Current Scenario of Tick-Borne Diseases in India - A Review

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Abstract

Ticks have been associated with human afflictions since time immemorial as evidenced by earlier records from many countries of the world. They are the obligatory blood-feeding arachnids and playing role as vectors for transmission of many infectious diseases in man and animal. Various wild and domestic animals are reservoir hosts for tick-borne pathogens of livestock and human hosts. In recent times, many of the newly emerging and re-emerging diseases of zoonotic origin are transmitted by ticks. Tick-borne diseases are prevalent only in specific risk areas where the favorable environmental conditions exist for the individual tick species. Indian tick typhus (ITT), first recognized in 1917 in India, is caused by Rickettsia conori, earlier reported sporadically from mountainous and forested areas and now reported from many parts of the country. In India, the fatal tick-borne viral diseases, viz., Cremian Congo Hemorrhagic fever (CCHF) and Kyasanur Forest Disease (KFD) were caused by ticks of Hyalomma analoticum and Hemophysalis spinigera. KFD is a re-emerging disease discovered in 1957 from Shimoga district of Karnataka state; however, in recent years it has moved its territory to seven districts of the state as well as centripetally spread to neighboring Kerala, Goa and Maharashtra states which are sharing borders with the state. CCHF, an emerging disease, was first reported from Gujarat in 2011; however, in recent years cases were recorded from Rajasthan and Uttar Pradesh states. There are sporadic records available for the occurrence of other tick-borne diseases, viz., relapsing fever, lyme disease, Gangam virus disease and Q fever from various parts of the country time to time. This paper reviews the current scenario of tick-borne diseases in the country and the factors responsible for the occurrence and probable measures for prevention and appropriate control.

Keywords: Tick borne diseases, Kyasanur forest disease, Rocky mountain spotted fever, Black faced langurs, Red faced bonnet monkeys

Introduction

Ticks are known for their human affliction since time immemorial and are ranked second after mosquito as vectors of human pathogens. The interest for their study was stimulated among scientists only during the second half of the 19th century when settlers in western United States died from Rocky Mountain Spotted Fever (RMSF). Since ticks are obligate hematophagus ectoparasites of animals and responsible as reservoirs for emerging infectious diseases arise from zoonotic pathogens in recent times and their role as vectors are reported from various states of the country.

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How to cite this article: Balakrishnan N. Current Scenario of Tick-Borne Diseases in India - A Review. J Commun Dis 2017; 49(2): 6-13.

Digital Object Identifier (DOI): https://doi.org/10.24321/0019.5138.201707

E ISSN: 0019-5138 | P ISSN: 2394-7047

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India is predominantly an agricultural country with about 70% of its population engaged in agriculture and farmers are keeping animals for milk, meat, wool, hide and for various farm operations. Amongst the 106 tick species reported from India, a few of them are playing the role vectors of disease pathogens. Indian Tick Typhus is the first recorded tick-borne disease in the country, mainly reported from forest and mountainous areas; however, recently it is prevalent in many states of the country. This is attributed to the ubiquitous presence of its vector Rephicephalus sanguineus (Indian dog tick) in various localities of rural and urban areas.\(^9\) KFD is the first discovered tick-borne arboviral disease from Shimoga district of Karnataka in 1957. After its discovery, more attention has been paid to the study of tick-borne diseases in India. H. spinigera and H. turturis are the major vector ticks, wild primates, black-faced langurs (Semnopithecus entellus) and red-faced bonnet monkeys (Macaca radiata) get the virus infection by tick bite and they act as amplifying host and are also susceptible to the infection.\(^11,12\) More recently, KFD is prevalent in seven districts of Karnataka state as well as from four neighboring states sharing borders with the state. Crimean-Congo Hemorrhagic Fever (CCHF) was first identified in 1944 on the Crimean peninsula in what was then Soviet Union. Later the Congo appellation was added in 1969 after the discovery of the same disease from central Africa in 1956. CCHF is a zoonotic viral disease that is asymptomatic in infected animals, but a serious threat to humans was first recorded in 2011 from Gujarat and is spreading to neighboring states.\(^8\) Due to occurrence of many tick-borne diseases as emerging and reemerging zoonotic diseases from various states of the country, it is an alarm for the future probable outbreak of similar dreaded diseases. Hence there is a need to reassess the renewed threat posed by the tick vectors and to prioritize the tick control research programs.

