immunodiffusion, counterimmunoelectrophoresis, and ELISA (enzyme-linked immunosorbent assay). Antibody can be measured by virus neutralization, complement fixation, and ELISA.

Intestinal lesions in other species are similar to those described for the calf. In the field, a synergestic action of rotavirus and *Escherichia coli* is believed to occur, but this has not been proven under controlled conditions. Dr. Torres at the University of Nebraska is currently working on this relationship and has been able to show the enhancing effect of viral infection on *E. coli* growth.

In a study in Canada on 55 calves submitted for necropsy in their first two weeks of age because of calf diarrhea, 46% of 35 calves on which a diagnosis was made had an etiologic diagnosis of rotavirus alone or in combination with *E. coli,* coronavirus, cryptosporidium, and IBR. No diagnosis was made on 20 calves; 19 of the 20 calves in this group were submitted dead.

Coronavirus infection has not received the amount of attention as rotavirus. A counterimmunoelectrophoretic test has been developed for detection of antigen in feces.

In the Canadian study previously mentioned, 37% of 35 calves on which a diagnosis was made had an etiologic diagnosis of coronavirus alone or in combination with rotavirus, cryptosporidium, IBR, and mycotic abomasitis. In a South Dakota study of 689 calves from one day to three months old, 16.4% had a coronavirus infection. Incidence of infection in 412 calves from one to 14 days old was 22%.

Neonatal calf diarrhea caused by an agent that morphologically resembled a coronavirus but was serologically unrelated has been reported. The clinical picture and lesions for this new agent were also different than those described for the first bovine coronavirus.

Malignant Catarrhal Fever

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Malignant catarrhal fever (MCF) is a disease of cattle, buffalo, American bison, and deer caused by a herpesvirus. The disease can occur in one or in a combination of 4 forms - peracute, head and eye, intestinal and mild. The most commonly recognized natural disease is the head and eye form. Generally MCF has a low morbidity and high mortality.

Etiology - An etiologic agent for MCF was first isolated in 1964 in Africa from a wildebeest cow and was characterized as a herpesvirus. In 1978, herpesviruses isolated from a European bison in a zoo in the Netherlands and from a cow in Minnesota were shown to be related to the African MCF virus. The wild virus is difficult to isolate in cell culture.

History - Malignant catarrhal fever occurs world wide. The disease is usually sporadic, but once it occurs in a herd there is a tendency for it to recur. However, epizootics of MCF involving large numbers of cattle or deer have been reported. In the winter of 1972-1973, a herd of 231 cattle in Colorado lost 87 head (37%) over a period of 68 days.

The association of MCF in cattle to contact with sheep, particularly lambing ewes, was first recognized in Europe in 1878. In the mid 1800's hunters in Southern Africa noted that MCF in cattle was associated with calving wildebeest.

Signs

Clinical features - Four forms of the disease are described - peracute, head and eye, intestinal and mild, but in reality there is considerable overlap; the clinical signs can be quite variable and the diagnosis elusive.

Peracute form: Severe inflammation of the oral and nasal mucosa and hemorrhagic gastro-enteritis are observed. The course of this form is 1-3 days.

Head and eye form: This is the typical clinical syndrome of MCF. The first sign of infection is a serous nasal and ocular discharge which may occur 2-7 days before pyrexia. Pyrexia is a common sign of the disease and is often biphasic. The temperature is usually high, 104-107°F, and remains high until shortly before death at which time, it is subnormal. The bilateral nasal discharge soon becomes mucoid and then mucopurulent. Accumulation and drying of nasal exudate is common in late stages of disease, and causes partial or complete blockage of nostrils resulting in dyspnoea. At this stage the sick animal breathes through its mouth and usually drools saliva.

The oral mucosa is reddened and has necrotic foci. Because the stratum germitivum is rarely involved, the necrotic lesions are designated as erosions rather than ulcers.

In the live animals, these lesions are pink or red due to the underlying capillary bed. Erosions occur more frequently on the lips, gums hard and soft palate and the mucosa of cheeks. The sharp-pointed buccal papillae are often reddened and blunted.

