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Heartwater

Cowdriosis, Malkopsiekte, Pericardite Exsudative Infectieuse, Hidrocarditis Infeciosa, Idropericardite Dei Ruminanti




Heartwater is an infectious, noncontagious, rickettsial disease of domestic and wild ruminants in areas infested by ticks of the genus *Amblyomma*. The other names by which the disease is known are Cowdriosis, *Malkopsiekte*, *Pericardite Exsudative Infectieuse*, *Hidrocarditis Infeciosa*, and *Idropericardite Dei Ruminanti*.

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Overview

- Organism
- Economic Impact
- Epidemiology
- Transmission
- Clinical Signs
- Diagnosis and Treatment
- Prevention and Control
- Actions to take



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In today's presentation we will cover information regarding the organism that causes heartwater and its epidemiology. We will also talk about the economic impact the disease has had in the past and could have in the future. Additionally, we will talk about how it is transmitted, the species it affects, clinical signs, necropsy findings, and diagnosis and treatment of the disease. Finally, we will address prevention and control measures for the disease as well as actions to take if Heartwater is suspected. Photo of *Amblyomma variegatum* (the tropical bont tick), from Mat Pound at USDA, ARS.

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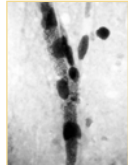
The Organism



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Cowdria ruminantium

- Family Rickettsiaceae
 - In cytoplasm of capillary endothelial cells of infected animals
 - Coccoid but occasionally ring formed
 - Clumps of a few to several thousand organisms
 - Stains blue with Giemsa



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Cowdria ruminantium is a rickettsial bacterium (family Rickettsiaceae). This organism is pleomorphic, measuring from 400 to more than 1,000 nm diameter. The organism initially reproduces in macrophages, then invades and multiplies in endothelial cells, especially in the brain of ruminants. The organism is an obligatory intracellular parasite and appears as clusters of blue stained granules within the cytoplasm of infected endothelial cells. It cannot survive outside a living host for more than few hours at room temperature. Photo: Brain smear from a goat showing colonies of *C. ruminantium* as the granular blue areas in the cytoplasm of the capillary endothelial cells. From www.vet.uga.edu/vpp/gray_book/photos/pages/061.htm.

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Importance



Heartwater is a threat to the U.S. for several reasons. There is a risk of introduction of the disease through infected ticks or of infected ticks on imported wildlife. Additionally, a carrier state of the disease has been discovered in several wild animal species that have been imported to the U.S. Finally, two tick species indigenous to the U.S. have been shown experimentally to serve as vectors for heartwater.

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History

- 1830: South Africa – sheep
- 1898: Transmissibility
- 1900: Tropical bont tick vector
- 1925: Caused by Rickettsial agent
- 1980: Found in Western Hemisphere
- 1992 and 1997: Florida-imported vector ticks

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The first historic identification of heartwater was made in sheep in South Africa in the 1830's. In 1898, heartwater was found to be transmissible experimentally by inoculation of blood from diseased to susceptible animals. The tropical bont tick (*Amblyomma variegatum*) was confirmed as a vector of the disease in South Africa in 1900. The rickettsial causative agent was found in the tissues of infected animals and ticks by Cowdry in 1925. In 1947, the rickettsial organism responsible for heartwater disease was named *Cowdria ruminantium*, after Cowdry. The first reported occurrence of the disease in the Western hemisphere was in 1980 in Guadeloupe, one of the Caribbean Islands. Since then it has gradually spread to as far north as Puerto Rico, southwards to Barbados and St. Vincent. The potential for the tropical bont tick, and thereby heartwater, to be introduced into the U.S. was demonstrated in 1992 when a cattle egret, banded in Guadeloupe (Caribbean), was found in the Florida Keys. Also, in 1997, the same tick species was found on a traveler to the Caribbean upon her return to Florida.