**Major Tick-Borne Diseases Prevalent in India**

**Indian Tick Typhus (ITT)**

In India ITT, recognized as early as in 1917, is known as a type of rickettsial spotted fever similar to rocky mountain spotted fever (RMSF) and is caused by Rickettsia conorii. The disease is also known as Boutonneuse fever and the clinical symptoms include fever, headache and malaise lasting for 10–12 days with the appearance of maculopapular rash from 2\(^{nd}\) to 5\(^{th}\) day of infection. The dog tick, *R. sanguineus*, is the principal vector of ITT although some species of *Hemaphysalis* and *Hyalomma* may also transmit the infection. Small and medium-sized mammals including rodents, insectivores and dogs harbor the potential tick vectors and act as the reservoir of the disease in nature. Due to lack of proper laboratory diagnosis, particularly in rural areas, the easy cure of cases with antibiotics and the role of vector aspects and epidemiology of the disease has been a neglected one for a long time.

The disease is reported from Maharashtra, Tamil Nadu, Karnataka, Kerala, Jammu and Kashmir, Uttarakhand, Himachal Pradesh, Rajasthan, Assam and West Bengal. However in recent years, ITT has been recognized clinically but cases have not been documented frequently, possibly due to the development of efficient diagnostic tools. An extensive study on tick-borne rickettsiosis in Pune district of Maharashtra revealed that ITT exists as zoonosis and subsequently, ITT has been reported in Mumbai, Himachal Pradesh, Haryana and northeastern states.\(^4\)

No rapid laboratory tests are available to diagnose rickettsial infection early in the course of the disease; however, Weil Felix test is cheap and easily available when other means of diagnosis are not available but the downside is its poor sensitivity and specificity. Indirect immune-fluorescence assay (IFA) is the preferred method for detection of infection but its availability and cost are major constraints in India and other developing countries. The ELISA technique, particularly immunoglobulin M (IgM) capture assay, is probably the most sensitive test available for diagnosis, and the presence of IgM antibodies indicates recent infection with rickettsial disease. As the incidence of tick-borne disease increases, and the geographic areas in which they are found expanded, it is of utmost importance that health workers should be able to distinguish the diverse and overlapping clinical symptoms of these diseases. The treatment of rickettsial infection is relatively easy after diagnosis and the commonly used antibiotics can be used for treatment.

**Kyasanur Forest Disease (KFD)**

It is a re-emerging zoonotic tick-borne arboviral disease affecting monkeys and men. This disease was first discovered in 1957 from Kyasanur forest area, Shimoga district of Karnataka state, following monkey deaths and human cases. The etiological agent, a flavivirus, has been isolated from dead monkeys, infected animals, but a serious threat to humans was first recorded in 2011 from Gujarat and is spreading to neighboring states.\(^8\) Due to occurrence of many tick-borne diseases as emerging and reemerging zoonotic diseases from various states of the country, it is an alarm for the future probable outbreak of similar dreaded diseases. Hence there is a need to reassess the renewed threat posed by the tick vectors and to prioritize the tick control research programs.

