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Epidemiology of Bovine Anaplasmosis

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Summary

Bovine Anaplasmosis is one of the most important tick borne diseases of ruminants worldwide causing significant economic losses in the livestock industries due to the high morbidity and mortality in susceptible cattle herds. The main aim of this paper is to review the epidemiology of bovine anaplasmosis. Bovine Anaplasmosis, caused by *Anaplasma marginale*, is an infectious but non-contagious disease. The mode of transmission of Bovine anaplasmosis includes mechanical (blood contaminated fomites (needles, ear tagging, dehorning and castration equipment), biological (tick bites) and transplcenta (mother to fetus). Bovine Anaplasmosis occurs in tropical and subtropical regions worldwide. Cattle of all ages are susceptible to infection with *A. marginale*, but the severity of disease increases with age. The common clinical sign of bovine anaplsmosis includes; Fever, anorexia, rapid loss of body condition, severe decrease in milk production, pale and icteric mucous membranes, increased heart and respiratory rates, muscle weakness and depression. Diagnosis of bovine Anaplasmosis can be made by demonstration of *A. marginale* on stained blood smears from clinically infected animals during the acute phase of the disease, but it is not reliable for detecting infection in pre-symptomatic or carrier animals. Instead of blood smears, serological demonstration of antibodies and confirmation of antigen with molecular detection method is more prefer than blood smear. Anaplasmosis can be treated by administration oxytetracycline; however a carrier animal doesn't recover with oxytetracycline treatment. Control measures for bovine Anaplasmosis vary with geographical location and include maintenance of Anaplasma free herds, vector control, administration of antibiotics and vaccination. Generally, Anaplasmosis is one of the ricketticia diseases of bovine which decrease development of country. Intensive acaridae application to control ticks has a number of limitations, therefore, immunization together with strategic tick control is recommended for exotic and crossbred cattle. Further studies on epidemiology of bovine anaplasmosis were not conducted in Ethiopia; therefore the researcher and Veterinarians should have to be focused on Bovine anaplasmosis.

Keywords: *Anaplasmosis, Anaplasma marginale*, Bovine Rickettsia, Tick

Introduction

Bovine Anaplasmosis is one of the most important tick borne diseases of ruminants across the worldwide which causing significant economic losses in the livestock industries in the tropical and subtropical areas mainly due to the high morbidity and mortality in susceptible cattle herds [1]. Bovine anaplasmosis also known as Red water or Gall sickness which is an important disease of cattle primarily caused by *Anaplasma marginale* and it infects erythrocytes, which results to erythrophagocytosis and subsequently anaemia [2]. The primary causative agent is *Anaplasma marginale,* Gram-negative obligate intracellular bacteria parasitizing erythrocytes [3]. It has been described in domestic and wild animals (Cattle, Water Buffalo, Bison, African Antelopes, White-Tailed Deer and Mule Deer); clinical disease is most notable in cattle, but wild ruminants can become persistently infected serving as reservoirs for infection of susceptible hosts [1].It is an infectious but noncontiguous disease, which spread through tick bites, mechanical transfer and/or transplacental transmission [3].

A. phagocytophilum causes febrile disease in cattle varying from undetectable clinical signs to serious complications, including death [4]. The disease is characterized by high fever, cough, abortion, decreased milk production, and anorexia [5].

Even if, the disease is present in Ethiopia, the epidemiology of bovine anaplasmosis has not been conducted well in Ethiopia. Therefore, the main objective of this paper is to review epidemiology of Bovine Anaplasmosis.

Literature Review

Etiology

Anaplasmosis in cattle is caused mainly by *Anaplasma marginale* and are intra-erythrocytic microorganisms of the order of Rickettsiales [6]. *Anaplasma marginale* is a tick-borne pathogen and the causative agent of bovine anaplasmosis. *A. marginale* is classified in the Rickettsial order, reorganized into two families such as Anaplasmataceae and Rickettsiaceae [7].

Anaplasma organisms are obligate intracellular Gram-negative *rickettsia*, found exclusively within vacuoles derived from the erythrocyte membrane, and are membrane-bound within the cytoplasm of the host cell. *A. marginale* persist in nature in mammalian and ticks hosts, which serve as reservoirs of infection in the bovine, A. marginale infect erythrocytes and endothelial cells [8, 9]. The genus Anaplasma includes three species that can infect ruminants, *A. marginale* and *A. centrale* in cattle as detailed in table 1. *A. marginale* and *A. centrale* infect cattle, but differ in morphology, virulence and geographical distribution [7].

