

## **BOVINE EPHEMERAL FEVER**

(Three-day sickness, Bovine epizootic fever, Three-day stiffness, Dragon boat disease)

- [Definition](#)
- [Etiology](#)
- [Host Range](#)
- [Geographic Distribution](#)
- [Transmission](#)
- [Incubation Period](#)
- [Clinical Signs](#)
- [Gross Lesions](#)
- [Morbidity and Mortality](#)
- [Diagnosis](#)
- [Field Diagnosis](#)
- [Specimens for the Laboratory](#)
- [Laboratory Diagnosis](#)
- [Differential Diagnosis](#)
- [Treatment](#)
- [Vaccination](#)
- [Control and Eradication](#)
- [Prevention](#)
- [Containment and Eradication](#)
- [Public Health](#)
- [References](#)
- [FAD Table of Contents](#)

### **Definition** [top](#)

Bovine ephemeral fever (BEF) is a noncontagious epizootic arthropod-borne viral disease of cattle and water buffaloes characterized by sudden onset of fever, depression, stiffness, and lameness. The clinical severity of the disease is inconsistent with the subsequent rapid recovery of most of the affected animals.

### **Etiology** [top](#)

The BEF virus is a single-stranded RNA, ether-sensitive rhabdovirus with five structural proteins. This virus is antigenically related to at least three other viruses

nonpathogenic for cattle: Kimberley virus, Berrimah virus, and Adelaide River virus and two that produce an ephemeral fever-like disease in cattle, Kotonkan and Puchong viruses in Africa and Malaysia, respectively (3). The antigenic relationships with other rhabdoviruses infecting cattle have more than academic significance because prior infections with related viruses, though not providing cross-protection, can enhance the antibody response of cattle subsequent to clinical ephemeral fever.

### **Host Range** [top](#)

Clinical disease has been observed only in cattle and water buffaloes. However, neutralizing antibodies to BEF virus have been found in Cape buffalo, and species of deer and antelope in Africa (4) and deer in Australia. Antibodies can be produced in various small laboratory animals by the intravenous or subcutaneous injection of BEF virus.

### **Geographic Distribution** [top](#)

Ephemeral fever was first described in South Africa in 1906, though the disease was known to have occurred previously and was referred to briefly by Schweinfurth in 1867. It was clearly recognized in Egypt in 1895 and 1924. The disease is now known to exist in a broad belt of tropical, subtropical, and temperate countries in Africa, Asia, and Australia and to be the same disease as bovine epizootic fever of Japan (14,16).

The countries where ephemeral fever occurs lie on both sides of the Equator and include all the countries of Africa and those of Asia south of the general line encompassing Israel, Syria, Iraq, Iran, Pakistan, India, Bangladesh, southern and central China, and southern Japan through Southeast Asia to Australia. There is serological evidence to support the absence of BEF virus from Papua New Guinea (since 1956), the Pacific Islands, New Zealand, and the United States. There has been no report of ephemeral fever from Europe or North or South America.

### **Transmission** [top](#)

The disease can be reproduced experimentally in cattle only by the intravenous inoculation of BEF virus. Subcutaneous or intramuscular injection is ineffective. Epizootiological evidence indicates that BEF virus is spread in nature only by an insect bite. The disease will not spread from cow to cow by close contact, droplet infection, bodily excretions, or by the transfer or injection of exudates (10). There is experimental evidence that BEF virus is not spread by semen. Meat does not represent even a theoretical risk for transmission because the virus is rapidly

inactivated at pH levels below 5 (7). Such acidic levels are attained rapidly in bovine muscle after death. Disinfection plays no part whatsoever in control of spread.

Epizootics of ephemeral fever occur in the summer in temperate climates of Australia, South Africa, China, and Japan and disappear with the first frosts. In Africa, China, and Australia the disease has moved rapidly over long distances but always in a general direction away from the Equator (14,15). In Kenya, epizootics are associated with recent rainfall. The BEF virus has been isolated from *Culicine* and *Anopheline* mosquitoes in Australia (12) and from biting midges of the genus *Culicoides* in Africa and Australia (16). The necessity for the BEF virus to be delivered intravenously to reproduce disease experimentally, plus the absence of the virus from in the lymph during early viremia, strongly supports mosquitoes as the major vectors.

They are vessel feeders. *Culicoides* species lacerate the skin and are pool feeders. A close study of the epidemiology in Australia also favors mosquitoes as the important vectors (8). It is not known whether suitable vectors exist in the Americas.

### **Incubation Period** [top](#)

The incubation period following experimental intravenous inoculation of BEF virus varies between 2 and 4 days, and 9 days is the rare extreme. The time is probably influenced by the strain and dose used. The natural incubation period can only be inferred but is probably similar. An index case or cases occur under epizootic conditions approximately 1 week ahead of the main wave of cases in a herd. The peak of viremia occurs 24 hours before the onset of fever (10).