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and *H. turturis* are found to inhabit the forest floors and vegetation and also infest various small mammals and birds. Since its discovery in 1957 to 2004 a total of 24,721 human cases and about 6475 monkey deaths have been recorded. This disease in men is often fatal unless recognized early and treated symptomatically and prompt laboratory investigations. This disease is endemic in Shimoga district for a long time and has centripetally moved to seven districts of Karnataka state. In recent years, this disease has crossed the state borders and reported from three neighboring states of Karnataka, viz., Kerala, Goa and Maharashtra with human cases and monkey deaths. In Tamil Nadu, only monkey deaths were reported from Mudhumalai sanctuary area of the Nilgiris district. The probable causes of outbreaks of the KFD in newer territories are interplay of a complexity of factors related to deforestation and human settlement in forest biotopes. Improved surveillance, enhanced diagnostic facilities and timely undertaking of appropriate disease-specific control measures are needed for successful containment of the disease.1-3

### KFD and its history

KFD is a tick-borne viral hemorrhagic fever caused by KFD virus (KFDV), a member of the virus family *Flaviviridae* (Genus: *Flavivirus*), which is immunologically related to Russian Spring Summer Encephalitis (RSSE) virus. It is also called as monkey fever, which is of zoonotic origin and transmitted by the bite of infective ixodid ticks, especially at its nymphal stage. Exactly 59 years ago, KFD was first recognized as a febrile illness in Shimoga district of Karnataka state, India. During the year 1957, reports of monkey deaths in the forested areas of Sagar-Sorab Taluks, Shimoga District, Karnataka state, followed by human cases with typhoid-like fever in villages adjoining the forests occurred almost at the same time. Due to the coincidence of a large number of monkey deaths as well as human cases it was initially suspected as yellow fever.11-13

Later it was ruled out and ixodid ticks of the genera *Haemaphysalis* were found as the vectors and a number of forest-dwelling small mammals and birds maintain the natural cycle of the virus. A wide range of hosts including human, wild primates black-faced langurs (*Semnopithecus entellus*) and red-faced bonnet monkeys (*Macaca radiata*) get the virus infection by tick bite and they act as amplifying hosts and also susceptible to the infection.

The monkey death areas are treated as hot spots and when man visits these areas due to forest-related occupation get the infection of the virus by tick bite. It is also evident that many birds, number of tick species, several small mammals like rodents, shrews and an insectivorous bat are maintaining the enzootic cycle of the virus. High mortality of monkeys is observed during the months of January to May, which coincides with the seasonal activity of nymphal stage of *Haemaphysalis* ticks. When the infected monkeys die, ticks drop from their body, thereby generating hotspots of infectious ticks that further spread the virus. KFD epizootics in monkeys are a regular feature during the primary KFD season in disease endemic areas.11-13

### Life cycle of vector ticks

The major vector ticks for KFD are *H. spinigera* and *H. turturis* found to inhabit the forest floors and vegetation and also infest various mammals and birds and they are three host ticks. In addition to above, virus isolations were made from eight other species of the genera in nature. The immature stages of *H. spinigera* that infest a variety of hosts are highly susceptible and maintain the natural enzootic cycle of the virus. Ticks’ life cycle has four life stages, viz., egg, six-legged larva, nymph, and adult. Blood-engorged female drops off the host and takes shelter under leaves, stones or buries itself under surface soil. After few days, female lays eggs (1000–8000) in a gelatinous mass and they hatch into larva which climb up vegetation and cluster at tips of grass, waiting for suitable host and this phenomenon is known as “questing.” The larvae, nymph and adults attach onto their host for feeding and drop to ground and take shelter, thus completing the life cycle since they are called three-host ticks.11,12

### KFD epidemics and the risk for exposure of disease

The KFD epidemics occurred every year and the number of cases averaged 400–500 a year, during the period of 1957–2004, a total of 24,721 human cases and 6475 monkey cases were reported. Data on the KFD incidence showed that approximately 1000 cases, with a case fatality rate of 2–10% are reported annually and all age groups are affected but incidence in working age group is high. Persons visiting forest for collecting wood/forest products will contract infection by accidental tick bites. The disease has seasonal occurrence mainly during dry periods (November–June). People engaged in occupations, viz., hunters, herders, forest workers and farmers visiting the forest areas during this period without adequate protective measures increase the risk of exposure. Formalin inactivated tissue culture KFD vaccine is in use since
Involving community for KFD control

