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Review on Pathogenesis, Economic Significance, Prevention and Controls of Foot and Mouth Disease

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Abstract: Foot and Mouth Disease (FMD) is extremely contagious, acute viral disease of cloven-hoofed animals. The disease is caused by genus Aphtovirus of the family *picornaviridae* which occurs as seven serotypes O, A, C, SAT1, SAT2, SAT3 and Asia1. It has worldwide distribution and one of the most infectious diseases found in nature. The disease has a wide host range and easily transmitted by ingestion, direct and indirect contact, as well as by aerosols. The pathogenesis of FMD virus starts by distributing throughout the body, to reach best sites of multiplication sites such as the epithelium of oro-pharynx, oral cavity, feet, the udder and heart. It is characterized by fever, loss of appetite, salivation and vesicular eruptions on the feet, mouth and teats. The diagnosis of FMD *is* based on the clinical signs, together with laboratory examination to establish the serotype of the causal virus. It can cause a high number of deaths among young animals and Economics Significance in adult livestock. Losses occur in many ways in which loss of production, prevention, treatment and control. Globally, control of the virus can be made by slaughter of affected and in contact animals together with strict regulation of trade in animal and animal products, or by regular vaccination using appropriate vaccine. In Ethiopia, the disease is endemic and the country is economically less developed, the recommended option for control is vaccination against the circulating serotypes based on the continuous surveillance of the disease.

Key words: FMD · Economics · Significance and Pathogenesis

INTRODUCTION

Foot and Mouth Disease (FMD) are also known Aphtosfever. The disease is a major global animal health problem. It ranks first among the notifiable list A-infection disease of animals. It is the most contagious transboundary animal disease (TAD) affecting cloven hoofed animals of domesticated and wildlife. Among species of the domesticated animals; cattle, sheep goats, pigs and buffalo are susceptible. It is caused by Aphthous virus known as foot and mouth disease virus; an RNA virus with seven antigenically different serotypes such as A, O, C and Southern African Territories (SAT) 1, SAT2, SAT3 and Asia1 as well as over 60 subtypes. Foot and Mouth Diseases are still wide spread throughout the world, particularly in Asia, Africa and the Middle East. Even though the disease can occur in any countries; Japan, New Zealand, Australia and some other countries are FMD free countries. Foot and Mouth Disease is a severe plaque of animal infected animals [1].

The main route of infection in ruminants is through the inhalation of droplets, but ingestion of infected feed, inoculation with contaminated vaccines, insemination with contaminated semen and contact with contaminating clothing, veterinary instruments and so on can all produce infections. In animals infected via the respiratory tract, initial viral replication occurs in the prepharyngeal area and the lungs followed by viremic spread to other tissues and organs before the onset of clinical disease. FMD virus is then distributed throughout the body, to reach best sites of multiplication sites such as the epithelium of oro-pharynx, oral cavity, feet, the udder and heart. Symptomatically, the disease is characterized by fever, loss of appetite and weight, blisters on the mucus membranes, especially those of mouth, feet and udder [2].

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Clinical diagnosis based on lesion identification, in the early stage of infection, FMD virus or viral antigens can be detected using several techniques. However, different serological methods are used to detect antibody against FMD virus and is the main indication that infection has taken place. The degree of control of FMD varies in different area of the world. Routine vaccination is used where the disease is endemic; in contrast, a number of disease-free countries have never vaccinated their livestock but have preferred the use strict movement controls and slaughter of infected and contract animals when outbreaks occur [3].

The risk of introduction of FMD can be reduced but not fully excluded and the cost is high. The global increase in travel, trade and transport will inevitably exacerbate the situation reducing the disease at source, in other words in Foot and Mouth Disease endemic countries, is therefore shared interest and should be considered a global public good. The economic importance of the disease is not only due to the ability of the disease to cause loses of production, but to the restriction of trade of animals both locally and internationally. The disease has a high morbidity and low mortality with low occurrence in adult animals. However, myocarditis may occur in young animals resulting to death. The recovered animals remain in poor physical

condition over long period of time leading to sustained economic losses for the livestock industry. Currently present in two-third of the OIE member countries where it creates sever economic problems and provides a reservoir of disease ready to spread into disease free areas [4].