Ocular discharges are at first serous and then purulent in later stages of disease. Ophthalmia, prominent scleral veins and swollen eyelids are common features. Corneal opacity starts at the periphery and progresses centripetally resulting in either partial or complete blindness. Corneal opacity is usually bilateral but occasionally one eye is affected more severely than the other. Photophobia is usually associated with keratitis.

Increased thirst starts in early stages of the disease and continues until shortly before death. Anorexia is observed in the late stages of MCF. Constipation is a common feature of the head and eye form but terminal diarrhea is occasionally observed.

Nervous signs are rare, although shivering, incoordinated movements and terminal nystagmus may be observed. Skin lesions are rare. The course of this form is usually 7-14 days.

Intestinal form: This form is characterized by pyrexia, diarrhea, severe hyperemia of the oral and nasal mucosa. Nasal and ocular discharge and enlargement of lymph nodes are common features. The course of this form is 4-9 days.

Mild form: This form has been observed after experimental infection of cattle with modified viruses. The animals often recover.

Incubation Period - The incubation period of MCF under natural conditions is not known. In experimental infections the incubation period has varied from 9 days to 2 months.

Pathological Changes

Postmortem lesions - The lesions vary according to the form and the course of the disease. Animals that die of the peracute disease usually show no diagnostic lesion. In this case the diagnosis must rest on the detection of characteristic histopathological changes.

In cases of the intestinal or head and eye form, the carcass may be normal, dehydrated or emaciated, depending on the course of the disease. The muzzle is often heavily encrusted and if wiped reveals an irregular raw surface.

The respiratory system may have minor or severe lesions. When the course is short, the nasal mucosa may be congested and have a slight to moderate serous exudate. Later, there is a profuse mucopurulent discharge. The mucosa may then be intensely congested and edematous. Erosions may be common. Occasionally pseudomembranes form. Turbinates may be severely inflamed and covered by pseudomembrane. The pharyngeal and laryngeal mucosae may be hyperemic, swollen and may have areas of necrosis, erosions or ulcers. These lesions are often covered by a greyish-yellow exudate. The tracheo-bronchial mucosa may be congested, petechiated and ulcerations may occur. The lungs are normal in peracute cases but may be emphysematous in others. Bronchopneumonia may complicate chronic cases.

The oral mucosa may have no significant lesions in the peracute disease. Hyperemia and diffuse superficial necrosis is a common feature in other forms of the disease. The erosive lesions often involve the tips of the buccal papillae, gingivae, hard and soft palate and the cheeks. The tongue is frequently normal. The esophagus may have brownish necrotic areas. The rumen, reticulum and omasum may have areas of congestion and occasionally multiple raised necrotic areas. The abomasal mucosa is usually hyperemic, edematous and may have petechial hemorrhages. Ulcerations are also common, especially in the pyloric region. The wall of the small intestine is firm and thickened by edema. Peyer's patches are usually normal or may be a little thickened. The large intestine has mainly lines of congestion along the longitudinal mucosal rugae.

Characteristic lesions may be present in the kidneys. They are usually small (2-4 mm) white foci (nonsuppurative interstitial nephritis). The urinary bladder may have small reddened edematous ares in the mucosa.

The liver may have miliary white foci. The gallbladder is distended but otherwise normal. The heart may have petechiae on the coronary groove.

All lymph nodes are usually enlarged but the abdominal nodes are less consistently involved than those of the periphery. Affected lymph glands, particularly the prescapular lymph nodes, are usually 2-5 times (but occasionally up to 10 times) normal size. Subcutaneous hemolymph nodes may become large enough to palpate.

Microlesions - Confirmation of MCF and differentiation from similar diseases are based on the histopathological changes. Significant lesions occur in oral epithelium, lymphoid tissues and adventitia and walls of small blood vessels.

