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Virology *Review Article*

A review on the FMD in Ethiopia

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ABSTRACT

Foot and mouth disease (FMD) is one of the most widespread diseases of animals in the world. The disease is caused by the foot and mouth virus which is a highly infectious disease that is recorded in many species of animals and also very occasionally in humans. To create new subtypes of the virus, mutations were made in the three major surface proteins (VP1–VP3) and occurred in the tissue culture. FMD virus affects the cloven-footed domestic and wild ungulates. FMD in susceptible animals has a high morbidity rate, but a low mortality rate. The disease can be serious in young calves as fatality may reach up to 20%. Many FMD outbreaks in Africa have been caused by the movement of infected livestock. Common symptoms of the disease include fever, loss of appetite, salivation, and sudden death of young livestock. Aerosolized virus spread is the most common mode of transmission. Serological tests and nucleic acid recognition are the most common methods of confirming an unequivocal diagnosis of a disease. FMD is subject to national and international control and the measure is taken depending on whether the country is free from the disease or endemic infection. FMD is endemic and widely prevalent in all areas of the Ethiopian country. There was a significant proportion of the serotypes O, A, South Africa Territories (SAT)-2, SAT-1, and C in Addis Ababa, Amhara, Tigray, Benishangul-Gumuz, and SNNPRS, respectively. So far, a seroprevalence study in Ethiopia has indicated that the prevalence in cattle varies from 0.8% to 53.6%. FMD can be controlled with quarantine, restrictions on animal movement, isolation of infected animals, vaccination programs, properly disposing of infected carcasses, as well as other means, which are practical for Ethiopia.

Keywords: Endemic, Ethiopia, Foot and mouth disease, Outbreaks, Prevalence, Serotypes

INTRODUCTION

Foot and mouth disease (FMD), caused by the FMD virus (FMDV), is important from an economic point of view.[1] The virus has seven immunologically distinct serotypes, specifically, O, A, C, South Africa Territories (SAT-1), SAT-2, SAT-3, and Asia-1.[2]

FMDV occurs in most parts of the world and is very endemic in most sub-Saharan African countries which exacerbates the farming socioeconomic issues.[3] The disease is also characterized by low mortality in adult animals and sometimes high mortality among young animals and is attributed to acute myocarditis.[4]

Formerly, five of the seven serotypes of FMDV (O, A, C, SAT 2, and SAT 1) were endemic in Ethiopia. FMD affects animals' performance directly through a reduction of milk yield, a high number of deaths among young animals, and fertility impairment due to an increased abortion rate.[5] Moreover, the economic importance of the disease is also related to the reaction of veterinary services to the presence of the disease and the restrictions on the trade of animals both locally and internationally.[6]

Rapid identification of FMDV serotypes during the outbreak is very important to determine the origin of infection and to use the appropriate emergency vaccine.[7] Therefore, the objective of this paper is to present a comprehensive review of FMD with special reference to its status in Ethiopia.

LITERATURE REVIEW

Antigenic variation

The impacts of antigenic variation are derived from the three major surface-exposed proteins of the virus (VP1–VP3).[8] The βG-βH loop and carboxyl terminus of VP1 provide at Site 1. Amino acids of VP2 contribute to Site 2, Site 3 is made partly by the βB-βC loop of VP1, and VP3 has to Site 4. The five sites, characterized by an amino acid of VP1, are mainly formed by the interaction of the VP1 loop region with other surface amino acids [Figure 1]. Site 1 is linear and trypsin sensitive, whereas all the other identified sites are conformational and trypsin resistant.[9]

Even though, the sites appear to be necessary for a complete immunologic response to either infection or vaccination, the major antigenic site, to which most of the immune response is directed and which is common to all of the serotypes, is located in the G-H loop of VP1.[8] Because of this antigenic variation, seven serotypes and multiple subtypes and variants of the FMDV have appeared. This variation results in the continual emergence of the latest variants that choose FMD vaccine candidates complicated.[10]

Species affected

Among the domestic species; bovines, water buffalo, swine, ovine, and caprine are the most sensitive with more severe diseases in bovine and porcine species. African buffalo play an important role as the natural maintenance host in Africa.[5]

