the flea are taken before the rats are killed as in case that the rats are killed first, the infected flea will have no recourse but to attack humans, in the absence rats which happen to be their natural prey, thereby increasing the chances of infection. The same was, however, not followed in Beed. Also, many “Irula” tribals were pressed into service, who killed the rats with their bare hands, thereby making them susceptible to infection. In case of Surat, and also in other major cities of India, Municipal authorities started indiscriminate use of disinfectants on the stagnant water, a step which might have been helpful for the control of malaria but not pneumonic plague. Similarly, rat poison was used in large amounts in farm lands all over the country to check the rat populations, which had its own ill effect on the ecology.

II

Dengue Outbreaks in Delhi

Dengue fever is an acute febrile illness which is caused by a RNA virus belonging to the family Flaviviridea. The common symptoms of Dengue are: 1. Sudden onset of continuous fever; 2. Severe headache, retro-orbital pain, severe myalgia/arthralgia/back pain, hemorrhagic manifestations or leucopenia; 3. A high
Haemorrhagic tendencies in the patient (which is evidenced by one or more of the following: positive tourniquet test; petechiae, ecchymoses or purpura; bleeding from mucosa, gastrointestinal tract, injection sites etc and haematemsis or melaena; thrombocytopenia (≤ 100,000 per mm³); and evidence of plasma leakage due to increased vascular permeability. Most severe complication arising out of dengue fever is Dengue Shock Syndrome (DSS). It shows all the symptoms of DHF along with the evidence of circulatory failure in the patient manifested by rapid and weak pulse, narrow pulse pressure, and cold, clammy skin. The condition can ultimately lead to the death of the patient.26

Dengue flavivirus has four sterotypes; DEN1, DEN2, DEN3 and DEN4. Infection with one sterotype provides lifelong homologous immunity but does not provide protection against the other sterotypes. Thus a person may acquire multiple dengue infections. Dengue fever (DF) and Dengue hemorrhagic fever (DHF) is widespread in Southeast Asia. Its geographical distribution and number of cases have increased dramatically in the past 40 years. It is endemic to more than 100 countries and threatens the health of about 40% of the world’s population.27

In India, although the disease has been known to exist for more than a century, the etiology of the disease was discovered only in 1945 when first isolates of the virus were isolated from the soldiers who became ill in Calcutta. The first major outbreak of dengue fever was reported in 1948 in which more than 50 people died.26

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27 DJ Gubler, “Epidemic Dengue/Dengue Haemorrhagic Fever: A Global Public Health in the 21st Century,” http://203.90.70.117/PDS_DOCS/B0776.pdf. According to Gubler, Epidemic dengue fever is a very old disease, but it was characterized during most of its history by periodic, often infrequent, epidemics. In the past 17 years, however, there has been a dramatic resurgence of epidemic dengue activity in the tropics worldwide. This increased epidemic activity, which has been caused by all four virus serotypes, has been associated with the Dengue/Dengue Haemorrhagic Fever: A Global Public Health Problem 2 Dengue Bulletin – Vol 21, 1997 geographical expansion of both the mosquito vectors and the viruses, the development of hyperendemicity (the cocirculation of multiple virus serotypes in an area), and the emergence of dengue haemorrhagic fever. Hyperendemicity is the most constant factor associated with the evolution of epidemic DHF in a geographical area.
in India took place from July 1963 to March 1964. Since then, more than 50 outbreaks of the disease have been reported to or investigated by National Institute of Communicable Diseases (NICD) in different parts of the country. All four virus stereotypes have been isolated from India from humans and *Aedes aegypti*, its main vector and sometimes also from *Aedes albopictus*. The largest recorded outbreak of Dengue took place in Delhi and its surrounding areas in 1996. The outbreak started in the last week of August and continued until the end of November. A total of 10252 cases were reported and out of these, 423 patients died.

In 2003, Delhi was struck with another outbreak of Dengue. It started in the month of September and reached its peak in October-November. The total reported cases during the period were 2882, out of which 35 patients died. Another major outbreak struck Delhi during 2006. The outbreak started in late August, peaked in the month of October and lasted till late November. A total of 3366 cases of dengue were reported in Delhi which resulted in 65 fatalities.