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Economic Impact

- Zimbabwe
 - US \$5.6 million annual losses
 - Acaricide, milk loss, treatment cost
- Serious threat to the United States
 - Caribbean Islands with infected ticks
 - Migratory cattle egrets
 - Susceptible cattle and deer population
- 40% to 100% death in U.S. expected

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Heartwater is a serious constraining to livestock development in much of sub-Saharan Africa. In an assessment of the economic impact of heartwater and its control in Zimbabwe (Preventative Veterinary Medicine 1999;39:173-189), the estimated total annual national losses due to heartwater were U.S.\$56 million. Losses in commercial systems, 25 times greater than losses in the communal system. The greatest components of economic loss were acaricide costs (76%), followed by milk loss (18%) and treatment cost (5%). Heartwater is a serious threat to the United States considering the presence of the disease in the Caribbean and the proximity to the southern coast of the United States. Migratory birds, especially cattle egrets (*Bubulcus ibis*), have been demonstrated to fly from the Caribbean to Florida. Additionally, our ruminant populations are naïve, and therefore more susceptible, to the severe form of the disease. It has been estimated that between 40% and 100% mortality in cattle population will be recorded if heartwater enters the United States.

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Epidemiology



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Geographic Distribution

- Sub-Saharan Africa
- The Caribbean Islands
 - Puerto Rico, Guadeloupe, Barbados, St. Vincent, Antigua, Marie, Galante
- Not reported in Asia



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Heartwater occurs where its tick vectors are present. The disease is endemic in Africa and the Caribbean islands. Carrier wildlife in these locations sustain the disease in nature. To date, heartwater has never been reported in Asia despite the presence of many species of *Amblyomma* ticks. Two indigenous ticks species in the United States, *A. maculatum* and *A. cajennense*, have been shown experimentally to be capable of serving as vectors of heartwater.

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Morbidity/Mortality

- Susceptible ruminants
- Morbidity: Approaches 100%
- Mortality:
 - 6% in Persian or Afrikaner sheep
 - 60% in Cattle
 - 80% in Merino sheep and Angora goats

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Untreated non-native cattle, sheep and goats often have morbidity rates approaching 100%. Death rate of 80% has been recorded in Merino sheep and Angora goats. Persian and Afrikaner sheep are more resistant to heartwater, with a mortality rate of 6% typically.

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Transmission


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Animal Transmission

- Vector-borne
- *Amblyomma* ticks
- Larvae and nymph infected
 - From infected animals
- Animal inoculation
 - Infected nymphs and adult ticks
 - To mammals, game birds and reptiles



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Heartwater is primarily transmitted by ticks of the genus *Amblyomma* (Family Ixoidae). At least twelve species of *Amblyomma* ticks have been shown to transmit *Cowdria ruminantium*. *A. variegatum* (tropical bont tick) is the most important transmitter of heartwater, pictured above. These three-host ticks can become infected during larval or nymphal stages and transmit the organism to the subsequent life-cycle stage (transstadial transmission). There is no transovarial transmission however (infected female ticks do not transfer the rickettsia to offspring). The life cycle of these ticks can take from 1-4 years. The immature stages feed on a wide variety of livestock, wild ungulates, ground birds, small mammals, reptiles and amphibians. Ticks can acquire the infection from the host from about the time of the febrile reaction for up to 361 days, or even longer. They thereafter probably retain the infection for life. Photo from The Gray Book at www.vet.uga.edu/vpp/gray_book.

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Animal Transmission

- Cow to calf transmission
 - Via colostrum
- Tick spread
 - Cattle egret
 - Helmeted guinea fowl
- Natural reservoirs
 - Blesbok
 - Wildebeest



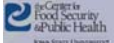
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In endemic areas, there has been evidence of transmission of HW from infected cows to their calves through colostrum. Wild ruminants such as blesbok (*Damaliscus dorcas phillipi*) and black wildebeest, as well as helmeted guinea fowl, leopard tortoise (*Geochelone pardalis*) and scrub hare have been shown to harbor *C. ruminantium* subclinically for long periods and do play a role as source of infection for ticks. Cattle egrets have become established in many regions with heartwater and have been implicated in the recent spread of the disease.

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Animals and Heartwater



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Affected Species

- Severe disease
 - Cattle, sheep, goats, water buffalo
 - White-tailed deer (experimentally)
- Mild disease
 - Indigenous African breeds of sheep and goats
- Inapparent disease
 - Blesbok, wildebeest, eland, springbok

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Heartwater causes severe disease in cattle, sheep, goats and water buffalo; mild disease in some indigenous African breeds of sheep and goats; and inapparent disease in several species of antelope indigenous to Africa, such as blesbok, wildebeest, eland and springbok. Several non-ruminant hosts have been shown to be carriers of *C. ruminantium*; these include guinea-fowl, leopard tortoises, and scrub hare. Experimentally white-tailed deer have been found to be susceptible to heartwater disease. The mortality rate was high. Additionally, *Amblyomma maculatum*, an experimentally proven vector of heartwater, is a common parasite of white-tailed deer in the U.S.