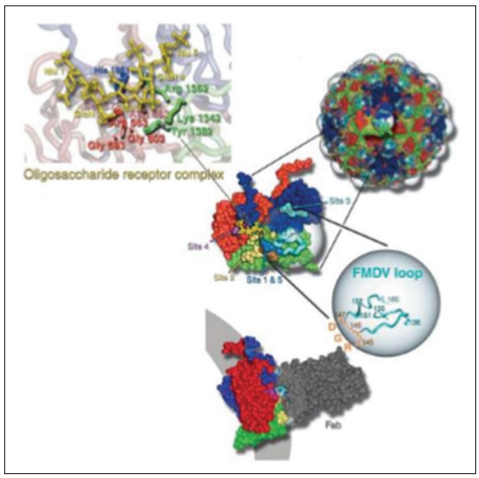

Figure 1: Antigenic sites of foot and mouth disease virus.[11]

Morbidity and mortality

The morbidity rate of FMD in the susceptible animal can rapidly approach 100%; however, the mortality rate is very low in adult animals, about 2% in comparison to 20% in young stock. Calves mostly die due to cardiac involvement and complication, such as secondary infection, exposure, or malnutrition. Mortality in suckling pigs and lambs ranges from 20% to 75% in most extreme cases and it is highly age-dependent, infected animals under 4 weeks of age, mortality is high and decreases rapidly as animals get older than 4 weeks.[2]

Clinical spectrum

The common characteristics of the disease are fever, loss of appetite, salivation, and sudden death of young stock.[6,12] death in young calves may occur due to myocarditis and mortality may reach up to 20% in young calves.[12] Clinical signs of FMD usually develop in 3–5 days although, in natural infection, the incubation period ranges from 2 to 14 days.[2] FMD is typically an acute febrile disease with vesicles (blisters) localized on the dental pad, tongue, muzzle or snout, hooves, teat, and another site of the skin that ruptures within 3 days to leave shallow erosions that ill rapidly.[13]

Lameness is usually the primary ascertained clinical sign in sheep and goats. Affected animals develop fever, show reluctance to walk, and might separate themselves from the rest of the flock. The vesicles square measure shaped in the mouth that ruptures simply feat shallow erosions, however, usually seen in the dental pad, adjacent to the incisors, additionally on the tongue, surface lips, and gums.[14]

Mode of transmission

FMD can replicate and be excreted from the respiratory tract of animals, leading to airborne excretion of the virus during the acute phase of infection, although, FMD might occur in all bodily secretions and excretions including aerosols that infect other animals. Hence, after an animal becomes infected by any means, the primary mode of virus spread is through respiratory aerosols since the respiratory tract is the major site of virus replication and a large number of viral particles are secreted from this site.[15] The principal modes of disease transmission are shown in Figure 2.

EPIDEMIOLOGY

Global distribution of the disease

FMD is one of the most widely distributed diseases worldwide mainly in South America, Asia, and the Middle East countries. Among 178 member States of the World Organization for Animal Health, only 66 countries are FMD-free (65 without vaccination and one with vaccination) and

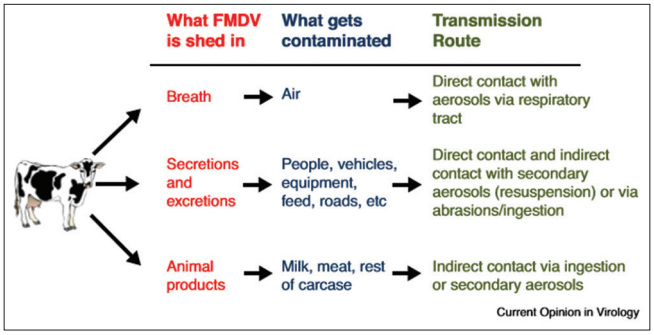

Figure 2: The principal routes of transmission of foot and mouth disease.[16]

10 countries have FMD-free Zones. North America, the majority of South America, West Europe, Australia, New Zealand, and most Island countries in the pacific are free of the disease.[17]

The seven serotypes of the disease do not seem to be equally distributed around the world. Types O and A have the broadest distribution and are continuously circulating in many parts of FMD endemic countries such as Africa, South Asia, the Far East, and South America.[18] Type C appears greatly in the Indian subcontinent and Asia-1 normally only occurs in South Asia. All the different serotypes of the virus are present in Africa except Asia-1. The SA-T serotypes are normally confined to sub-Saharan Africa.[19]