Imparting health education to community will pave the way for the effective control of KFD. Advise people not to go to the forest where monkey deaths are reported. Persons who are forced to visit the forest, should cover the body with thick cloths. Use of tick repellents like DMP oil is also recommended to avoid tick bites. Washing clothes and body with hot water and soap after returning from the forest are other preventive measures to avoid tick infestation. Since KFD is endemic in Karnataka state for a long time, the Directorate of Health Services, Karnataka, with its Virus Diagnostic Laboratory, Shimoga, has the expertise for the surveillance and control of the disease. They have developed a calendar of activities and are coordinating KFD control measures undertaken in various other districts of the state. KFD is a seasonal disease mainly reported during early and peak summer months. Major preparatory aspects are being carried out during non-transmission months, strengthening of active surveillance in endemic and other forest fringe during the primary transmission period of KFD (December–June).

Eco Epidemiology of KFD affected area

Shimoga district is the central focus of the KFD and this disease established due to deep encroachment of human colonization on a primitive sylvan territory. This area is characterized by the presence of forest land having closed forests with few open forests. The type of vegetation is tall rain forest interspersed with deciduous and semi-deciduous forest on the slopes, with mixed bamboo and shrub jungle at the edges situated in Western Ghats. Initially KFD was mainly confined to three taluks (Sagar, Shikaripur and Sorab) of Shimoga district of Karnataka, until 1972. Later cases were reported from four new districts, namely Chikmagalur, Dakshina Kannada, Udupi and Uttara Kannada. Spread of KFD to newer areas attributed to changes in environment including deforestation and new land-use practices for farming and timber harvesting might have led to the spread of this disease to newer localities. Grazing of cattle in forest areas with infected ticks will lead to introduction of these ticks to new areas. Presence of wild monkeys and other animal reservoirs is also conducive for the spreading of KFD to newer territories. For a long time, KFD was thought to be endemic in Shimoga district. However, serological evidence suggests prevalence of KFD in other geographical areas of the country, viz., Saurashtra, forested regions of Kolkata, and Andaman Islands.\(^{1,2,10,11}\)

Crimean Congo hemorrhagic fever (CCHF)

Crimean fever was first identified in 1944 on the Crimean peninsula in what was then Soviet Union. The Congo appellation was added in 1969 after the discovery of the same disease in central Africa in 1956. CCHF is a zoonotic viral disease that is asymptomatic in infected animals, but a serious threat to humans. Nairovirus of the family Bunyaviridae is the causative agent.

Bionomics of Hyalomma ticks

The members of the genus *Hyalomma* are hard ticks, often existing under varied climatic conditions of cold, heat and aridity. The geographic distribution of CCHF coincides with that of *Hyalomma* ticks; the principal vector and the virus is maintained by a cycle involving transovarial and transstadial transmission. *H. anatolicum* and *H. marginatum* are the vectors of CCHF. The engorged larvae and unfed adults of the *H. anatolicum* exhibit over wintering phenomenon by hibernating in cracks and wooden crevices in animal shelters of Russia and in rodent burrows in African deserts. The survival of larvae is up to 241 days, nymphs up to 246 days and adults over one year. *H. marginatum* often occurs in high numbers and is an aggressive human parasite and the unfed adults survive over 2 years and may oviposit 4 to 15 thousand eggs in their lifetime.\(^{2,5,8}\)

CCHFV circulates in an enzootic tick-vertebrate-tick cycle

Antibodies against CCHFV have been detected in the sera of horses, donkeys, goats, cattle, sheep and pigs. Domesticated ruminants including cattle, sheep and goats are viraemic for one week after experimental infection. Hard ticks are the reservoir and vector of CCHF virus and in addition the infected animals may also act like a reservoir during the period of viraemia. The CCHF virus may infect a wide range of wild animals like hare, rodents and domestic animals such as sheep, goats, cattle and camel. Many birds are resistant to this infection except ostriches in endemic areas. Animals become infected with CCHF virus by the bite of infected ticks and various environmental factors also influence the transmission of the virus.
Epidemiology

CCHF is one of the most widely distributed viral hemorrhagic fevers recorded from Turkey, Bulgaria, Central Asia (Afghanistan, Iran, Pakistan), the Middle-East, and Africa. Seasonal outbreak occurs during June to September months. Climate and anthropogenic factors such as changes in land use, agricultural practices and movement of livestock may influence host-tick-virus dynamics as it is a rural and occupational disease. Human infections begin with nonspecific febrile symptoms with progress to a serious hemorrhagic syndrome with a high fatality rate.