Foot and Mouth Disease is most important livestock disease which is endemic and known for its wider distribution in Ethiopia, where the local economy is heavily dependent on livestock. It has the largest livestock population in Africa possessing about 43.1 million cattle, 23.6 million sheep and 18.4 million goats. Losses incurred due to Foot and Mouth Disease in reduced production and efficiency of livestock may be severe and local food security impaired [5]. Therefore, the objectives of this review paper are:

- To address the pathogenesis, distribution and prevention and control measures of FMD virus.
- To address the economic impact of Foot and Mouth Disease
- To highlight the public significance of Foot and Mouth Disease

Literature Review

Definition of Foot and Mouth Disease: Foot and Mouth Disease (FMD) is a severe, highly contagious viral disease of livestock with significant economic impact. The disease affects cattle and swine as well as sheep, goats and other cloven-hoofed ruminants. All species of deer and antelope as well as elephant and giraffe are susceptible to FMD. Animals with FMD typically have a fever and blisters on the tongue and lips, in and around the mouth, on the mammary glands and around the hooves. These blisters, called vesicles, pop and turn into red areas called erosions. Pain and discomfort from the vesicles and erosions lead to other symptoms such as depression, anorexia, excessive salivation, lameness and reluctance to move or stand. Most affected animals will not die from FMD, but the disease leaves them weakened and unable to produce meat and milk the way they did before. It is a list a disease according to OIE disease classifications. The disease was identified for the first time by Friedrich Loefffler in 1898 and has different names in different regions of the world which include: Aphtous fever, Epizoticaphtae, Infectiousaphtous stomatitis, Aftosa (Italian and Spanish), fievereaphtheuse (French), Maul and Klavenseuch (German) [6].

Epidemiology

Agent: The virus is resistant to external influences including common disinfectants and the usual storage practices of meat trade. It may persist over one year in infected premises, for 10-12 weeks on clothes and feeds. Foot and Mouth Disease virus can survive in dry fecal material for 14 days in summer, up to 6 months in slurry in winter, for 30 days in urine and 3 days in summer and 28days in winter. Under favorable condition of low temperature, high humidity, moderate wind and comfortable topography, the virus in aerosols may spread to for long distance. Generally, the integrations of these three factors are important for the disease occurrence, of which if one is not available, the disease does not occur [7].

Geographic Distribution of FMD: Foot and Mouth Disease are endemic in parts of Asia, Africa, the Middle East and South America. While serotypes O and A are widely distributed, SAT viruses occur mainly in Africa (with periodic incursions into the Middle East) and Asia 1 is currently found only in Asia. North and Central America, New Zealand, Australia, Greenland, Iceland and Western Europe are free of FMD. Western Europe was

affected by some recent outbreaks (eradication was successful), but FMD has not been reported in North America for more than 60 years. The last U.S outbreak occurred in 1929, while Canada and Mexico have been FMD-free since 1952-1953 [8].

Risk Factors of FMD: The species of animals is important factor for the spread of disease as well as susceptible of animals. Cattle and pigs are more susceptible, but goats, sheep, buffalo and other wildlife such as antelope, deer, hedgehogs, elephants, llama and alpaca are also developed a mild symptomatic disease. Although, cattle, sheep and goats can be carriers, they are not regularly source of infection. Immature animals are relatively more susceptible. The wildlife species also play a great role as reservoirs of infection for domestic animals which is difficult to eradicate the disease as well as important for disease control when an outbreak is occurred [9].

Host Range: Aphthovirus can infect more than 70 species of mammal belonging to more than 20 families particularly cloven-hoofed animals domestic and wild such as; cattle, swine, sheep, goats, camels, deer, moose, llama, chamois, alpaca, vicuna, giraffe and others . The most sensitive hosts of FMDV are cattle and swine, because of their extreme sensitivity to respiratory infection, these animals due to their sensitivities develop sever clinical sings. The clinical signs in sheep, goats and wild ruminants are milder than in cattle. Horses, dogs and cats are not susceptible hosts but they can inevitably spread the virus via their fur if contaminated. FMDV is not a human pathogen, although there have been reports of infection in human but they are rare [10].

Transmissions: FMD is a directly transmitted disease with the predominant means of spread being direct or close contact between infected and susceptible animals. However, less frequently, transmission may occur indirectly through infection enabled by transporting healthy animals in vehicles which have previously transported infected livestock or through people handling healthy animals soon after being in contact with infected ones. Other mechanisms of local spread: such as short-distance air-borne transmission during outbreaks: are suspected but unequivocal evidence is yet to be provided in this respect. Much confusion has resulted from the finding in northern Europe that long-distance transmission has very rarely occurred through virus-containing aerosols being transported for many kilometers by air currents [11].