The global FMDV population may be roughly divided into seven regional pools. Pool, one covers Southeast Asia with results in East Asia. Pool 2 represents southern Asia. Pool 3 covers Euro-Asia (Middle East). In these three pools, serotypes O, A, and Asia-1 are circulating viruses. Pools 4, 5, and 6 cover the East, West, and South African continent, respectively. In Pool 4, serotypes O, A, SAT-1, SAT-2, and SAT-3 are circulating. In Pool 5, serotypes O, A, SAT-1, and SAT-2, and in Pool 6, the SATs tended to circulate. Pool 7 covers South America and has solely sort A and O circulating.[20]

Diagnosis

An essential component of the FMD control strategy includes diagnostic assays to rapidly confirm the initial clinical determination of infection. The diagnosis is mainly relying on the clinical signs, in combination with laboratory examination to establish the serotypes of the causal virus.[5]

Diagnosis by clinical signs alone is complicated by other viral diseases of livestock, vesicular stomatitis and swine vesicular disease produce lesions that are identical to those of FMD. Lesions induced by bovine popular stomatitis, bovine herpes mammillitis, infections of bovine rhinotracheitis, bovine mucosal disease, malignant catarrhal fever, rinderpest in cattle, bluetongue, *Parapoxvirus*, peste des petits ruminants, and foot root in sheep might also be mistaken for FMD and all these listed diseases should be considered during the diagnosis.[2]

Serological test

Serological tests are necessary for an additional diagnosis of FMD, for certification of animals for import/export, in determining the freedom from infection, and for demonstrating vaccine efficacy. Virus infections are often diagnosed by the detection of a particular protein response. Enzyme-linked immunosorbent assay (ELISA), agar gel immune diffusion test and virus neutralization test, and complement fixation test are used for serological diagnosis of FMDV. Previous or current infections can be diagnosed using antibodies to FMDV structural proteins and include ELISA (solid-phase competition ELISA and liquid-phase blocking ELISA) and virus neutralization tests which are serotype specific.[21]

The virus neutralization test could be a gold standard test for the detection of antibodies to structural proteins of FMDV.[21] The presence of FMDV viral antigens in high concentrations and types of the virus can be detected using an antigen ELISA (Sandwich ELISA) from active outbreak samples.[22]

Nucleic acid recognition method

Polymerase chain reaction (PCR) techniques are the most broadly used nucleic acid-based diagnostic technique for rapid detection of FMDV and sequence analysis of any PCR-positive result.[23]

Treatment

Antiviral approaches including 2-C-methylcytidine[24] and ribavirin[25] are useful for prophylaxis in susceptible animals. Treatment of secondary bacterial infection and dressing of lesions with proper animal husbandry practices is recommended in FMD endemic countries in which slaughter policy is hard to apply. Furthermore, sick animals could be treated by applying broad-spectrum antibiotics, such as tetracycline by parenteral route in particular, to control secondary bacterial infections.[26]

Prevention and control

FMD is subject to national and international control and the measure is taken depending on whether the country is free from the disease or endemic infection. A good infrastructure, veterinary staff trained in disease control, well-stocked laboratories, good governance, rapid and accurate diagnostics, rapid response measures, monitoring, surveillance, and vaccination are required.[27,28]

Control in endemically affected countries

In countries where the disease is endemic, control and prevention of FMD mainly rely on repeated vaccination, control of animal movement, and physical separation of wildlife and livestock.[29] However, due to economic and social problems, it is not advisable to adopt a test and slaughter policy for the control of the disease.[30]

Control in the disease-free area

FMD-free countries use a "stamping out" policy, consisting of the slaughter of all affected and in-contact susceptible animals. Furthermore, zoosanitary measures, like the imposition of movement restrictions, are used to control the outbreaks of disease. Such measures may additionally be preemptively slaughtering alternative herds within which there is no clinical evidence of the disease; however, they are epidemiologically joined with an outbreak and would possibly so contain infected animals.[31]

FMD IN ETHIOPIA

Disease status

According to FMD outbreaks annually reported[32] from 2009 to 2015, the highest and lowest number of FMD outbreaks are reported from Oromia and the Afar Regional State of Ethiopia, respectively [Figure 3].

The serotypes of the FMDV

From 1981 to 2007, the prevalence of serotypes, O (73.3%), A (19.5%), SAT-2 (4.1%), SAT-1 (1.8%), and C (1.3%) in Addis Ababa, Amhara, and Tigray, Benishangul-Gumuz, and SNNPRS, respectively, is testified. Serotype C is not isolated in any of the outbreak investigations since 1983 and there is only a single isolation report of SAT-1 in 2007.[34] The distribution of serotypes of the virus is presented in Figure 4.