Mode of transmission of CCHF is from animal to human through tick bite or infected tick is crushed between the fingers, and there is no evidence of clinical disease in animals other than humans. High-risk groups are animal herders, livestock workers, abattoir workers and healthcare workers in endemic areas. CCHF can be transmitted from one infected human to another by contact with infectious blood or body fluids by nosocomial infection. Documented spread of CCHF has also occurred in hospitals due to improper sterilization of medical equipment, reuse of injection needles and contamination of medical supplies. The transmission of the CCHF infections and deaths among healthcare workers has been reported in parallel with outbreaks in the general population.

CCHF: Human as an indicator host

Vector, amplifying-host and climatic conditions exist for centuries and serological evidence of CCHF in camel, sheep and goats was reported by NIV Pune in 2010. Neighboring countries have been reporting for decades. As the nosocomial infection is reported in CCHF outbreaks, they constitute a threat to public health due to its epidemic potential. Other features of the outbreaks are high case fatality, potential for nosocomial infection and difficulties in treatment and prevention. Awareness should be created in persons working with livestock or other animals to take practical measures to minimize exposure to ticks by use of repellents on the skin (e.g. DEET) and clothing (e.g. permethrin) and wear light clothing that covers legs and arms, tuck pants into socks while working in tick-infested environment or wearing gloves or other protective clothing to prevent skin contact while working with the infected tissues or blood. Avoiding or minimizing exposure to the virus will prevent occurrence of illness and hence all suspect cases should be treated following strict barrier nursing precautions. Healthcare workers should follow strict hospital infection control measures to avoid nosocomial spread. CCHF being a zoonotic vector-borne disease, multi-sectoral integrated approach involving medical, veterinary and entomology specialties is the key for prevention and control of outbreaks. As in other vector-borne diseases, breaking the chain of transmission will control the outbreak.2,5,8

Other tick-borne diseases

Tick-borne relapsing fever is a major public health problem in Africa; however, in India the knowledge on the distribution of the disease and the vector Argasid ticks is scanty. The disease is caused by spirochete Borrelia carteri and the vector soft ticks are genus Ornithodorus species O. thalazani, O. Crossi and O. lahourensis. Serological evidence of Lyme disease has been reported from Nilgris hills of Tamilnadu state. Q fever is another tick-borne disease reported worldwide and known to occur in India and the causative organism is Coxiella burnetti, which has been isolated from many soft and hard vector species; however, their exact role is not clear. Babesiosis is caused by various species of protozoan parasite Babesia. This disease has not been recorded in man in India but B. microti is known to cause a malaria-like illness in parts of USA and Canada. However a lone human case has been reported in India.

Many viruses like Ganjam, Bhanja and Kaisodi are associated with ticks, human isolation of strains of Ganjam and Bhanja viruses from isolated cases of south India in the past. Other tick-borne diseases are sporadic and reported from some regions of the country more particularly from mountainous and forest fringed biotope; however, their detailed study aspects are very much warranted.2,5,10

Prevention and control of tick infestation

Early removal of attached ticks on human body is of primary importance and may be accomplished by steady traction of tick body grasped with forceps as close to the skin as possible. Care should be taken to avoid twisting or crushing the tick which may leave the mouth parts attached to the skin or inject toxins into the wound. After removal, the wound should be cleaned and monitored for secondary infection due to pathogenic infectious agents and if necessary appropriate infection control methods need to be undertaken. Preventive measures used in tick-infested areas include the wearing of protective clothing covering the exposed body parts like ankle, waist and neck thereby preventing the tick access to body.
Topical application of insect repellents such as DEET, DMP oil in body is generally effective. Large-scale tick-control measures like insecticidal application should be carried out in areas for the control of tick-borne diseases.