Source: Rymaszewska, and Grenda (2008)

Table 1: The characteristic of pathogens of genus *Anaplasma* causative agent of Bovine anaplasmosis

Aetiological agent		Disease	Vector	Infected organism or host
Before 2001	**After 2001**			
Anaplasma marginale	Anaplasma marginale	Bovine anaplasmosis	Ixodes spps; dermancentor spps	Ruminnat farming
Anaplasma central	Anaplasma central	Bovine anaplasmosis	Haemaphysalis spps, Ixodes spps	Ruminants farming
E.equi E.phagocytophila	Anaplasma phagocytophilum	Human and animal granulocytic anaplsmosis	Ixodes spps; Dermacentor spps	Small ruminants forming an wild,horses,dogs, Humans

Epidemiology

Geographic distribution

Bovine anaplasmosis is the major cause of morbidity and mortality in the tropics and subtropics, particularly in exotic and crossbred cattle. The geographic distribution of the disease is dependent on the density and distribution of tick vectors and reservoir host. The distribution of Anaplasmosis may continue to change due to the trend of global warming, which may influence the movement of the tick hosts [10].

Host occurrence

Among domestic livestock, *A. marginal* infects ruminants, but is principally pathogenic only in cattle. The pathogen has a wide host range including various wild animals. The epidemiological contribution of domestic and wild animals toward prevalence of disease is insufficient due lack of further research conduction [11]. Severity of Anaplasmosis is related to various factors such as virulence of the strain, age-related host susceptibility and breed resistance. Calves less than 1 year old show only mild signs or remains asymptomatic and Cattle more than 2 years of age are most likely to have severe, acute and potentially fatal disease. *Bos Taurus* cattle appear to be more likely to develop severe, acute disease than *Bos indicus* cattle [12, 13].

Calves are much more resistant to disease (although not infection) than older cattle. This resistance is not due to colostral antibody from immune dams, but they regenerate red blood cells faster than adults. In endemic areas where cattle first become infected with *A marginale* early in life, losses due to anaplasmosis are minimal [14, 15]. Animals that recover from the disease may remain carriers for life and becoming reservoirs for transmission to other susceptible hosts. However, these chronically infected cattle may relapse to anaplasmosis when immunosuppressed (by corticosteroids), when infected with other pathogens, or after splenectomy. Carriers serve as a reservoir for further transmission. Serious losses occur when mature cattle with no previous exposure are moved into endemic areas or under endemically unstable situations when transmission rates are insufficient to ensure that all cattle are infected before reaching the more susceptible adult age [15].

Source of infections

Anaplasmosis is a vector-borne and also known as yellow-bag or yellow fever. This parasite infects the red blood cells and causes severe anemia. It is most usually spread by ticks. The tick is considered the primary vector for this disease, and it acquires *A. marginale* by feeding on infected erythrocytes in cattle. The tick then acts as a reservoir by replicating in several tissues, but primarily in the midgut and salivary glands, with the latter of greater importance for transmission back to cattle [16].

Method of Transmissions

A. marginale transmission typically occurs via two different routes, the biological pathway through mostly ticks and mechanical pathway [9, 11, 17]. Mechanical transmission can occur through reusing of needles, dehorners, ear taggers, castrating knives or other surgical instruments, and tattoo instruments [1, 18]. In mechanical transmission, the organism is transferred by blood-contaminated mouthparts of biting flies or by blood-contaminated equipment. Horse flies are capable of transmitting the organism and may remain mechanically infective for up to two hours after feeding on an infected animal. Blood-contaminated equipment, such as used vaccination needles, can also transfer *A. marginale* from an infected animal to uninfected animals [19, 20].

Biological transmission occurs through ticks. Once a tick acquires the organism through a blood meal, the organism infects the tick's gut cells and completes part of its life cycle. Over time, other tissues within the tick, including salivary glands, become infected. When a tick feeds on cattle, it transmits the organism through its saliva. Ticks can develop persistent infections and, with their intermittent feeding, can transmit the organism to multiple animals within the herd and nearby herds [20, 21]. Transplacental transmission occurs when the organism is transmitted from dam to fetus. This transmission appears to occur during the second or third trimester of pregnancy [22, 23].