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Clinical Signs

- Incubation period: 14 to 28 days
 - Experimental i.v inoculation
 - Sheep and goats: 7 to 10 days
 - Cattle: 10 to 16 days
- Four forms of disease
 - Peracute (rare)
 - Acute (most common)
 - Subacute (rare)
 - Mild or subclinical

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Clinical signs and lesions of heartwater are representative of injury to the vascular endothelium and the resulting increase in vascular permeability. The incubation period ranges from 14-28 days, typically being shorter in sheep in goats than in cattle. In experimentally inoculated (i.v.) ruminants, clinical signs manifest quicker [7-10 days in sheep and goats, 10-16 days in cattle]. Disease can be peracute (rare), acute (most common), subacute (rare), mild or subclinical (calves) determined by various strains of the heartwater agent and animal susceptibility.

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Clinical Signs: Acute

- Most common form
- Sudden fever (107°F)
- Inappetence, depression
- Tachypnea, respiratory distress
- Nervous signs
 - Chewing movements, eyelid twitching, tongue protrusion, circling, high stepping gait, paddling
- Death in 1 week

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The most common form of heartwater is the acute form. This is seen in both nonnative and indigenous domestic ruminants. Animals develop an acute high fever, loss of appetite, depression and respiratory distress and tachypnea. Nervous disorders can soon follow and be seen as excessive chewing movements, incoordination, head tilting upwards, overly rigid posture and walking with a high stepping gait. Some animals may have convulsions. Galloping movements and opisthotonus are commonly seen before death.

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Clinical Signs: Subclinical

- "Heartwater fever"
- Asymptomatic
- Transient fever



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The mild form of the disease is called "heartwater fever". It is present in some affected regions among indigenous breeds with resistance or partial immunity to heartwater and antelope species. The only symptom is a transient fever. Photo: wildebeest.

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Clinical Signs: Other Forms

- Peracute
 - Sudden death
 - Fever, severe respiratory distress, convulsions, ± severe diarrhea
- Subacute
 - Prolonged fever, coughing, edema of lung, mild incoordination
 - Recovery or death in 1-2 weeks

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There are two other forms of heartwater that are rarely seen. The peracute form of heartwater is rare and typically occurs in non-native breeds of cattle, sheep and goats introduced into an enzootic area. Heavily pregnant cows are especially prone to develop the peracute form of the disease. Sudden death is the typical manifestation for this form. Clinical signs possibly seen prior to death may include fever, severe respiratory distress, and convulsions. Additionally, some breeds of cattle (Jerseys and Guernseys) may develop severe diarrhea. Clinical signs of the subacute form include prolonged fever and coughing due to prolonged edema of the lungs. Animals may show mild incoordination and will either recover in 1-2 weeks or will die.

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Post-Mortem Lesions

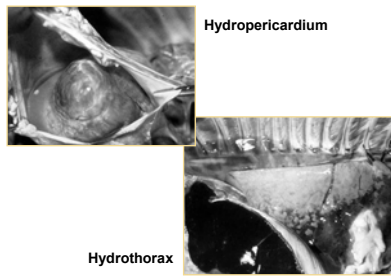
- Hydropericardium
- Hydrothorax
- Ascites
- Pulmonary and mediastinal edema
- Petechiae and ecchymoses
 - Mucosal and serosal surfaces
 - GI tract, esp. abomasum
- Congestion and edema in the brain

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The characteristic post-mortem lesion for heartwater is hydropericardium with straw-to-red colored pericardial fluid. It is more commonly found in sheep or goats than cattle. Other common lesions include hydrothorax, edema and congestion of the lungs, splenomegaly, petechiae and ecchymoses on mucosal and serosal surfaces and occasionally hemorrhage into the gastrointestinal tract, especially the abomasum. Additionally, edematous lymph nodes may be noted.

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Hydropericardium (top photo) and excessive fluid in the thoracic cavity and pulmonary edema (bottom photo). Note the distended interlobular septa. Photos from The Gray Book at www.vet.uga.edu/vpp/gray_book.