Infected nymphs and larvae of KFD vector ticks are shed in forest, mainly by monkeys, rats, shrews, porcupines, squirrels and probably a few birds. In monkey death hot spot areas, treatment of insecticide on the ground in a 50 meter radius by dusting of 5% Malathion powder has been recommended. For long-term measures, control of vector ticks by spraying of forest ground should be done along the tracks frequently used by villagers.

Spraying of Lindane emulsion is also recommended in 10-feet wide area along the road and footpaths frequented by man. Other insecticides like Carboryl, Fenthion and Propoxur, at 2.5 (kg ai)/ha can also be used in this regard. Phenothrin 85% in combination with Methoprene can be applied on the tick-infested animal for tick control. In areas where proper insecticidal application is not feasible in tick infested areas, prevention of tick bites by the use of repellents should be considered.

Host management and targeted chemical control of CCHF vectors

Host exclusion is the practice by which the removal of tick populations is segregated from the host animals which usually feed. Fences may also be made to exclude wild animals from entering into human habitation. Pesticide applications need to be undertaken against ticks, at the tick host or habitat. In areas with tick infestation they can be controlled by insecticidal application in animal houses, houses, furniture, wall crevices and cavities should be treated with residual insecticides. The heavy tick-infested animals should also be treated with insecticidal dusts and formulation on their body. CCHF vector tick-control measures should be undertaken on the tick host and habitat. Surveillance and monitoring of ticks infestation on animals and occurrence of human cases in a locality on long term basis is necessary. Various insecticidal formulations can be applied to domestic pets, such as dogs, to get rid of their ticks. Recommended treatment includes solution of 0.5% Dichlorovos (DDVP), 1% Carbaryl (Sevin) or 3-5% Malathion which can be applied to the coats of animal habitats. The dipping of sheep and cattle, and sometime other livestock, in acaricidal bates, or spraying them with insecticides can be done. It is crucial if ticks and tick-borne diseases of man as well as livestock rate is effectively controlled. Ground application of dust formulation of acaricides should be carried out in gardens, yards, animal sheds, walls and crevices and nearby fields during disease outbreak when control of ticks is difficult to achieve.3

Spread of tick-borne diseases to newer areas in recent years

KFDV was restricted to three taluks of Shimoga district till 1971 and was subsequently reported from other districts of the state, viz., Chikmagalur, Uttara Kannada, Dakshina Kannada and Udupi and later in 2012 from Chamarajanagar, and recently in 2016 from Belagavi district of Karnataka state. In 2013, KFDV was detected in autopsy of dead monkeys in Nilgiris district of Tamil Nadu. Monkey deaths as well as human cases were reported in Wayanad and Malappuram districts of Kerala during 2014-15. KFD outbreaks have been reported from North Goa district of Goa state bordering Karnataka in 2015, and in Sindhur Durg district of Maharashtra in 2016. It is evident that KFDV is centripetally spreading to newer areas of Karnataka as well as neighboring states.

In India, first outbreak of CCHF was reported in January 2011 in Gujarat. After the first case, the infection was transmitted to healthcare workers along with the contact of the patient. High index of clinical suspicion, early laboratory diagnosis and institution of containment measures curtailed further spread of disease. Though CCHF first human positivity was recorded from Ahmedabad in Gujarat state, but human positivity has now been recorded in seven districts. The recent sero-survey study by NIV, Pune, has revealed that domestic animals are positive for anti-IgG antibody in at least 15 districts of Gujarat state (NIV unpublished data). Due to this, it would be worth identifying areas at risk for CCHF and enhance surveillance by countrywide survey in animal blood samples.