Risk Factors

Bos taurus breeds are not commonly affected by Anaplasmosis because of their reistance to heavy tick infestation, however they are more likely to develop acute Anaplasmosis than cross Zebu breed [1]. Anaplasmosis infection is higher in female than male animals due to hormonal disturbances, milk production, draught power and breeding system which pose it to weakened immune system (Setotaw et al., 2014). In temperate regions seasonal occurrence of the disease is associated with the occurrence of the vectors and the prevalence of Anaplasmosis is found higher in hot and humid weather associated with the abundance of ticks [24].

Lifecycle and Pathogenesis

Ticks acquire the rickettsia while feeding on carrier hosts (figure1), and within the erythrocyte, the rickettsia replicates by binary fission to form 8–12 initial bodies and exit from the erythrocyte does not involve destruction of the host's cell. Once out of the host cell, the initial bodies invade new erythrocytes in endless cycles. In the tick, the rickettsia infects midgut cells, where there is a first cycle of replication and from here dense forms move to other tissues. After several rounds of replication, dense forms travel to the salivary glands where the rickettsia is transmitted to a new mammalian host (Rodríguez et al 2009; Futs e et al 2003). When cattle are exposed to A. marginale, an incubation period of 7-60 days follows depending on the infective dose. *A. marginale* is a strictly intra-erythrocyte microbe and the infected erythrocyte contains a membrane-bound inclusion, called initial body, that each contains four to eight rickettsias [1].

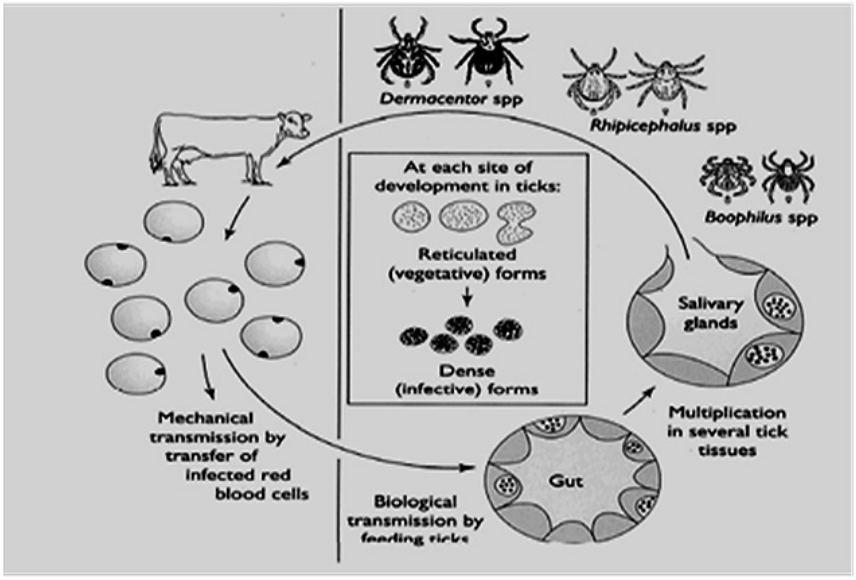

Figure 1: Life cycle of *A. marginale* (Source: Kocan et al. 2003)

In the erythrocytes, A.marginale undergoes a cycle of replication, and subsequently they are phagocytized by the reticuloendothelial system to further reinvade other erythrocytes. During this acute phase as many as 109 erythrocytes per milliliter of blood, corresponding 70 % of all erythrocytes, can be infected [26, 27]. The phagocytosis of erythrocytes results in mild to severe haemolyticanaemia and icterus without hemoglobinemia or hemoglobinuria [9, 11].

Clinical Signs

Bovine anaplasmosis have different forms of clinical phases including; Peracute, acute, chronic and mild. Acute anaplasmosis is most common and usually occurs in summer and fall during peak vector season. Fever (in some), anorexia, rapid loss of body condition, severe decrease in milk production, pale and icteric mucous membranes, increased heart and respiratory rates, muscle weakness and depression are common. Aggression from cerebral anoxia is common, especially in beef cattle. Abortions can occur in females and temporary infertility can occur in males. Since the hemolysis is extravascular, hemoglobinuria does not occur [13]. Peracute anaplasmosis is most common in highly susceptible purebred animals and dairy cows and also the death occurs within hours of the onset of clinical signs due to icterus [28]. Chronic disease occurs in severely affected animals that do not die. It may take weeks to months for animals to recover, during which time production losses can be significant (decreased calf weaning weights, infertility). Clinical signs of anaplamosis include fever, jaundice, anorexia and lethargy, which can lead to a dramatic decrease in milk production [28, 29].