In tropical/sub-tropical climates these requirements are seldom, if ever, met. A recent publication has postulated that aerosols may be derived from the skin of infected animals but that remains to be proven [12]. Among ruminants, cattle certainly, infection usually occurs via the respiratory tract and cattle may be infected by small numbers of infectious virions [11]. Conversely, large amounts of infectivity are required to cause infection by the oral route in cattle. In pigs by contrast, the oral route of infection is most common with infection resulting from the feeding of pigs with untreated swill being a common source of FMD outbreaks in. It has been shown experimentally that animals infected with a FMD virus may excrete significant amounts of infectivity for up to 3 days before obvious clinical signs develop and this has been considered epidemiologically important. Recently, however, it was shown in a series of experiments in cattle that the amounts of virus excreted before the development of clinical signs were insufficient to result in transmission; only about half a day after clinical signs developed did transmission occur [13].

Pathogenesis: The respiratory system is the most important portal of infection. After inhalation, the virus can affect the pharynx and primary multiplication of the virus in the mucous membrane is transported by lymphatic and blood circulation to the sites of secondary multiplication in the lymphatic glands, epithelial tissues in and around the mouth, feet and in the mammary glands. Following secondary replication in other glandular tissues, the virus appears in different body fluids such as milk, urine, respiratory secretions and semen, before the appearance of frank clinical signs of FMD. The virus can period after the acute infection. In cattle, virus may be detectable for periods up to 2 years after exposure to infection, in sheep for about 6 months [14].

The tissues of the naso-pharynx and FMD viruses have a complex relationship because not only does initial infection of ruminants take place there but the naso-pharynx is also the site of viral persistence in chronically infected animals (so-called carriers). Vesicle formation, cell lysis and significant inflammation occur at secondary replication sites (oral mucosa, skin of the horn-hoof junction & skin of the teats) but not in the epithelium of the primary replication site. The cells which support viral replication are located in the basal layer of naso-pharyngeal epithelium. However, the mechanism by which viral replication occurs in the naso-pharyngeal epithelium without causing cell lysis is unknown; nor is there an explanation as to why virus can be readily cultured from

pharyngeal scrapings (obtained using probing cups) that, in recently infected animals, may contain high levels of antibody (mainly IgA) directed against the infecting virus. In pigs, delayed clearance of viral RNA from pharyngeal and lymphoid tissues has been observed but that has not been shown for infectious. It is currently concluded that persistent infection of pigs does not occur or at least is not epidemiologically important. One or two days before the onset of clinical signs, cattle and pigs develop viremia which may endure for up to 3 days virus [14].

In infected animals the vesicles which develop at the sites of secondary replication contain by far the highest levels of infectivity; however, high concentrations of virus can also be found in lymph nodes, myocardium, lungs and skin even in the absence of obvious lesions [4, 15]. Virus may also accumulate in the spleen, liver, adrenals, myocardium, pancreas, thyroid and mammary glands. In mammary tissue and myocardium, however, viral replication occurs in secretory epithelial cells of the alveoli and myocytes respectively, resulting in clear microscopic lesions. There is an association between FMDV and dendritic cells in lymph nodes that results in localization of virus in germinal centres but the details of this association remain to be elucidated [6].

Epithelial lesions at secondary replication sites are initiated by infection of single cells in the stratum spinosum [16]. Following infection of these cells, bullae develop either by lysis of cells swollen as a result of ballooning degeneration and the release of intracellular fluid, or by the formation of areas of focal intercellular edema. The bullae then coalesce, rupture or, more rarely, the fluid seeps away resulting in desiccation of the lesion. Development of characteristic vesicular lesions in FMD is dependent on persistent local irritation or friction. In transplantation studies in guinea pigs it was shown that epithelium from predilection sites grafted to other body areas lost that predilection and vice versa. This explains why the mouth, feet and teats are predilection sites for the development of lesions and why pigs often develop lesions on the dorsum of the snout, i.e. as a result of "snuffling". Similarly, warthog which often "kneel" on their carpal joints while feeding tend to develop lesions on their "knees" [17].