The NIV, Pune, and IVRI, Izatnagar, carried out and reported the presence of IgG antibodies with positivity ranging from 0 to 53% indicating the circulation of virus in nature. There is a need to map out the prevalence of Hyalomma ticks to identify hotspots for institution of further measures to prevent outbreaks. In order to prevent this disease, education of risk groups and awareness in healthcare workers is very much needed. High degree of clinical suspicion, early diagnosis and good supportive care following hospital infection control measures will help in preventing outbreaks.
Discussion

Before the discovery of KFD, little attention was paid to tick-borne diseases, since it is a seasonal disease affecting forest visiting people. KFDV is transmitted by ticks of *H. spinigera* and widely distributed in the enzootic area, causing epidemics of the disease. KFD newly reported areas constitute a number of diverse biotypes such as forest, cultivated clearings and grass lands. Clearing of the forest area for cultivation causes changes in tick fauna, and is considered as the temporary risk factor which resulted in the recent KFD outbreaks. The organized disease surveillance system has helped proper diagnosis and prompt undertaking of disease-specific control measures from the above areas. Though the CCHF main endemic foci are in Gujarat state, it has been suspected in other parts of the country, based on earlier serology data and reporting of cases from adjoining states. CCHF is a disease of high public health concern in India as it has displayed high fatality rate, involvement of healthcare workers which further compromises healthcare and outbreaks have been reported every year since 2011 in Gujarat and now in adjoining states displaying geographical expansion. In general, as the incidence of tick-borne diseases increases in any area, surveillance in other/ adjoining geographic areas should also be expanded. According to Mourya et al., in view of the current status of increased incidence of tick-borne viral diseases in the country, the Indian Council of Medical Research (ICMR) has taken the initiative to survey to determine the probability of the existence of KFD in states adjoining Karnataka. Similarly, a joint initiative has been taken up by ICMR and ICAR to conduct a survey of IgG antibodies against CCHF in domestic animals in different states of India.

According to various recent study groups, India is considered a “hot spot” for emerging infectious diseases, on a global map. In the recent years, vector-borne diseases have emerged as a serious public health problem in many countries of the South-East Asia, including India. Many emerging zoonoses have spread globally at the human-animal interface and the risk factors for emergence reside in multiple sectors. As such, India has extremes of climatological and geographical conditions, temperatures range from extremely low to high, temperate regions and desert, thick evergreen forests, and areas of high rainfall. Increased population, urbanization, international travel, change in agricultural practices, environmental factors, change in lifestyle, deforestation, close contact with animals, and a porous international border make this country a high-risk area for outbreaks of emerging and new diseases.

Conclusion

KFD and CCHF are both of high importance for public health in India, as cases are observed almost every year in Karnataka and Gujarat states, respectively. It is important that the health system should be able to distinguish these tick-borne hemorrhagic diseases from other diseases, which have diverse and often overlapping, clinical presentations. KFD was originally assumed to be restricted only to Karnataka state, but there is now evidence of its spread; similarly, CCHF is not restricted to one district of Gujarat and more recently human cases were reported from neighboring states. Vector-borne zoonoses now occur in epidemic form; in recent years these have had an impact not only on public health but also on the livelihood and economy of affected countries. A network of laboratories, trained laboratory staff, more high-containment diagnostic laboratories, surveillance programs, modern equipment and trained medical professionals are required in order that the country is prepared to deal with this kind of emergency situation by strengthening of public health system networking. The Integrated Disease Surveillance Project (IDSP), an organized surveillance system developed in the country, has helped the proper early diagnosis and prompt undertaking of disease-specific control measures in newly reported tick-borne diseases. The “One health concept” put forward by WHO, for the control of zoonotic diseases, in which public health, veterinarians and other stakeholders unify their efforts by contributing towards early diagnosis are very much needed for effective and control of re-emerging and newly emerging diseases. Routine surveillance, early and prompt detection, and deploying of appropriate disease-specific control strategies and strengthening of existing health infrastructure will pave the way for control of tick-borne diseases in the country on long-term basis.

Conflict of Interest: None

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