If cattle are carefully observed, weakness may be the first clinical sign that is noticed with Anaplasmosis. Infected cattle will fall behind the rest of the herd and will not eat or drink. Cows with light skin will initially look pale around the eyes and muzzle, but later this can change to a yellowish color (jaundice). This jaun dice is due to the destruction of the blood cells and their contents being released into the blood stream. Weight loss is rapid. Cattle can become extremely aggressive if they are oxygen deprived due to the severe anemia. Oxygen deprivation can also result in abortions in pregnant cows. Constipation, high fever, and labored breathing can also be seen. The most critical period is the first 4 to 9 days after clinical signs appear [13, 30].

Signs are refusal to eat, constipation, very hard dung, panting, sudden drop in milk production, Fever (41°C), swollen abdomen, loss of balance, raised hair, animal is depressed and docile; it seeks shade. The urine may be brown but, in contrast to babesiosis, hemoglobinuria does not occur. Surviving cattle convalesce over several weeks, during which hematologic parameters gradually return to normal [14].

Necropsy

Lesions are typical of those found in animals with anemia due to erythrophagocytosis. The carcasses of cattle that die from anaplasmosis are generally markedly anemic, jaundiced; watery blood and enlarged spleen. The liver may be mottled and yellow-orange. The gallbladder is often distended and contains thick brown or green bile (Gall sickness). Hepatic and mediastinal lymph nodes appear brown. There are serious effusions in body cavities, pulmonary edema, petechial hemorrhages in the epi- and endocardium. Widespread phagocytosis of erythrocytes is evident on microscopic examination of the reticuloendothelial organs. A significant proportion of erythrocytes are usually found to be parasitized after death due to acute infection [14].

Diagnosis

The diagnosis of Bovine anaplasmosis is depending on clinical history of animals and laboratory examination. The clinical history of patient has a history of tick bites or exposure of animals to ticks in environment, and then, after an incubation period of 2-7 days the bovine animal develops an illness of sudden onset of muscle pains, headache, fever and a rapidly evolving severe illness with the development of a haemorrhage state with bleeding from the mucous membranes and petechial in the skin, associated with thrombocytopenia and leucopenia [11].

The most commonly used laboratory method for the identification of the organism in most developing countries is microscopic examination of Giemsa stained thin blood film. However, this method cannot detect low level of rickettsiaemia as seen in infected host. In addition, in persistently infected cattle, it is difficult to differentiate the pathogen from similar structures such as Howell-Jolly bodies, Heinz bodies and staining artifacts, thus rending this method unreliable [31].

Microscopic examination of Giemsa-stained thin and thick blood films is critical to distinguish anaplasmosis from babesiosis and other conditions that result in anemia and jaundice, such as leptospirosis and theileriosis [32]. Blood sample is taken to anticoagulant vacutainer tube from jugular vein of bovine animals for hematologic testing. Then, the blood is examined by Giemsa staining of thin blood films and thus Anaplasma spss appears as dense, homogeneously staining blue-purple inclusions 0.3–1 μm in diameter. Anaplasma marginale inclusion is usually located toward the margin of the infected erythrocyte, whereas A. centrale inclusion bodies are located more centrally [32]. Even if Anaplasma infections usually are persistent, it may be undetectable by microscopy after the acute phase. Thus, for detection of pre-symptomatic and persistently infected animals serological method seems more reliable. The only way to diagnose of the presence of the causative organism is to demonstrate it, either by presence in blood smears or by molecular diagnostics. The golden standard is to inoculate blood from a suspected animal into a spleenectomized calf. This procedure is followed by multiple blood-smear examination every 2nd–3rd week for the presence of the pathogen. This method is very expensive and raises welfare issues (OIE, 2012)

Chronically infected carriers may be identified with a fair degree of accuracy by serologic testing using the msp5 ELISA, complement fixation, or card agglutination tests. Nucleic acid–based detection methods are most useful, because species and strain differentiation tests may not detect carrier levels. At necropsy, thin blood films of liver, kidney, spleen, lungs, and peripheral blood should be prepared for microscopic examination [32].