Prevalence of the disease

FMD is endemic and widely prevalent in all areas of the Ethiopian country.[36] The seroprevalence investigation undertaken so far in the country indicated that the prevalence ranges from 0.8% to 53.6% in cattle.[37,38] However, the prevalence of the disease is varying from place to place.

The seroprevalences of FMD in cattle in different parts of Ethiopia from 2009 to 2020 were 12.08% in Bench Maji[34], 5.6% in Afar, 14.05% in Somali, 8.01% in Dire Dawa, 21.4% in Kellem Wollega, 40.4% in West Shewa, 8.18% in South Omo, 10.88% in Bishoftu, 24.22% in Central Ethiopia, 24.39% in Oromia, Amhara and SNNPRS[39-47].

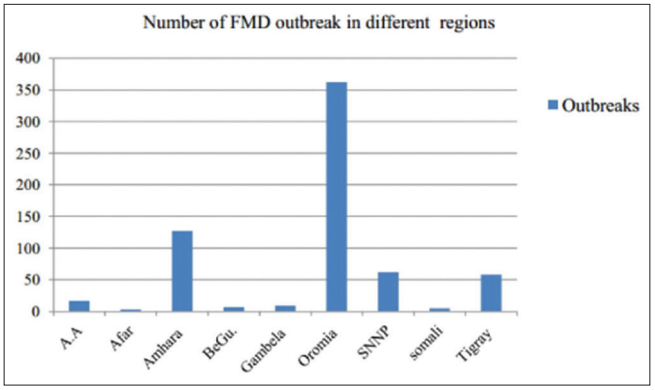

Figure 3: FMD outbreaks in the regional states of Ethiopia according to MoLF from 2009 to 2015.[33]

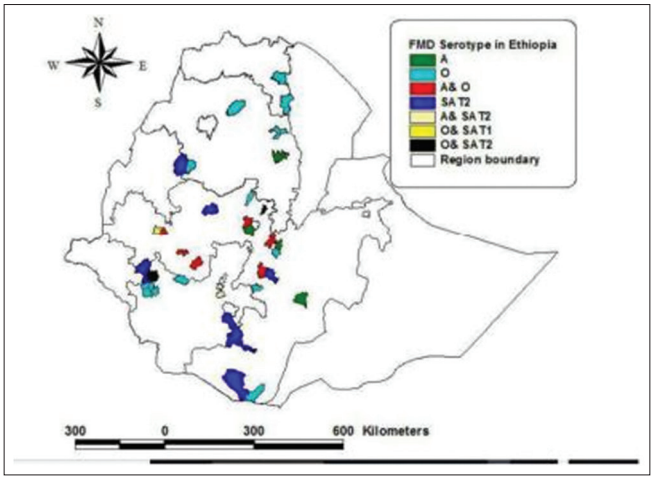

Figure 4: Distribution of foot and mouth disease virus serotypes in Ethiopia.[35]

Control program

Control measures for FMD include involvement of quarantine, restriction of animal movement, isolation of infected animals, vaccination programs, proper disposal of an infected carcass, and other methods which are feasible to the Ethiopian economy.[48] The vaccination program should emphasize the control of all outbreaks occurring in the country through ring vaccination and vaccination of all export cattle before entering the quarantine stations. All dairy animals should be vaccinated and a ring vaccination is carried out around an infected area.[49] As FMD has zoonotic implications, it is advised that animal handlers, dairy farmers, veterinarians, and laboratory workers should take precautions to prevent the infection.[12]

CONCLUSION

FMD is one of the most important endemic livestock diseases in Ethiopia. In addition, due to this disease's economic

importance, it is vital to pay great attention to this disease, since its occurrence can harm the country's export earnings, thereby threatening the livelihood of farmers and the overall economy of the nation. Serotype O is the most prevalent of the five FMDV serotypes documented in Ethiopia (O, A, C, SAT1, and SAT2). In cattle, FMD prevalence in Ethiopia ranges from 0.8% to 53.6%. A vaccination program should be implemented based on the specific serotypes circulating in the area to combat FMD. It is recommended that disease reporting, surveillance, detection, and quick response should be improved to tackle the outbreaks of this highly infectious disease.

Contribution of the authors

Both authors contributed equally. The final version was accepted for publishing after it was critically reviewed.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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