Tick-borne diseases (TBDs)

Wetlands inhabited by ticks and susceptible animals

Wildlife ✓
Livestock ✓
Human ✓

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Synonyms: TBDs include: African swine fever, anaplasmosis, babesiosis, Crimean-Congo haemorrhagic fever, ehrlichiosis, equine piroplasmosis, heartwater (or Cowdriosis), louping ill, Lyme disease, Nairobi sheep disease/Ganjam virus, Powassan encephalitis virus, rickettsiosis (including Q fever & Rocky Mountain spotted fever), theileriosis (including East Coast fever & tropical theileriosis), tick-borne encephalitis (TBE), tick-paralysis, tick-borne relapsing fever, tularemia.

KEY FACTS

What are tick-borne diseases?

Tick-borne diseases (TBDs) encompass a wide range of disease-causing pathogens that all have a tick vector. These include bacterial (*e.g.* heartwater and Lyme disease), protozoan (*e.g.* theileriosis) and viral diseases (*e.g.* TBE), which are maintained and transmitted by ticks to numerous wild and domestic animal hosts.

Ticks are among the most important arthropod vectors of disease. These blood-feeding ectoparasites are found in almost every region of the world, typically in grassy, wooded habitat. They can act as vectors and/or reservoirs of disease, transmitting pathogens from an infected vertebrate to another susceptible animal, or human, whilst feeding.

There are two major tick families: the Argasidae (soft ticks) and the Ixodidae (hard ticks), the latter (Ixodidae) having a number of attributes that enhance their potential to transmit disease, including long feeding durations (often days), firm attachment whilst feeding, a usually painless bite and the utilisation of a variety of hosts.

Aside from disease transmission, ticks are also responsible for severe toxic conditions (tick paralysis or toxicosis), irritation, secondary infections and physical damage associated with their bites.

Causal agents

A wide variety of pathogens (including bacteria, viruses and protozoa) are harboured and transmitted by ticks. Salivary neurotoxins, produced by some tick species, are the causal agents of tick paralysis.

Species affected

TBDs affect a wide variety of vertebrate species including domestic animals, wildlife and humans.

Geographic distribution

TBDs occur worldwide as their tick vectors also have a global distribution. Most individual TBDs are geographically localised, occurring in foci with favourable conditions for the ticks and animal hosts involved in the transmission of the pathogen.

Environment

Each tick species is well adapted to its habitat, environment and host. Depending on the species of tick, they are mostly found in deciduous woodland, coniferous forest, wetland and meadows.

Areas with leaf litter, weeds, long grass or brush often have higher densities of ticks as this vegetation is used by most species (hard and some soft ticks) to 'quest' for a suitable host animal. When questing, a tick climbs vegetation, extends its first pair of legs and uses them to grasp a host when it passes. Conversely, most soft ticks inhabit environments commonly used by potential hosts (*e.g.* bedding or cracks in dens, stables or caves) and often feed when the host animal sleeps.

TRANSMISSION AND SPREAD

Vector

Ticks of the Argasidae (soft ticks) and Ixodidae (hard ticks). An estimated 10% of the currently known 867 tick species act as vectors of diseases of domestic animals and humans.

A tick species is only considered as a vector for a pathogen if it:
- feeds on an infectious vertebrate host;
- acquires the pathogen during the blood meal;
- maintains the pathogen through one or more life stages; and
- transmits the pathogen on to other hosts when feeding again.

How is the disease transmitted to animals?

TBDs are transmitted to animals when an infected tick feeds on a susceptible animal. Usually, a pathogen must infect and multiply within a tick before the tick is able to transmit disease to a host *via* its salivary glands and mouthparts (hypostome).

Ticks become infected with pathogens by:
- **feeding** on an infected animal host
- **transstadial transmission**
  Pathogen passed through tick life stages (*i.e.* from larvae to nymph to adult)
- **transovarial transmission**
  Pathogen passed from parent tick to offspring *via* the female ovaries (increasing vector potential by several thousand times).