However, the dengue threat during the Commonwealth games in New Delhi in 2010, gained international publicity. Close to 2000 cases were reported during September 2010. By November, it had crossed 6000.

As a result of the dengue scare, despite the preparations by the government, there were serious fallouts in New Delhi. There were at least two primary implications – on the commonwealth, and second on tourism and economy. First, the Commonwealth games, which India was scheduled to organize during this period was affected. From the US to

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32 “Dengue cases cross 1900 in Delhi,” Times of India, 14 September 2010.

Australia, there was an extra concern on New Delhi, due to dengue fever. More than twenty countries wrote to the Commonwealth Games Organizing Committee, seeking information about the situation and measures taken by the Government to address the problem. In particular, countries asked about the dengue status in New Delhi and whether it had become an epidemic by then. The Indian Government assured them that the situation was well under control. In the meanwhile, government tried to involve all agencies for a possible role to provide relief should the need arise, including the Indian Army.

The fear of dengue fever, also affected tourism in India, especially to Delhi, which was being promoted by the government as a favorite tourist destination in view of the Commonwealth games. Besides the athletes, more than 10,000 tourists were expected to visit Delhi to watch the games. However, in reality, very few foreign tourists visited Delhi. Surprisingly, such a big sports event in the country’s capital did not attract even domestic tourists in a major way. Attendance of spectators, even in the most popular sports events in which Indian athletes were participating, was well below satisfactory level. The main reason for such a poor spectator response was the dengue scare and adverse media coverage of the issue.

**Dengue in New Delhi, 2010: How did the Government handle?**

The Delhi government pursued the following strategy to handle the dengue threat during the commonwealth games. This includes prevention, creation of awareness, and meeting the challenge. As a part of prevention, the Health Minister of Delhi, Ms. Kiran Walia instructed senior health officials to intensify the anti-mosquito drive to fight the rising number of dengue; high-level meetings were organized, which was attended by the

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36 “Commonwealth Games 2010” Indian Army stands by in Delhi over Dengue fever outbreak,” *The Telegraph*, 8 September 2010.
37 “Dengue threat may hit tourist influx,” *Asian Age*, 1 September 2010.
Health Secretary and other health officials from various agencies. The Municipal Corporation of Delhi was asked to undertake cleanliness drives.

As a part of awareness, there was a serious discussion in the Assembly. The government and the opposition had an intense debate on the handling of issue, which led the government to make better efforts.

As a part of meeting the challenge, out-patient departments in all the Delhi Government hospitals were made to keep a vigil round-the-clock to check on the rising number of dengue. Mobile health vans with doctors and Para-medical staff were deployed in the entire city to control the situation. The Health minister was also reported telling that the government would be contacting the National Institute of Virology, Pune, to procure testing kits for dengue.

As evident in the case study, outbreaks of dengue fever in India have become a regular feature and in spite of concerted and sincere efforts by the government and the community, we have not been able to prevent occurrence of dengue fever even in the capital of the country, where health care facilities are definitely better compared to many backward regions of the country. Various factors like an ideal climatic condition (Plenty of rains followed by cool dry season during the months of September and October), large and susceptible population and abundant breeding sites for the mosquito provide the backdrop for these outbreaks. All these three factors of epidemiological triad, which are, Agent (Dengue virus), Host (susceptible population in the absence of availability of any vaccine against the pathogen) and Environment (abundant mosquito breeding sites like water coolers, metal receptacles, rubber tyres, water storage tanks and items of garbage produced as a result of modern life style etc.) operate in combination with each other and ultimately result in outbreak of dengue epidemic in Delhi.

38 “Mobile vans to tackle dengue cases,” The Hindu, 21 October 2010.
39 “It's dengue epidemic in Delhi,” The Hindu, 4 September 2010.
41 “Mobile vans to tackle dengue cases,” The Hindu, 21 October 2010