The immune response of domestic animals to FMD *i*s characteristically ephemeral and this, together with the wide immunological diversity of FMD viruses (SAT serotypes particularly) often results in ineffective herd immunity following vaccination and even following disease outbreaks. Although the responses of very young piglets and calves differ from those of more mature animals, they are immunologically competent to FMD viruses from an early age. The poor antibody responses of calves and piglets to immunization are probably due more too immunological interference by colostral antibody than to immunological immaturity. Cattle are immune to re infection with homologous virus for one to three years and occasionally for up to 4.5 years [18].

Circumstantial evidence suggests that the duration of immunity after infection with SAT serotypes may be shorter. The duration of immunity in other domestic species is largely unknown, but it is probably shorter than in cattle. Tongue lesions commence as blanched foci which develop into vesicles containing serous fluid Ruptured vesicles lead to the appearance of irregular erosions with serrated edges since recovery from infection with FMD is the rule, little attention has been paid to the immunological mechanisms involved in recovery from infection. Conversely, since it is clear that the level of neutralizing antibody in the circulation correlates with resistance to infection or re-infection in immunized and recovered animals respectively, the humoral immune response and the antigens which are able to induce it have been better studied [18].

The relationship between neutralizing antibody activity and the degree of resistance to infection is, however, not simple and depends on the virus serotype as well as in immunized animals the period between immunization and exposure to infection. It is important to appreciate that vaccinal immunity may not prevent infection but it rather prevents subsequent spread within the body of infected animals. Thus, FMD vaccines do not induce so-called sterile immunity [11]. The antibody response to FMDV is T cell. However, since different species recognize different determinants as T cell recognition sites, not all FMDV antigens are equally immunogenic in different species dependent [19].

Clinical Signs: When susceptible animals are in contact with clinically infected animals, clinical signs usually develop in 3 to 5 days, although in natural infection, the incubation period may range from 2-14 days. The severity of clinical signs of the disease varies with the strain of the virus, the exposure dose, the age and breed of the animal, the host species and its degree of immunity. The signs can range from a mild or in apparent in sheep and goats to a severe disease occurring in cattle. The disease in cattle is characterized by fever, depression, excessive salivation, lameness and formation of vesicular type lesions on the mucous membrane of the mouth (tongue, dental pad and gums) and the skin of the muzzle, interdigital spaces,

udder, teats and coronary band. Lesions on the tongue often heal within a few days, but those on the feet and within the nasal cavities often become infected secondary with bacteria resulting in prolonged lameness and mucopurulent nasal discharge [20].

Young calves, lamps, kids and piglets may die before showing any vesicles because of necrotizing myocarditis. Vesicles also develop in the skin of teats and udders of lactating cows in which milk yield drops dramatically and resulting in mastitis. The sudden onset of severe lameness is the commonest finding in affected pigs, the feet of which are obviously painful. The back may be arched, reluctance to move is common and movement may be accompanied by squealing. Vesicles appear as raised white areas of0.5-1cm in diameter on the dorsum of the tongue, on the snout and on the teats of the sow and rupture readily to leave small ulcers. In sheep and goats, if the clinical signs occur, it tends to be very mild and may include dullness, fever; and small vesicles or erosions on the dental pad, lips, gums and tongue. In most cases mild lameness is the only sign which occurs with vesicles and erosion of the interdigital space [8].

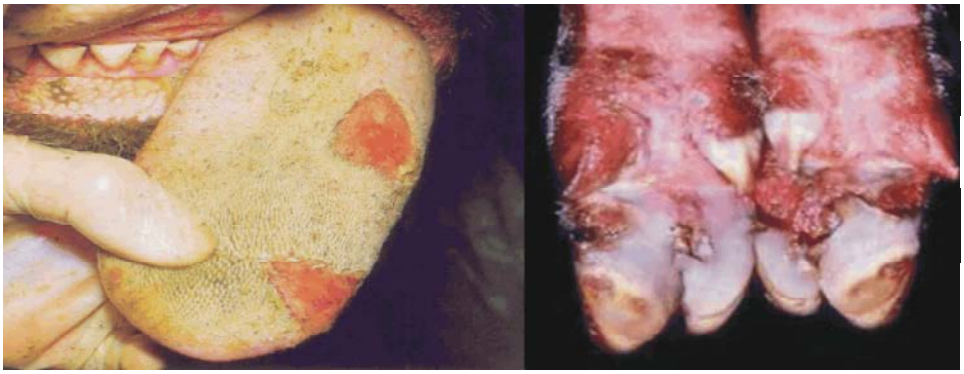

Fig. 1: Clinical signs of FMD infected cattle [21].