Ticks are often a robust and long-lasting reservoir of infection. For example, they can remain infected with *Ehrlichia ruminantium* (the causative agent of heartwater) for at least 15 months and can harbour the pathogen responsible for theileriosis for up to two years.

Pathogens harboured in a tick are transmitted to an animal host through salivary secretions, regurgitations or tick faeces when the ectoparasite feeds. The likelihood of disease transmission increases with tick attachment time.

Some TBDs (*e.g.* TBE) can also be transmitted between ticks co-feeding on a host, without that host becoming systemically infected. This is important for the epidemiology and has implications for disease surveillance.

Infrequently, some TBDs are transmitted indirectly *via* fomites and mechanical vectors contaminated by infected blood or plasma.

How does the disease spread between groups of animals?

The spread of TBDs requires the dispersal of the **tick vectors** and/or the **reservoir hosts**. For a TBD to spread to a *new* area, the vector ticks or reservoir hosts must find respective hosts or ticks that are susceptible to infection and can maintain the pathogen.

TBDs may be dispersed by:
- **Tick movement:** ticks may walk short distances (seldom exceeding 50m).
- **Hosts:** whilst attached to a host, ticks may travel larger distances (particularly in the case of migratory animals).
- **Anthropogenic activity**
  - Movement and trade of livestock (infected with TBD or tick-carrying)
  - Changes in agricultural practices
  - Tick-habitat modification.
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How is the disease transmitted to humans?

Direct routes, as with animals, involve humans being bitten by disease-transmitting ticks.

Indirect routes of transmission are also possible, such as contamination of cuts or the eyes following crushing of ticks with the fingers.

IDENTIFICATION AND RESPONSE

Field signs

Due to the wide range of pathogens transmitted by ticks, there are no signs specific for TBDs. Signs can include: fever, diarrhoea or incontinence, lack of appetite and weight loss, weakness, lethargy, muscle and/or joint pain (reduced mobility), neurological signs (convulsions, head pressing *etc.*), anaemia (weakness, paleness of gums and mouth), discharge from the eyes or nose, or jaundice (yellowing of skin and eyes).

Infected animals may not have all of the signs, and many are associated with other diseases. The development and severity of TBD will depend on numerous factors (host susceptibility, agent virulence and infective dose).

Important TBDs of domestic animals, include:

- **Bovine babesiosis** (Redwater disease).
  Fever, weight loss, anaemia, jaundice, depressed or unusual behaviour, occasional muscle tremors and convulsions, red-coloured urine.
- **Heartwater** (Cowdriosis).
  Fever, loss of appetite, listlessness, shortness of breath, purple spots (petechiae) on mucous membranes, occasional diarrhoea (particularly in cattle), high-stepping gait, unusual behaviour, convulsions and frothing at the mouth. Death usually occurs within a week of infection.
- **Anaplasmosis** (Gall sickness).
  Fever, anaemia, jaundice, weakness, loss of appetite and co-ordination, shortness of breath, constipation, death (mortality is usually between 5-40% but can reach 70% in a severe outbreak). Pregnant cattle may abort.
- **Theileriosis** (including East Coast Fever and Tropical Theileriosis)**.**
  Swelling of the lymph nodes, high fever, shortness of breath and high mortality (can be up to 100% in susceptible cattle). Tropical theileriosis may additionally present with jaundice, anaemia and bloody diarrhoea.
- **Equine piroplasmosis.**
  High fever, reduced appetite, congestion of mucous membranes, dark red urine.
- **African swine fever.**
  Fever, anorexia, reddening of skin, cyanosis, vomiting and diarrhoea, abortion, or sudden death.

Many TBDs may cause little or no detectable disease in the reservoir host (*e.g.* African swine fever in wild African suids). This can be significant for zoonotic diseases such as TBE (reservoir hosts include forest rodents), where human cases can occur without detectable disease in wild or domestic animals.