### **Clinical Signs** [top](#)

The name ephemeral fever was applied very early in the disease's recorded history. The disease is not ephemeral in the sense of being hard to see. The clinical signs are very obvious and can be quite severe (2). The fever of ephemeral fever is generally biphasic, sometimes triphasic, with peaks of 40-41.5° C (104-107° F) spaced 12-18 hours apart. Thus, the actual height of the rectal temperature measured during an initial examination varies with the stage of the febrile cycle. The physical signs during the first febrile phase tend to be mild except for the dramatic fall in milk production of lactating cows. The characteristic signs associated with BEF are those of the second febrile phase (5,10,18,22). These signs include accelerated heart and respiratory rates, anorexia, ruminal atony, depression, serous or mucoid nasal and ocular discharges, salivation,

muscle twitching or waves of shivering, a generalized stiffness or a shifting lameness. There may be submandibular edema or patchy edema elsewhere on the head. Many animals become recumbent for 12-24 hours but are able to rise if sufficiently stimulated. Others are completely unable to rise and remain in sternal recumbency for hours or days with the head turned to the flank, or in lateral recumbency with or without loss of most reflexes. Recovery begins 1-2 days after the overt clinical signs are first noticed and is usually complete and without sequelae in a further 1-2 days after the overt clinical signs are first noticed. The early signs of improvement develop in a few hours after fever disappears in most cattle. Most cases, especially those in young cattle, are mild to moderately severe, and recovery is well advanced by the third day after clinical signs are first observed. Lactating cows, bulls in good condition, and fat steers are the worst affected, and their recovery may take up to a week even without complications.

A range of complications can occur in a minority of cases. Death can occur suddenly in the febrile or in the recovery phase. Paralysis of the limbs may persist for days, weeks, or permanently. Recovery from the longer-term paralysis can be complete, or some disablement of gait may remain. A temporary infertility may occur in bulls that show structural defects in spermatozoa persisting for up to 6 months, but infertility may be a nonspecific effect of the inflammatory nature of the illness. The loss of fertility of bulls can be minimized with nursing care and treatment. There is no effect on the long-term fertility of the female, though abortions do occur if the cow suffers ephemeral fever in the eighth or ninth month of pregnancy. Earlier reports on the teratogenic effects of BEF virus in Australia have since been correctly attributed to the Simbu group viruses— particularly Akabane and Aino viruses.

Emphysema and the subcutaneous accumulation of air along the backline is an uncommon complication (19). Aspiration pneumonia can occur from inhaled ingesta or from oral medication in those animals in which the swallowing reflex has been lost.

Except for those cows that abort in late term, the milk production of most cows returns to 85-90 percent of the predisease levels within 10 days of disease. The 10-15 percent loss of production (5,18) persists in affected animals for the balance of the lactation period. Subsequent lactations are normal except in those cows that develop a secondary bacterial mastitis.

The full spectrum of clinical signs is not seen in any one animal nor usually in one herd. The signs are exacerbated by forced exercise or severe climatic stress. Mortality varies from 1-2 percent on average. In focal outbreaks in very fat cattle, mortality can exceed 30 percent. The other economic effects of the disease are due to lost production and trade restrictions.

## Gross Lesions [top](#)

The pathology of experimental disease is well described. Personal observation suggests it is consistent with that of the natural disease for which few descriptions have appeared. The sporadic mortality is responsible for this gap in published information. The most obvious gross lesions are the small amounts of fibrin-rich fluid in the pleural, peritoneal, and pericardial cavities and variable amounts in the joint capsules. The joint capsules of the limbs are the most consistently involved, but even the synovial surfaces of the spine may have fibrin plaques. The lungs may have patchy edema. Lymphadenitis is consistent, but petechial hemorrhages of the lymph nodes are less frequent. Focal necrosis can be found in major muscle groups in some cases.

The hematological changes are very characteristic. There is an absolute rise in leukocyte numbers with a reversal of neutrophil and lymphocyte proportions. With the onset of fever, there is a rapid fall in circulating lymphocytes, and a return to normal levels after 3-4 days. This fall is followed some hours later by a rapid rise in neutrophil numbers and the concurrent appearance of immature forms. The leukocyte counts return to normal on clinical recovery. Eosinopenia is constant. The serum fibrinogen level rises to 3-4 times the normal level and returns to normal 1-2 weeks after recovery. The total serum calcium level falls to  $1.8 \text{ mmol}^{-1}$  during the febrile phases and returns to normal on recovery. This is the biochemical event that causes the reversible early paralysis. However, the biochemical dyscrasias are far more extensive. These biochemical changes are similar to those of milk fever. Collectively, these changes are typical of a systemic inflammatory disease (1,11,16,20,22).

## Morbidity and Mortality [top](#)

Morbidity is partly influenced by the number of susceptible cattle in the herd and partly by the intensity of the epidemic. The course of the disease in the herd may range from 3 to 6 weeks. Quite often, the main wave of clinical cases occurs a week or more after a single case or a small cluster of cases.