Pathological Lesions

Post Mortem Finding: The lesions of Foot and Mouth Disease consist of vesicles and erosions in the mouth, on the feet and udder. The erosions become ulcers especially if secondary bacterial infection has occurred. Grossly, the ventricular walls appear streaked with patches of yellow tissue interspersed with apparently normal myocardium giving the typical tiger heart appearance; necrosis and lysis of keratinocytes in the deeper layers of the epidermis and accumulation of fluid in the space. The location and prominence of FMD lesions can differ with the species; however, common sites for lesions include the oral cavity and snout/ muzzle; the heel, coronary band and feet; the teats or udder; pressure points of the legs; the ruminal pillars (in ruminants); and the prepuce or vulva. Coronitis may be seen on the hooves and the hooves or claws may be sloughed in severe cases. Involvement of the pancreas, as well as heart failure and emaciation, were reported in mountain gazelles [22].

Histopathology: Tissues to be submitted for histopathology should include oral mucosa and skin containing vesicles or fresh erosions. The heart, mammary gland and pancreas should also include. Most animals infected with foot and mouth disease will not die and since it is important to make prompt diagnosis from clinical cases, histopathology of necropsy of material is often secondary. Piglets can have histological evidence of myocarditis without gross lesions in the heart. Signs of septicemia, abomasitis and enteritis, as well as myocarditis, have been reported in lambs. Only nonspecific gross lesions were described in infected fetuses from experimentally infected sheep. They included petechial hemorrhages in the skin, subcutaneous edema, ascites with blood-tinged peritoneal fluids and epicardial petechiae. Vesicles were not found and the placenta did not appear to be affected. Some infected fetuses had no gross lesions. In another study, infected fetuses were generally autolyzed [23].

Morbidity/Mortality: The morbidity rate in outbreaks of FMD in susceptible animals can rapidly approach 100% but some strains are limited in their infectivity to particular species. However, the mortality is generally very low, about 2% in adults and 20% in young stock. Mortality in adult animals is usually low to negligible; up to 50% of calves may die due to cardiac involvement and complications such as secondary infection, exposure or malnutrition. Mortality in suckling pigs and lamps ranges from 20-75% in most extreme cases and it is highly age

dependent, infect for animals under 4 weeks of age, mortality is high and decrease rapidly as animals get older than 4 weeks [10].

Diagnosis

Diagnostic Techniques: The diagnosis of Foot and Mouth Disease is based on the clinical signs, together with laboratory examination to establish the serotype of the causal virus. Due to highly contagious nature and economic importance of FMD, the laboratory diagnosis and serotype identification of the virus should be done in a laboratory. For laboratory diagnosis, the tissue of choice is epithelium or vesicular fluid. Laboratory diagnosis of FMD is achieved by a combination of virus isolation, serological tests and nucleic acid recognition method. Virus Isolation: The isolation and characterization of the virus is the "golden standard" for the diagnosis of viral diseases. The suspensions of field samples suspected to contain FMD virus are inoculated into cell cultures (primary pig kidney cells), incubated at 37 °C and examined for cytopathic effect (CPE), 24 to 48 hours post infection. If there is no CPE, it confirms the absence of FMDV in the samples. Serological Tests: The virus infection can be diagnosed by the detection of specific antibody response [17].

The tests generally used are CFT, VN, solid phase ELISA, liquid phase ELISA and non-structural protein antibody tests such as ELISA, enzyme linked immune electro transfer blot assay. The preferred procedure for the detection of FMD viral antigen and identification of viral serotype is the ELISA. Nucleic Acid Recognition Methods: The polymerase chain reaction (PCR) techniques are increasingly used for rapid identification of FMD virus and sequence analysis of any PCR positive. The reverse-transcription PCR (RT-PCR) can be used to amplify the genome fragment of FMD virus in diagnostic material. Specific primers have been designed between each of the seven serotypes [24].

Laboratory diagnosis

Samples

- ✓ 1 g of tissue from an unruptured or recently ruptured vesicle
- ✓ Epithelial samples should be placed in a transport medium which maintains a pH of 7.2–7.6 and kept cool.
- ✓ Esophageal-pharyngeal fluid collected by means of a probang cup. Probang samples should be refrigerated or frozen immediately after collection [12].