Recommended action if suspected

Seek advice from animal health professionals. Many TBDs are listed as notifiable by OIE and suspected or confirmed cases must be reported to local and national authorities and the OIE.

Diagnosis

Ticks can carry more than one pathogen, which can make diagnosis of a TBD difficult. For a definitive diagnosis of a TBD, laboratory confirmation is required.

National laboratories will provide guidance on the samples that are required, which often include: tissue (brain, lymph node), whole blood, serum and ticks.

Some tick-borne pathogens may be directly observed by the microscopic examination of stained tissue and/or blood samples. Abnormal blood test results in TBD cases may include low platelet count, low serum sodium levels, abnormal white blood cell counts or elevated liver enzyme levels.

Serological assays (including indirect immunofluorescence assay (IFA), ELISA or EIA, latex agglutination and dot immunoassays) are often used to aid in the diagnosis of a TBD and molecular methods such as PCR can be used for rapid detection.

For more detailed information regarding laboratory diagnostic methodologies, refer to the latest edition of the OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals.

PREVENTION AND CONTROL IN WETLANDS

Environment

A well planned and thorough monitoring programme should form the basis of integrated tick control. A number of tick survey methods may be implemented to monitor tick densities. These include: tick walks and drags, carbon dioxide trapping, tick flags and host trapping and examination.

Habitat modification.
The free-living stages of most tick species are often restricted to specific conditions within the ecosystems inhabited by their hosts. **Reduction** of **leaf-litter** and **understory vegetation** will remove tick microhabitats and reduce the abundance of ticks.

The removal of the structural vegetation used by ticks to quest (*i.e*. weeds, high grass and brush) has also proved a successful method of tick-control in recreational areas. **Controlled burning** of habitat has been shown to reduce tick numbers for up to a year, yet the long-term impacts of burning on tick populations are unclear.

Avoiding areas with large populations of ticks can be used to reduce TBDs where possible (*e.g.* select grazing areas for domestic animals).

Biological Control.
Predators naturally control tick numbers in some areas of the world and habitat modification to encourage tick predators may provide a method of free-living tick control. However, most tick predators are generalists with a limited potential for tick control. Some wasp species parasitise and kill ticks, but are not thought to reduce tick numbers significantly (although inundative releases have shown potential value). Research has suggested several species of bacteria, entomopathogenic fungi and nematodes that are pathogenic to ticks and may have potential as biocontrol agents.

Chemical control.
Control of ticks with an appropriate acaricide is a widely used method to control TBDs. Acaricides have been used against free-living ticks in the environment by treating vegetation at specific sites (*e.g.* along paths or animal trails). This method is not recommended for wider use due to the environmental implications and the cost of treating large areas. However, the free-living stages of soft ticks are more frequently and effectively treated with acaricides, as they are usually found in specific foci (*i.e.* animal holding pens, livestock runs, poultry housing and in human dwellings).

*The **environmental consequences** of undertaking any form of habitat modification must be carefully evaluated **before** being implemented as a method to control tick populations.*

For further information ►**Section 3.4.2. Control of Vectors.**

Livestock

The **exposure** of livestock to ticks may be reduced by the use of **repellents**, **acaricides** and regular **inspections** of premises and animals. A variety of tick control programmes may be integrated into livestock management:

Chemical control.
Tick control in livestock is most commonly achieved by **acaricide** treatment. Acaricides are most effectively applied through total immersion of livestock in a dip-vat. They may also be applied as sprays, dusts, pour-ons, spot-ons and more recently *via* slow release technologies such as impregnated ear tags, or systemically from implants or boluses. Fowl are usually treated with a dust application. The frequency of acaricide treatment depends on the targeted tick species, the TBD present and the livestock-management practices followed. Treatment may vary from every three days (as followed in east Africa for the protection of cattle against East Coast fever transmission by *Rhipicephalus appendiculatus*) to every six months (for the control of *Rhipicephalus* (formerly *Boophilus*) *microplus* tick populations).