High mortality may occasionally occur (13,14). Cattle of all breeds have similar signs, and the clinical course in buffaloes, though milder, seems to be much the same as in cattle.

## Diagnosis [top](#)

## Field Diagnosis [top](#)

Single cases are difficult to diagnose, but with a herd outbreak, when cattle at various stages of disease can be examined, diagnosis is made from clinical observations and the history of the outbreak.

## Specimens for the Laboratory [top](#)

A sample of blood should be taken during the period of fever and a second 1-2 weeks later. Part of the first sample of blood is allowed to clot, and another portion is mixed with anticoagulant. From the uncoagulated blood, a smear is made on a glass slide and allowed to dry in air. The balance is used for virus isolation (22). When blood taken during illness is allowed to clot, it usually fails to contract on standing, even over several days. It may be streaked with fibrin. Samples should be taken from animals in various stages of the disease to facilitate a rapid laboratory confirmation.

## Laboratory Diagnosis [top](#)

The most efficient means of proving the identity of the disease is the transmission to susceptible cattle by the intravenous injection of uncoagulated whole blood. These cattle are closely observed for the development of fever and the characteristic signs. Virus isolation can be attempted (from the leukocyte fraction of the blood) in tissue cultures but is not very efficient (22). A differential leukocyte count on the blood smear provides the most rapid supporting evidence for the field diagnosis. A high percentage of neutrophils with many immature forms is not pathognomonic of ephemeral fever, but if not present the field diagnosis is likely to be wrong. Eosinopenia also occurs. Testing of antibody (virus-serum neutralization test) is the most generally available laboratory test. However, false positives do occur. The enzyme-linked immunosorbent assay test is specific and rapid and distinguishes between antibodies induced by BEF and those from infections with antigenically related viruses (26).

## Differential Diagnosis [top](#)

Various diseases may be confused with ephemeral fever when a diagnosis in the field has to be made on a single animal (for example, early Rift Valley fever, heartwater, bluetongue, botulism, babesiosis, or blackleg). The salivation may suggest foot-and-mouth disease; however, there is no vesicular lesion in the mouth or on the feet. It is very simple to have a blood smear stained and examined at any veterinary or human laboratory to check for the characteristic neutrophilia and to obtain supporting, though not definitive, evidence to exclude

most other viral diseases. When many cattle are involved, different stages of the disease will be observed — some with the characteristicly rapid resolution of severe clinical signs.

### **Treatment** [top](#)

Ephemeral fever is one of the rare virus diseases for which treatment is effective (21). The inflammatory nature of the disease process means it is responsive to anti-inflammatory drugs. These drugs must be given for the expected course of the clinical disease. During fever, the paresis or paralysis responds to injected calcium borogluconate in the same manner as parturient paresis (milk fever) (15). In both syndromes, low levels of ionized calcium in the plasma induce the signs. Early treatment is more effective than late. Also, relapses occur in ephemeral fever if anti-inflammatory treatment is discontinued too early. Viremias and subsequent immunity are not significantly affected by treatment. An underlying paralysis of the Guillain-Barré type persists in a small proportion of cattle after the fever has gone.

### **Vaccination** [top](#)

Almost all animals that undergo a single bout of ephemeral fever are immune to natural or artificial challenge. Although antigenic variation has been demonstrated by panels of monoclonal antibodies, challenge with BEF strains of a different origin does not cause disease in immune animals. The immunity is sterile, for no evidence of carrier animals has been found experimentally or been suspected from epizootiological evidence (9,15). Where double bouts of disease have been reported, they have been within a single epizootic season. Various vaccines have been produced in South Africa, Japan, and Australia because the virus is easy to attenuate (7,22). These vaccines appear to protect against severe laboratory challenge, but evidence of their effectiveness in the field in the face of an epizootic is variable. A subunit vaccine has been developed and protects against laboratory and field challenge (25). The vaccine has not yet been manufactured.

### **Control and Eradication** [top](#)

### **Prevention** [top](#)

The species of insect vector involved in the spread of BEF virus are not yet defined. Therefore, no large-scale specific control can be recommended. Housing may protect small numbers of susceptible cattle. In Australia, clinical cases are seldom seen in housed animals, but this may be related to local vector biology and not apply generally throughout the world. Vaccination is the only useful preventive

measure.

## Containment and Eradication [top](#)

Unless very special circumstances apply, containment is not possible. A particular circumstance would be when the disease is recognized in a quarantine area in recently imported stock. Useful steps are to place the cattle in an insect-proof area, spray with insecticides, or suppress insects in the local environment. No country has attempted to eradicate BEF, although it did die out naturally in New Guinea.

## Public Health [top](#)

There is no evidence that humans can be infected, although many thousands of people have been in contact with infected cattle and potentially exposed in the same environment to the vectors of the virus. A limited amount of serology on farmers handling infected cattle and on laboratory workers handling the BEF virus has given negative results.

## GUIDE TO THE LITERATURE [top](#)

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