Procedures: Identification of the agent: Demonstration of FMD viral antigen or nucleic acid is sufficient for a positive diagnosis. Laboratory diagnosis and serotype identification should be done in a laboratory meeting OIE requirements for Containment Group 4 pathogens.

- ✓ Antigen ELISA – detects FMD viral antigen and identifies serotype; preferred over CF test.
- ✓ Complement fixation test – less specific and sensitive than ELISA; affected by pro- and anticomplement factors.
- ✓ Virus isolation: Inoculation of primary bovine (calf) thyroid cells or primary pig, calf and lamb kidney cells; inoculation of BHK-21 and IB-RS-2 cell lines; inoculation of 2-7 day old unweaned mice and once cytopathic effect is complete, culture fluids (or musculo-skeletal tissues from dying mice) can be used in CF, ELISA or PCR tests.
- ✓ RT-PCR – recognizes nucleic acids of agent; rapid and sensitive; samples: epithelium, milk, serum: Agarose gel-based RT-PCR and Real-time RT-PCR.
- ✓ Electron microscopic examination of lesion material [15].

Differential diagnosis

- Rinderpest
- Bovine viral diarrhea and Mucosal disease
- Infectious bovine rhinotracheitis
- Bovine popular stomatitis
- Vesicular stomatitis
- Swine vesicular disease [16].

Treatment: No treatment exists for foot and mouth disease. However, proper animal husbandry practices and treatment of secondary bacterial infection and dressing to inflamed areas to prevent secondary infection is recommended in endemic countries where slaughter policy is not enforced. Sick animals may be treated topically with mild disinfectants but also by applying broad-spectrum antibiotics parentally, tetracycline in particular, in order to control the consequences of secondary bacterial infections [13].

Prevention and Control: Foot and Mouth Disease is subject to national and international control and the measures taken depend on whether the country is free from the disease, is subject to sporadic outbreaks or has endemic infection. Countries free of FMD impose strict import regulation on animals, animal products and potentially contaminated materials from FMD countries. Quarantine and vaccination programs are also used to

control outbreaks and to prevent spread of the disease. In countries where the disease is endemic, efforts are generally directed at protecting high yielding dairy cattle by a combination of vaccination and control of animal movement. Preventive measures in the absence of disease should be implemented as follows: Control of national borders to regulate or prevent significant movement of animals and livestock products from non-free neighbors or trade partners [4].

For officially free countries, prohibition of imports of animals and livestock products from no free countries in accordance with the OIE standards, prohibition to distribute untreated catering waste (human food) to pigs. Emergency measures in the event of outbreaks through: Rapid slaughter of infected animals, in contact animals and herds considered to have received infection by contact, to reduce the quantity of virus released policy of stamping-out. Cleaning and disinfection to reduce the risk of re-infection, strict movement controls, extending to movement on and off farms of livestock products are used as to prevent and control FMD. Intensive investigations to determine if infection is likely to have spread to additional locations within or outside of the protection and surveillance zones and containment measures for such herds or villages, depending on the risk identified. And also possible emergency vaccination is important. In Ethiopia context the control of FMD *i*s practiced by involvement of quarantine, restriction of animal movement, isolation of infected animals, vaccination programs, proper disposal of infected carcass and other methods which are feasible to Ethiopian economy. Currently there is no country-wide vaccination program aimed to control FMD and a ring vaccination is carried out around an infected area. Considering the wide prevalence of serotypes O and A, the National Veterinary Institute (NVI) is producing an inactivated vaccine [9].

The procedures commonly used are; control by eradication and control by vaccination or a combination of the two. Eradication: It is policies and actions designed to eliminate completely FMD virus following an outbreak of disease. This includes both 'stamping out', defined by OIE as the slaughter of all infected and in-contact animals, together with cleaning and disinfection and all the other measures that are necessary in the event of an outbreak in an FMD-free country, region or zone. Stamping out involves: slaughter and disposal, cleaning and disinfection, movement controls, zoo sanitary measures and epidemiological monitoring. Vaccination: Killed trivalent (containing O, A and C strains) vaccines are in general use, but because of the increasing occurrence of antigenically dissimilar subs trains the production of vaccines from locally isolated virus is becoming a more common practice. The current foot and mouth disease vaccine confers protection for 6 months and hence at least two vaccinations are recommended for prophyl active protection in endemic areas. In vaccinated animals the peak antibody response is attained in 21-28 days and protection can be achieved with in one to two weeks post vaccination. Vaccination can be used to reduce the spread of foot and mouth disease or protect specific animals [23].