Organochlorines, organophosphates, carbamates, amidines, avermectins and pyrethroids have been used for tick control. The development of acaricide resistance in ticks has necessitated the development of new compounds, such as phenylpyrazoles.

Acaricide usage is not considered sustainable as they are expensive, can cause environmental damage, may leave potentially harmful residues in meat and milk and ticks can develop resistance over time. More sustainable methods for the control of some TBDs may involve a combination of strategic tick control and vaccination, however, these are yet to be successfully applied on a large scale in endemic areas.

N.B. Tick eradication with acaricide is not recommended in some situations. Where TBDs are endemic, it may be preferable to allow tick populations to remain at high levels. This permits the re-infection of immune livestock, boosting immunity and leading to endemic stability.

Tick-resistant livestock.
Zebu (*Bos indicus*) and Sanga (*B. indicus* crossed with *B. taurus*) are indigenous cattle breeds of Asia and Africa which are very resistant to hard ticks after initial exposure. Conversely, European cattle (*B. taurus*) usually remain susceptible. Tick-resistant cattle and their cross breeds may be exploited as a method to control the parasitic stages of ticks. Although these breeds continue to support tick populations, they are not conducive to large tick infestations. The use of Zebu cattle has been successful in Australia and the introduction of tick-resistant cattle is becoming an increasingly important method of tick control in the Americas and Africa.

Pasture spelling.
Pasture rotation or pasture spelling can be used as a method to control one-host tick species (such as *Rhipicephalus microplus*, an economically important parasite of livestock that spreads the pathogens responsible for babesiosis). Larval ticks are starved due to the absence of their host, so the duration of pasture spelling is determined by the lifespan of the free-living larvae. This

technique requires the existence of well maintained pasture boundaries and the absence of suitable alternate hosts. Pasture-vacation schedules must be rigidly followed. This method has minimal application to soft ticks (nymphs can survive for long periods without food) and multi-host tick species.

Vaccines.
TBD control in livestock may also be achieved by the use of live, attenuated vaccines. Notable vaccination programmes include the development of an East Coast fever vaccine in Kenya and the implementation of a vaccine for tick fever in Australia. Furthermore, live attenuated vaccines have been used to control tropical theileriosis (caused by *Theileria annulata*) and heartwater (caused by *Ehrlichia*, formerly *Cowdria ruminantium*).

A potential alternative is to vaccinate against the tick species itself. Recently, a vaccine against *R. microplus* has been developed that stimulates the host production of an antibody which damages tick gut cells, causing tick mortality or reduced reproductive potential. One-host ticks such as *R. microplus* are good candidates for livestock vaccines, yet vaccine development for multi-host ticks, which infest both cattle and wild ungulate species, may not be feasible.

Quarantine.
The control of livestock movements through quarantine can help control TBD spread. In all tick-borne disease-free areas or countries, it is recommended that livestock are inspected for ticks before allowing entry. Area quarantine, on areas with large infestations, ensures all livestock are inspected for ticks and given precautionary treatment before leaving. Premises quarantines act to prevent the spread of infested livestock from individual pastures, farms or ranches with suitable physical barriers.

Antibiotics.
Livestock moved into endemic areas of TBDs may be protected from bacterial disease by prophylactic treatment with broad-spectrum antibiotics. Antibiotic administration can also be effective for the treatment of bacterial TBDs in their early stages and the secondary infection of lick lesions.

Manual tick removal may also provide an effective control method for small numbers of animals.

Wildlife

Control of wildlife populations may be difficult, but the interaction of livestock and wildlife should be prevented where possible. This will minimise the transmission of TBDs and ticks to and from susceptible wild animals.

Humans

Reducing exposure to ticks is the best method to prevent TBDs which affect humans.