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Differential Diagnosis

- Anthrax (sudden death)
- Acute form
 - Rabies
 - Tetanus
 - Meningitis or encephalitis
 - Chlamydiosis
 - Theileriosis
 - Poisonings: strychnine, lead, arsenic

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Anthrax should be considered as a differential for the peracute form of heartwater (i.e., sudden death). Other diseases to consider with the acute form of heartwater include rabies, tetanus, bacterial meningitis or encephalitis, chlamydiosis or theileriosis. Additionally, poisonings from strychnine, lead or arsenic should be considered.

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Sampling

- Before collecting or sending any samples, the **proper authorities should be contacted**
- Samples should only be sent **under secure conditions** and to **authorized laboratories** to prevent the spread of the disease


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Before collecting or sending any samples from animals with a suspected foreign animal disease, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease.

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Diagnosis

- Clinical signs
 - Fever, respiratory distress, sudden death
 - Presence of *Amblyomma* ticks
- Laboratory Tests
 - Microscopic identification organism
 - PCR, IFA, ELISA




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Heartwater should be suspected in animals with the clinical signs including fever, respiratory distress, characteristic nervous symptoms, and sudden death. The presence of the vector tick *Amblyomma* species would be added evidence of suspicion. Diagnosis of heartwater can be done by identification of the *C. ruminantium* organism in Giemsa-stained smears of cerebral or cerebellar gray matter. PCR assays have provided more sensitive tests in both ticks and ruminants. There is no adequate serodiagnostic test for heartwater at this time due to cross reaction with closely related *Ehrlichia* species.

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Treatment

- Early stage
 - Oxytetracycline
- Late stage
 - When neurological signs occur
 - Usually futile




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Tetracycline antibiotics (especially oxytetracycline) are very effective in the treatment of heartwater, especially when used early in the course of the disease. Treatment is usually ineffective if the first dose of oxytetracycline is not administered until neurological signs appear.

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Heartwater in Humans



Heartwater does not infect humans nor produce disease in humans.

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Prevention and Control



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Recommended Actions

- Notification of Authorities
 - Federal:
 - Area Veterinarian in Charge (AVIC)
 - www.aphis.usda.gov/vs/area_offices.htm
 - State veterinarian
 - www.aphis.usda.gov/vs/sregs/official.htm
- Quarantine

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As soon as a farmer suspects the presence of clinical signs that are associated with heartwater and ticks are found on the animal, it is important to contact the Federal veterinarians-in-charge and the State veterinarian to report the observations and location.

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Recommended Actions

- Quarantine
 - All wild ruminants imported from Africa
 - PCR for *C. ruminantium*
 - All wild ungulates, birds, and reptiles imported to US
 - Examine for ticks

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At the ports of entry of animals into the United States, all incoming wild ruminants, ungulates, birds and reptiles should be quarantined. This exercise requires placing all incoming animals under intense examination for carrier status of cowdriosis and for presence of the ticks. Quarantine results are forwarded to the Veterinary Officer-In-Charge at Federal and State levels.

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Prevention

- Tick control program
 - Acaricides
- Eradication of the tropical bont tick from the Caribbean
- Importation control and monitoring
 - Infected wildlife or ticks on wildlife

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Preventative measures for heartwater include implementation of an effective tick control program, as well as regular inspection of animals and pastures for ticks. Elimination of the vector can be achieved through the use of acaricides. However acaricide resistance may develop.

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Vaccination

- Attenuated *C. ruminantium*
 - BALL3-strain serial passage
 - Confers solid immunity
- Universally effective vaccine not developed


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The only commercial vaccine available is made of the blood of sheep infected with live *C. ruminantium* organism BALL3-strain. The vaccine is administered intravenously into the jugular vein at dosage of 3 ml for cattle, sheep and goats, irrespective of age and size.

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Additional Resources



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Internet Resources

- World Organization for Animal Health (OIE) website
 - www.oie.int
- USAHA Foreign Animal Diseases – “The Gray Book”
 - www.vet.uga.edu/vpp/gray_book

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Further information on heartwater can be obtained from the web at the World Organization for Animal Health website, also at the webpage of the USAHA Foreign Animal Diseases book. The websites are as given here.

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