Economic Significance: It is the most contagious of animal diseases with a great potential for causing heavy *economic lose* in susceptible livestock. Impact of FMD on farmers or producers was considered in terms of cattle productivity that means reduction in milk yield, age specific mortalities weight loss and abortions. This impact can be separated into two components the direct losses due to reduction in production and changes in herd structure and indirect losses that relate to the significant costs of FMD control and management and poor access to markets and limited use of improved production technologies. And also, there are losses resulting from constraints in international trade in animals and animal products originating from infected countries. The direct production effects in extensive production system include loss of milk due to udder involvement and reduced draught animal power from lesions on the feet [12].

FMD also causes lower rates of live-weight gain in growing animals due to reduced feed intake and reduction in reproductive capacity by increased abortion rates of up to 10% in animals infected during pregnancy; the disease also causes up to 6% mortality in calves. Restrictions on animal movement and international trade can cause much more serious losses. In Ethiopia, where the local economy is heavily dependent on livestock, the burden may be severe and local food security impaired. The impact of reduced productivity of animals can be a long lasting and diseases can have lasting effects on livestock output in a number of "hidden" ways (such as delays in reproduction leading to fewer offspring and the consequences of a reduced population) which often exceed the losses associated with clearly visible illness [19].

At the local level, FMD reduces farmers' income and food availability for consumption. At the national level, FMD slows economic growth by severely limiting trade opportunities. Heavy losses occur in small scale mixed farming system when outbreaks affect draft oxen during the planting season. It causes considerable losses of milk yield and weight gain among dairy and fattening stock. Its

role in contributing to the suffering and death of livestock particularly when affected at periods of drought (by limiting their access to feed and water) or at early ages is believed to be significant. The impact of the disease in affecting our export trade has been witnessed by import bans imposed by different countries at different times [18].

Foot and Mouth Disease are not considered to be a public health problem, as infections seem to be very rare and their consequences mild. In the past, many people who worked with FMDV in vaccine laboratories or other locations developed antibodies to this virus, but there were few clinical cases. One laboratory reported only 2 cases in more than 50 years and a large FMD vaccine manufacturer documented 3 cases among its workers. It may be that exposure to extremely large amounts of virus or a predisposing condition is necessary for infection. Between 1921 and 1969, reports of more than 40 laboratory-confirmed cases of FMD in humans were published. The symptoms included vesicular lesions and influenza-like symptoms and the disease was generally mild, short-lived and self-limiting. Broken skin was a recognized route of entry for some human cases, with the initial lesions developing at the inoculation site. There is also a report that three veterinarians deliberately infected themselves in 1934, by drinking virus-contaminated, unpasteurized milk for three days. Person-to-person transmission has never been reported; however, vesicles from affected people do contain virus [24].

CONCULISION

FMD is a global disease that is distributed throughout the world, spread through importation of live animals and animal products as well as visitors from infected countries. The *economic importance* of the disease is not only due to the ability of the disease to cause losses of production, but also related to the reaction of veterinary services to the presence of the disease and to the restrictions on the trade of animals both locally and internationally. Ethiopia is among the countries that are endemic for FMD. The outbreaks of FMD in the country are increasing from time to time. Among the seven serotypes of the virus, the presence of four of them (O, A, C and SAT2) is confirmed in Ethiopia. The presence of foot and mouth disease in the country is a major obstacle to the development of agriculture because of its adverse effects on livestock production and agricultural exports. The current review indicated that trans-boundary movement of livestock between Ethiopia and the neighboring countries might be the major risk for the distribution of *FMD*. Based on the above conclusions, the following points are recommended:

- ✓ Implementing strict animal movement control Botha cross national and international boundaries to limit the spread of existing serotypes and introduction of new serotypes.
- ✓ Priority should be given to well-equipped veterinary services and resources to ensure adequate epidemiological surveillance.
- ✓ The multivalent vaccine candidates should be formulated containing all serotypes isolated.
- ✓ Those areas with highest rate of FMD infection should be considered during control program.
- ✓ The importance of wild life in the role of FMD should be studied.
- ✓ Rapid diagnosis and information on the epidemiology of each outbreak are key elements of effective disease management.

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