FOOD ANIMAL MEDICINE VCM 501 LECTURE NOTE ON:
AFRICAN ANIMAL TRYPANOSOMOSIS
(Nagana, Tsetse Disease, Tsetse Fly Disease)

Definition
African animal trypanosomosis (AAT) is a disease complex caused by tsetse-fly-transmitted *Trypanosoma congolense*, *T. vivax*, or *T. brucei brucei*, or simultaneous infection with one or more of these trypanosomes. African animal trypanosomosis is most important in cattle but can cause serious losses in pigs, camels, goats, and sheep. Infection of cattle by one or more of the three African animal trypanosomes results in subacute, acute, or chronic disease characterized by intermittent fever, anemia, occasional diarrhea, and rapid loss of condition and often terminates in death. In southern Africa the disease is widely known as nagana, which is derived from a Zulu term meaning "to be in low or depressed spirits"— a very apt description of the disease.

Etiology

African animal trypanosomosis is caused by protozoa in the family Trypanosomatidae genus *Trypanosoma*. *T. congolense* resides in the subgenus *Nannomonas*, a group of small trypanosomes with medium-sized marginal kinetoplasts, no free flagella, and poorly developed undulating membranes. In east Africa, *T. congolense* is considered to be the single most important cause of AAT. This trypanosome is also a major cause of the disease in cattle in West Africa. Sheep, goats, horses, and pigs may also be seriously affected. In domestic dogs, chronic infection often results in a carrier state.

T. vivax is a member of the subgenus *Duttonella*, a group of trypanosomes with large terminal kinetoplasts, distinct free flagella, and inconspicuous undulating membranes. *T. vivax* is a large (18-26 µm long) monomorphic organism that is very active in wet-mount blood smears. Cattle, sheep, and goats are primarily affected. Although this organism is considered to be less pathogenic for cattle than *T. congolense*, it is nevertheless the most important cause of AAT in West African cattle. This trypanosome readily persists in areas free of tsetse flies (for example, in Central and South America and in the Caribbean), where it is transmitted mechanically by biting flies or contaminated needles, syringes, and surgical instruments.

T. brucei brucei resides in the subgenus *Trypanozoon. T. b. brucei* is an extremely polymorphic typanosome occurring as short, stumpy organisms without flagella, long slender organisms with distinct flagella, and intermediate forms that are usually flagellated. Horses, dogs, cats, camels and pigs are very susceptible to *T. b. brucei* infection. Infection of cattle, sheep, goats and sometimes pigs results in mild or chronic infection.

Host Range
Cattle, sheep, goats, pigs, horses, camels, dogs, cats, and monkeys are susceptible to AAT and may suffer syndromes ranging from subclinical mild or chronic infection to acute fatal disease. Rats, mice, guinea pigs, and rabbits are useful laboratory species.

More than 30 species of wild animals can be infected with pathogenic trypanosomes, and many of these remain carriers of the organisms. Ruminants are widely known to be active reservoirs of the trypanosomes. Wild Equidae, lions, leopards, and wild pigs are all susceptible and can also serve as carriers of trypanosomes.

Geographic Distribution
The tsetse-fly-infested area of Africa extends from the southern edge of the Sahara desert to Angola, Zimbabwe, and Mozambique.

Transmission
In Africa, the primary vector for *T. congolense*, *T. vivax*, and *T. b. brucei* is the tsetse fly. These trypanosomes replicate in the tsetse fly and are transmitted through tsetse fly saliva when the fly feeds on an animal. The three main species of tsetse flies for transmission of trypanosomes are *Glossina morsitans*, *G. palpalis*, and *G. fusca*.
Trypanosomosis is also mechanically transmitted by tsetse and other biting flies through the transfer of blood from one animal to another. The most important mechanical vectors are flies of the genus *Tabanus*, but *Haematopota*, *Liperosia*, *Stomoxys*, and *Chrysops* flies have also been implicated. In Africa, both *T. vivax* and *T. b. brucei* have spread beyond the "tsetse fly belts", where transmission is principally by tabanid and hippoboscid flies.
The vector for *T. vivax* in the Western Hemisphere remains unknown, but several species of hematophagous (especially tabanid and hippoboscid) flies are believed to serve as mechanical vectors.