Avoid and repel ticks:

- Walk in the centre of trails to avoid contact with overgrown vegetation.
- Where possible avoid tick habitat, especially during peak tick seasons.
- Wear clothing to cover arms, legs and feet whenever outdoors.
- Apply repellents containing DEET (20% or more) to exposed skin and clothing.

Find ticks:

- Wear light-coloured clothing to enable ticks to be observed easily.
- Check yourself, your children and gear thoroughly for ticks after being outdoors.
- Companion animals should be routinely checked for ticks; cats and dogs can be treated with commercially available acaricide dusts or washes.

Remove ticks:

- Using tweezers, grasp the tick as close to the skin as possible.
- Pull the tick out it one, steady movement. Do **not** twist or jerk.
- Wash hands and disinfect the bite. Freeze tick, if possible, to aid with the identification of a TBD if symptoms develop.
- If a rash, flu-like symptoms or other illness develop, seek medical advice.

► **Section 3.4.3. Control of vectors: tick control**

Educational talks and **informative material** (such as brochures and pamphlets) can also help reduce the likelihood of tick bites and zoonotic disease transmission, especially for high-risk employees such as reserve wardens. **Signage**, warning people they are entering tick-infested areas, may also help reduce the incidence of tick bites.

Treatment

Seek advice from medical health professionals. Early diagnosis is essential. Antibiotic treatment is indicated in cases of clinical bacterial TBDs such as anaplasmosis, Lyme disease, tularemia, Rocky Mountain spotted fever, and ehrlichiosis.

IMPORTANCE

Effect on wildlife

Ticks and TBDs have co-evolved with numerous wild animal hosts, often living in a state of equilibrium with little detectable clinical disease. Where TBDs emerge in new areas or naïve species, wildlife can be clinically affected (*e.g.* African swine fever in European wild boar *Sus scrofa*).

Effect on livestock

The multiple TBDs can cause a wide range of clinical syndromes leading to variable morbidity and mortality**.** Major TBDs of livestock include bovine babesiosis, bovine anaplasmosis, theilerioses and heartwater, African swine fever, louping ill and equine piroplasmosis. In addition to other diseases, these TBDs can result in mass herd die-offs and cause severe losses to the livestock industry.

Livestock may also suffer direct impacts from feeding ticks:

- Tick paralysis and toxicosis.
- Discomfort and irritation, leading to production losses (milk and weight gain).
- Blood loss, resulting in reduced live weight and anaemia.
- Damage to hides.
- Reduced suckling efficiency due to scarring on udders and teats.
- Formation of lesions susceptible to secondary infections.

Effect on humans

Ticks and TBDs constitute a serious public health threat, particularly in the northern hemisphere. Lyme disease is the most frequently reported zoonotic tick-borne disease globally and viral TBDs, characterised by haemorrhagic fevers and encephalitis, cause the highest morbidity and mortality in humans of the tick-borne zoonoses.

TBD resulting in livestock mortality affects humans indirectly, due to the reduction in animal protein available for human consumption.

Economic importance

TBDs are responsible for severe economic losses worldwide, primarily due to their impacts on livestock production and human health.
TBDs are a significant impediment of export, trade and the development of livestock production. TBDs affecting companion animals are only of economic significance in industrialised countries and TBDs of equines constitute important constraints to international trade and sporting events involving these animals.

FURTHER INFORMATION

Useful publications and websites

- World Organisation for Animal Health (OIE). **Technical disease card – heartwater**. http://www.oie.int/fileadmin/Home/eng/Animal_Health_in_the_World/docs/pdf/HEARTWATER_FINAL.pdf [Accessed March 2012].
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- FAO Corporate Document Repository. **Ticks and tick-borne diseases: selected articles from the World Animal Review**. http://www.fao.org/DOCREP/004/X6538E/X6538E06.htm [Accessed March 2012].
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- Merck & Co. Inc. **The Merck veterinary manual: tick control**. http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/72120.htm&word=tick [Accessed March 2012].

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