Kyasanur Forest Disease (KFD)
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Heavy mortality in two species of monkeys viz. the black faced langur (Semnopithecus entellus) and the red faced bonnet monkey (Macaca radiata) in March 1955 in the forested areas of Shimoga district, Karnataka State led to the discovery of the disease. The mortality in monkeys was followed by high incidence of acute prostrating febrile illness and a few deaths among the villagers in the neighborhood. Investigations resulted in the isolation of the virus from monkeys, man and ticks. The disease was named after the forest area where it was first discovered as Kyasanur Forest Disease (KFD), and the virus was named as KFD virus. The initial focus of about 100 sq km in Sagar taluk, Shimoga district, widened in subsequent years and the disease has been recorded from Uttar Kannada, Udipi, Mangalore and Chikmagalur districts of Karnataka state.

Clinical features

The onset is sudden with chills, frontal headache and high fever about 40°C. The clinical symptoms include continuous fever for 12 days or longer, usually associated with severe myalgia, cough, diarrhea, vomiting and photophobia. The incubation period is of 2-7 days. The convalescent phase is prolonged. Often, there is a relapse after 1 to 2 weeks of a febrile period. The second phase lasts for 2-12 days and is marked by the same symptoms. Neck stiffness, mental disturbance, giddiness and abnormality of reflexes are additional complications in the second phase of illness.

Diagnosis

Diagnosis is mainly syndromic. Laboratory tests include Hemagglutination inhibition, immunofluorescence and neutralization tests. Neutralization test is most useful for

The virus

KFD virus belongs to Russian Spring Summer Encephalitis group, a member of family Flaviviridae. Virions are spherical particles, 45 nm in

The first monkey death that marked beginning of KFD saga was reported from this place - March 1957.
**Epidemiology**

KFD nosoarea constitutes a number of diverse biotopes such as forest, cultivated clearings and grasslands. The forest biotope is composed of tropical evergreen, semi evergreen and moist deciduous forests. Clearing of forest area for cultivation causes changes in tick fauna and is considered as an important risk factor for outbreaks.

The number of human cases occurring each year varied from 40 to ~1000 with a mortality rate of 4 to 15 percent. All age groups are affected, but the incidence in very young children is low, primarily because children in this age group rarely visit the forest. KFD epizootics in monkeys are also a regular feature in the area. 2,442 monkey deaths were recorded from 1957 to 1975. The number of human cases shows a rising trend over the last 5 years.

KFD virus has been isolated from 16 species of ticks. However, *Haemaphysalis spinigera* is considered as the main vector. In enzootic state, KFD virus circulates through small mammals such as rodents, shrews, ground birds and an array of tick species including *H. spinigera*. When monkeys come in contact with the infected ticks, they get infected, amplify and disseminate the infection creating hot spots of infection. The people who pass through the forest are bitten by the infected nymphs of *H. spinigera*, which are highly anthropophilic.

Ticks have a definite stage-wise seasonal activity. The adults become active after a few monsoon rains in June. The adult population reaches its peak during July and August and gradually declines in September. Each fed female lays large number of eggs. Larvae preferably feed on small animals like rodents, shrews, etc. Larval population builds up in the monsoon months but remains dormant under the forest litter and becomes suddenly active when the litter dries up during the post monsoon months - October to December. Nymphal activity is high from January to May. Epidemics coincide with nymphal activity; hence nymphs are considered as the most important stage for human transmission. Adult ticks feed on large animals like cattle, monkeys, etc. These large animals are good hosts for proliferation of ticks but are not significant for virus dissemination due to insignificant viremia in them.

**Vertebrate hosts**

The virus has been isolated from naturally infected *Semnopithecus entellus* (langur), *Macaca radiata* (bonnet monkey), *Rattus blanfordi*, *Rattus rattus wroughtoni* (rat), *Suncus murinus* (shrew) and a bat *Rhinolophus rouxi*.

Neutralizing antibodies have been found in cattle, buffaloes, goats, wild boars, porcupines, squirrels, flying squirrels, rats, mice, shrews and a number of bird species.

**Experimental transmission**

Black-naped hare, porcupines, flying squirrels, Malabar giant squirrels, three striped squirrels, gerbils, mice, long-tailed tree mice and shrews have been shown to circulate high titer of virus. KFD virus has been also shown to persist in latent form in the organs, particularly the brain tissues of experimentally infected rodents, such as the spiny mouse, porcupine and long-tailed tree-mouse.

**Human is dead-end in natural cycle of the virus. Trans-stadial transmission in ticks is common but transovarial transmission is absent except in *Ixodes petauristae*.**
Vaccine
NIV has developed an inactivated chick embryo tissue culture vaccine against KFD. This vaccine evokes neutralizing antibodies response in about 70% of the vaccinated persons. The technology has been transferred to the Karnataka Public Health Department for production and vaccination.

Treatment, prevention and control
- A timely supportive therapy reduces mortality in humans.
- One or 2 treatments of forest floor with the insecticide Lindane was highly effective in killing ticks. This was particularly useful to clear infection following detection of monkey deaths.
- Tick repellents such as DEET, DMP, DBP provide 90-100% protection against tick bite.
- Vaccination of villagers and forest workers is effective.

Biosafety concerns
Internationally, KFD virus is ranked as one of the highest risk categories of pathogens belonging to Bio Safety Level-4.

During investigations, over 100 laboratory persons got infected and suffered with the disease. Majority of the infections occurred in field during investigations on etiological agent, arthropods and mammals in nature.

The scientists and technical staff of the institute exhibited exemplary and highest degree of commitment and dedication during this period.

Studies on natural cycle resulted in substantial and original contributions in taxonomy and biology of ticks and rodents.

Discovery of KFD by the NIV is a landmark achievement; provided relief to poor and underprivileged persons.

KFD is a complete success story, beginning from detection of virus to the development of killed vaccine.

There is an urgent need to develop new diagnostics and new vaccine to deal with this disease effectively. The up-coming BSL 3+ facility will pave the way for new developments.