Treatment

In the carrier phase, animals that have recovered from Anaplasmosis become persistent carriers of the organism. The benefit of the carrier state is that the animal has life-long immunity and rarely shows clinical disease again, but it does serve as a reservoir of the organism within the herd. Because of the latter, elimination of carrier animals through either culling or chemo sterilization has been attempted [26]. Chemo sterilization involves the use of antimicrobials. Until recently, it was believed chemo sterilization could be achieved with repeated administration of injectable oxytetracycline, but new studies show this method to be ineffective [33, 34]. The long-term feeding of chlortetracycline has been proposed as an option, but this strategy is not 100 percent effective and requires feeding chlortetracycline in an unapproved manner, which is unlawful [20, 40].

Prevention and Control

Control measures currently available for tick-borne diseases include the use of acaricides for reduction or tick populations, specific chemotherapy, chemoprophylaxis, controlled exposure and vaccination. These measures limit losses caused by ticks and the diseases they transmit [27]. Control measures for bovine anaplasmosis vary with geographical location and include maintenance of Anaplasma-free herds, vector control, administration of antibiotics and vaccination [11]. For effective control of anaplasmosis, early diagnosis and treatment is essential, while continuous screening should be practiced to control the disease. The strategies commonly employed to control Anaplasmosis are minimizing transmission, use of feed antimicrobials, and vaccination [13, 32].

To minimize transmission, control of arthropod vectors such as ticks and horse flies is recommended when feasible. Several sprays pour on and fly tag products are approved for tick control, but control of biting flies can be more difficult and may require the use of alternative methods. Finally, eliminating carrier animals from the herd and testing new animals may be warranted in some cases. The benefits versus risk of an Anaplasmosis-free herd in a region where the disease is common, along with the costs associated with testing and eliminating carrier animals would need to be considered [35]. Control measures implemented vary with geographic location, and depend on availability, cost, and the feasibility of application. Vaccination has been an effective means of preventing outbreaks of anaplasmosis, but these vaccines, live and inactivated, are dependent on bovine blood as the source of infection or antigen [35, 36].

For an effective vaccination program, the herd owner should follow these recommendations: the initial vaccination (1st year) consists of 2 doses given 4 weeks apart, scheduled so that the second dose is given at least 2 weeks or more before the vector season begins. The following year, a booster should be administered two weeks or more before the next vector season. After the first booster, additional boosters should be administered at least every other year to provide adequate protection. Identification of Anaplasmosis carriers, by testing, could constitute an appreciable savings in heavily infected herds because vaccination of the carriers is unnecessary. A positive test reaction resulting from vaccination cannot be differentiated from the positive reaction caused by the natural infection [36].

Economic Impacts

Bovine anaplasmosis cause great economic losses in developing countries where it is highly endemic. Economic losses are due to reduced production, decreased weight gain, treatment costs, bull infertility, death loss and abortion [26]. Costs are incurred from mortality, loss of milk and meat production, control measures (acaricides treatments, vaccines, and chemotherapy), and its impact on international cattle trade (Bock et al., 2004). Anaplasmosis has also the grave socioeconomic consequences often leading to trade restrictions both locally and internationally [38].

Bovine Anaplasmosis Status in Ethiopia

The Bovine analasmosis has been reported in Ethiopia, however further studies were not conducted as well. As reported that the prevalence of Bovine anaplasmosis was 6.8% in Jimma town and its surrounding [39]. Other studies have not been conducted to expose Bovine anaplasosis in Ethiopia.

Conculsion and Recommendations

Bovine anaplasmosis is one of the overwhelming infectious diseases in cattle industry which cause diminishes socioeconomic of developing country. It is caused by intracellular rickettisia microorganisms. Bovine anaplasmosis have the behavior of self limit in blood of animals this lead persistence carrier of cattle, thus it is so difficult to treat this disease with antibiotics. It is better to prevent and control future outbreaks and the spread of Anaplasmosis to naive herds than treatment. Problems of acaridae resistance, chemical residues in food and the environment and the unsuitability of tick resistant cattle for all production systems make the current situation unsatisfactory and require the development of absolute control through effective vaccine. Generally, Anaplasmosis is one of the rickettisia diseases of bovine which decrease development of country by reducing number of animal production and productivity. Therefore, in line with the above conclusions; the following recommendations were forwarded:

- The government should monitor the use of potentially drugs and conserve foreign exchange.
- Intensive acaridae application to control ticks has a number of limitations, therefore, immunization together with strategic tick control is recommended for exotic and crossbred cattle.
- The researcher need to study Bovine anaplsmosis and its control in Ethiopia
- The veterinarian ought to aware the community how to prevent bovine anaplasmosis.

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