Incubation Period
The incubation period for *T. congolense* varies from 4 to 24 days; for *T. vivax*, from 4 to 40 days; and for *T. b. brucei*, from 5 to 10 days.

Pathogenesis
Initial replication of trypanosomes is at the site of inoculation in the skin; this causes a swelling and a sore (chancre). Trypanosomes then spread to the lymph nodes and blood and continue to replicate. *T. congolense* localizes in the endothelial cells of small blood vessels and capillaries. *T. b. brucei* and *T. vivax* localize in tissue. Antibody developed to the glycoprotein coat of the trypanosome kills the trypanosome and results in the development of immune complexes. Antibody, however, does not clear the infection, for the trypanosome has genes that can code for many different surface-coat glycoproteins and change its surface glycoprotein to evade the antibody. Thus, there is a persistent infection that results in a continuing cycle of trypanosome replication, antibody production, immune complex development, and changing surface-coat glycoproteins.
Immunologic lesions are significant in trypanosomosis, and it has been suggested that many of the lesions (e.g., anemia and glomerulonephritis) in these diseases may be the result of the deposition of immune complexes that interfere with, or prevent, normal organ function. The most significant and complicating factor in the pathogenesis of trypanosomosis is the profound immunosuppression that occurs following infection by these parasites. This marked immunosuppression lowers the host's resistance to other infections and thus results in secondary disease, which greatly complicates both the clinical and pathological features of trypanosomosis.

Clinical Signs

Because simultaneous infections with more than one trypanosome species are very common, and simultaneous infection with trypanosomes and other hemoparasites (*Babesia* spp., *Theileria* spp., *Anaplasma* spp., and *Ehrlichia* spp.) frequently occurs, it is difficult to conclude which clinical signs are attributable to a given parasite.

The cardinal clinical sign observed in AAT is anemia. Within a week of infection with the haematic trypanosomes (*T. congolense* and *T. vivax*) there is usually a pronounced decrease in packed cell volume, hemoglobin, red blood cell, and white blood cell levels, and within 2 months these may drop to below 50 percent of their pre-infection values. Also invariably present are intermittent fever, edema, lethargy and loss of condition. Abortion may be seen, and infertility of males and females may be a sequel. The severity of the clinical response is dependent on the species and the breed of affected animal and the dose and virulence of the infecting trypanosome. Stress, such as poor nutrition or concurrent disease, plays a prominent role in the disease process, and under experimental conditions, where stress may be markedly reduced; it is difficult to elicit clinical disease.

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Gross Lesions

No pathognomonic change is seen in AAT. Anemia, edema, and serous atrophy of fat are commonly observed. Subcutaneous edema is particularly prominent and is usually accompanied by ascites, hydropericardium, and hydrothorax. The liver may be enlarged, and edema of lymph nodes is often seen in the acute disease, but they may be reduced in size in the chronic disease. The spleen and lymph nodes may be swollen, normal, or atrophic. Necrosis of the kidneys and heart muscle and subserous petechial hemorrhages commonly occur. Gastroenteritis is common, and focal polioencephalomalacia may be seen. A localized lesion (chancre) may be noted at the site of fly bite, especially in goats.

The lesions caused by the trypanosomes in susceptible host species vary considerably, depending on the species and strain of trypanosome and the species and breed of host animal affected. The haematic trypanosomes (*T. congolense* and *T. vivax*) cause injury to the host mainly by the production of severe anemia, which is accompanied in the early stages of the disease by leukopenia and thrombocytopenia. In the terminal stages of the disease caused by the haematic trypanosomes, focal polioencephalomalacia probably results from ischemia due to massive accumulation of the parasites in the terminal capillaries of the brain.