Diagnosis

In the field - The history of the disease indicating close contact between the infected animal and calving wildebeests in Africa or lambing ewes aids a tentative diagnosis. Typical clinical features help in forming a presumptive diagnosis. These include high temperature, profuse nasal discharge, severe congestion and necrotic foci in the oral and nasal mucosae, ophthalmia, corneal opacity and gross enlargement of peripheral lymph nodes.

Laboratory diagnosis - Specimens required for laboratory examinations in the study of MCF are: (Virus isolation and serology will probably only be available under special circumstances.)

(1) Blood for virus isolation and cell counts. Blood (about 500 ml) should be collected in EDTA (1 mg of EDTA per 1 ml of blood) or heparin.

(2) Tissues for virus isolation. Spleen, lymph nodes, adrenals, tonsils, and thyroids are suitable for virus isolation.

(3) Nasal swabs for virus isolation.

Blood and tissues for virus isolation should be refrigerated but not frozen and should be sent to the laboratory as soon as possible. Buffy coat or cell suspensions from these tissues are inoculated into established thyroid cultures. These are checked for the typical CPE that may be formed 4-20 days after inoculation. Primary cultures of thyroid, adrenal, kidney and testis cells from infected animals show the typical CPE. But no CPE is observed in primary cultures of buffy coat or lymph nodes from the same animal, although these tissues have the highest titers.

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(4) Serum for serological tests. Paired serums are required, the first collected at the onset of the disease and the second during convalescence, if possible. The course of the disease varies a great deal. Blood taken when the animal is near death, or even shortly after death, may constitute the second sample.

(5) Tissues for histopathological studies should include kidney, spleen, liver, adrenals, lymph nodes, and brain fixed in 10% formalin.

Differential diagnosis - The clinical syndrome of MCF resembles that of other diseases especially those that cause necrosis, ulcerations, and erosions of the oral mucosa of cattle. Differential diagnosis should therefore include bluetongue, bovine viral diarrhea-mucosal disease (BVD-MD), rinderpest, vesicular diseases and ingestion of caustic substances.

(1) Bluetongue: The clinical reactions of MCF resemble bluetongue especially in the diffuse necrosis of oral mucosa and crusting of the muzzle. Lameness common in bluetongue is absent in MCF and ophthalmia and corneal opacity often associated with MCF are rare in bluetongue.

(2) BVD-MD: The classic clinical syndrome of BVD-MD occurs sporadically and is characterized by fever, leucopenia, diarrhea, lacrimation, nasal discharge and erosions of the oral mucosa. Oral lesions in this disease, unlike those of MCF, are discrete, rounded or linear depressions. Severe hyperemia and ophthalmia, common in MCF are not observed in BDV-MD.

(3) Rinderpest: The clinical syndrome of rinderpest is similar to that of BVD-MD. The introduction of rinderpest virus into the highly susceptible bovine population of USA would result in high morbidity and mortality rates, rapid transmission between animals and herds and a disease generally more drastic than that of MCF.

(4) Vesicular disease: i.e., FMD and vesicular stomatitis are excluded on the ground that these diseases elicit vesicles on the oral mucosae, teats, and coronary bands of cattle. These vesicles rupture quickly leaving flaps of epithelium.

Prognosis

Prognosis is poor for MCF. The case fatality rate of MCF is 90-100% in African while that of major Colorado epizootic of MCF was 30-40%.

Epizootiology

Geographical Distribution - MCF has been reported in many countries all over the world.

Transmission - In the natural disease, transmission may occur when cattle graze with calving wildebeest or are in close contact with sheep particularly lambing ewes. Close contact between the donor and the recipient is presumed to be essential factor in transmission. Transmission of MCF between sick and other susceptible cattle has not been reported.

Host range - Infection with the virus and clinical signs of MCF have been reported in the following species: cattle, buffaloes, Pere David's deer, American deer, bison and rabbits.

Control and Eradication

Preventive measures - Our present knowledge of MCF dictates that the incidence of this disease can be reduced by separating cattle and the natural hosts during the lambing or calving seasons.

Natural Immunity - Cattle or rabbits recovered from this disease develop solid immunity against all strains of MCF virus.

Public Health Aspects

The disease is not transmissible to man.

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