The lesions resulting from *T. b. brucei* (a tissue parasite) are remarkably different from those seen with the haematic trypanosomes. Anemia is an important lesion, but much more dramatic are the inflammation, degeneration, and necrosis resulting from cellular invasion of various organs. Marked proliferative changes reflecting immunologic response are observed in most body tissues.

Diagnosis

Field Diagnosis

Trypanosomiasis should be suspected when an animal in an endemic area is anaemic and in poor condition. Confirmation depends on the demonstration of the organism in blood or lymph node smears.

In the early phases of infection, especially with *T. vivax* and *T. congolense*, the parasite can readily be observed by microscopic examination of a wet-mount of blood slides. Thick blood films and stained with Giemsa are also a good technique, but in thin fixed blood films, which are favored for species identification, the parasites may be hard to demonstrate. When parasitemia is low, smears of buffy coat (obtained by microhematocrit centrifugation) can be useful for demonstration of the parasites. Because *T. congolense* tends to associate with the erythrocytes, it is essential that buffy coat and adjacent erythrocytes be included in the smear to ensure demonstration of the parasite.

Stained lymph node smears are a very good method for diagnosis, especially for *T. vivax* and *T. b. brucei*. In chronic *T. congolense* infection, the parasites localize in the microcirculation of the lymph nodes and in other capillary beds, allowing diagnosis by examination of lymph node smears or smears made with blood collected from the ear. Early in infection, blood smears are optimal for the demonstration of *T. congolense*.

These conventional techniques of microscopic examination for the presence of trypanosomes are still widely used, but newer and far more sensitive methods are beginning to supplant them. The antigen-detecting enzyme-linked immunosorbent assay is extremely sensitive for the detection of trypanosomosis in cattle and goats, and species-specific DNA probes have been shown to detect simultaneous infection of cattle with *T. vivax*, *T. b. brucei*, and *T. congolense* when conventional methods revealed only single infections.

Specimens for the Laboratory

To perform the preceding and more sensitive procedures, the following specimens should be submitted to the laboratory from several animals: serum, blood with the anticoagulant EDTA, dried thin and thick blood smears, and smears of needle lymph node biopsies.

Control and Eradication

Vector Control

Fly eradication and drug prophylaxis are the only effective trypanosomosis control methods now available. The recent introduction of odor-baited targets impregnated with insecticides is proving promising as a means of reducing the tsetse fly.

Chemotherapy and Chemoprophylaxis

Chemoprophylactic drugs: Isometamidium chloride, which comes under the trade names Samorin, Trypamidium, and M&B 4180A, is excellent for the prophylaxis of all three African animal trypanosomes, and gives protection for 3-6 months. The development of resistance to this drug has been reported in both east and West Africa. Homidium bromide has also been found to be an effective chemophrophylactic drug in Kenya, and the newly introduced arsenical Cymelarsan is effective in treatment of *T. b. brucei* infection.

A very widely used chemotherapeutic drug is diminazine aceturate (Berenil), which is effective against all three African animal trypanosomes. The isometamidium drugs are also excellent chemotherapeutic agents as are the quaternary ammonium trypanocides Antrycide, Ethidium and Prothidium.

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Immunization
No vaccine is currently available for African animal trypanosomosis.

Trypanotolerance
It has long been recognized that certain breeds of African cattle are considerably more resistant to African trypanosomosis that others. This is especially true of the
West African short-horned cattle (Muturu, Baoule, Laguna, Samba, and Dahomey) and the N'Dama, which is also of West Africa.

Public Health
The three AAT trypanosomes are considered to be nonpathogenic for humans. *T. b. brucei*, although not causing human disease, is closely related to *T. b. gambiense* and *T. b. rhodesiense*. The latter is the cause of human sleeping sickness, a very debilitating and often fatal disease considered to be of major public health significance in 36 sub-Saharan countries of west, central, and east Africa.

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Session prepared: 2010/2011