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Review Article

Review on Epidemiology of Foot and Mouth Disease (FMD) in Ethiopia

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ABSTRACT

Foot and Mouth Disease (FMD) is a highly contagious transboundary disease that affects all cloven hoofed animals. It is caused by a virus that belongs to the genus Aphthovirus of the family Picornaviridae. Foot and Mouth Disease Virus (FMDV) occurs in seven standard serotypes: A, O, C, and South African Territories (SAT) 1, SAT 2, SAT 3, and Asia1. The disease has a high morbidity although mortality is rare in adult animals. The impact posed by the disease is enormous. It affects animal's performance directly through reduction of milk yield. Death of young animals and fertility impairment due to increased abortion rate are also the grave consequences of the disease. FMD has a great potential for causing severe economic loss. Greatest losses can result from refusal of FMD free countries to import livestock and livestock products from infected region. The disease has been present in almost every part of the world where livestock are kept. More than 100 countries are still affected by FMD worldwide and distribution of the disease roughly reflects economic development. Despite considerable information being available about the virus, the disease and vaccines, FMD remains a major threat to the livestock industry worldwide. FMD is endemic disease in Ethiopia with multiple serotypes in circulation at varying prevalence levels. Estimation of economic losses by FMD can provide a better overall view of the impact of the disease on national economy and can contribute in estimating the extent of the losses to be avoided and also understanding its transmission dynamics can contribute for suggesting appropriate control intervention mechanism. In Ethiopia there is limited research done on this aspect. Many resources have been and still are devoted to surveillance and molecular characterization of FMD, therefore the aims of this seminar paper are to review the major risk factors for transmission of disease, review the economic impact of FMD and suggest prevention and control measures.

Keywords: Economic impact; Ethiopia; Foot and Mouth Disease (FMD); Risk factors

INTRODUCTION

Foot and Mouth Disease (FMD) is a highly contagious transboundary disease that affects all cloven hoofed animals. It is caused by a virus that belongs to the genus Aphthovirus of the family Picornaviridae. Foot and Mouth Disease Virus (FMDV) occurs in seven standard serotypes: A, O, C, and South African Territories (SAT) 1, SAT 2, SAT 3, and Asia1. Within each serotype, many strains can be identified by genetic and immunological tests. Serotypes O and A are widely distributed, whereas serotypes SAT 1, SAT 2, and SAT 3 are normally restricted to Africa, and serotype Asia 1 to Asia . The occurrence of serotype C has been declining during the last 30 years, and its distribution has become very limited in the recent decade; the last reported occurrence of serotype C was in Kenya in 2004 and the last reported outbreak due to serotype C FMDV in Ethiopia was during 2005 [1].

This suggest that serotype C viruses may no longer exist outside of laboratories. The disease has a high morbidity although mortality is rare in adult animals. The impact posed by the disease is enormous. It affects animal's performance directly through reduction of milk yield. Death of young animals and fertility impairment due to increased abortion rate are also the grave consequences of the disease. The recovered animals remain in poor physical condition over long periods of time leading to economic losses for livestock industries. Loss of flesh, diminished milk production, mastitis, calf mortality etc. This combined with the time and money spent for treating animals and their long convalescence contributes to consider it the single most important animal disease in a worldwide contest pastoralists are severely affected by the direct impact of the disease since their livelihood is directly linked to livestock production. FMD has a great potential for causing severe economic loss in susceptible cloven-hoofed animals. Greatest losses can result from refusal of FMD free countries to import livestock and livestock products from infected region Moreover; the disease is becoming the major constraint hampering export of livestock and livestock products. For example, the Egyptian trade bans of

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2005/2006 due to FMD costs Ethiopia more than US$14 million [2].

The disease has been present in almost every part of the world where livestock are kept. More than 100 countries are still affected by FMD worldwide and distribution of the disease roughly reflects economic development. The more developed countries have eradicated the disease. However, an incursion of the disease into the normally disease free countries can cause enormous economic losses [3].

Foot and mouth disease is the most important livestock disease which is endemic and known for its wider distribution in Ethiopia. In Ethiopia, where the local economy is heavily dependent on livestock, losses incurred due to foot and mouth disease in reduced production and efficiency of livestock may be severe and local food security is impaired. In Ethiopia context, traditional livestock management with uncontrolled movement of animals, foot and mouth disease spread is attributed to moving of infected cattle. In general, extensive movement of livestock, the high rate of contact among animals in communal grazing areas, watering points and at commercial markets could be considered as major transmission and dissemination factors for the virus [4,5].

In Ethiopia, outbreak of FMD frequently occurs in the pastoral herds of the marginal lowland areas of the country. This is mainly due to lack of vaccination, free livestock movement among different regions in the countries and across international borders, the existence of multiple FMD virus serotypes, and involvement of wildlife. This might be exacerbated by genetic shift and drift of the FMD virus that may result in new antigenic variant of the virus and, consequently, may cause outbreaks of the disease. These indicate the presence of complexity and dynamic epidemiological situation of the disease in the area [6-8]. Thus, continuous epidemiological studies are important to understand disease situation and to design appropriate control and prevention strategies. A lesson from other developing countries shows, estimation of economic losses can provide a better overall view of the impact of the disease and can contribute in estimating the extent of the losses to be avoided. And also understanding the transmission dynamics can contribute for suggesting appropriate control intervention mechanism [9]. Nevertheless, there are no or few published report on the economic impact of FMD and its transmission dynamics. Literature related to the economic impact of FMD in Ethiopia and its transmission dynamics is limited and few available focuses on the pastoral production system and very few places. In order to choose among alternative disease control, prevention measures and economic decision making, understanding the transmission dynamics and estimating economic impact plays a vital role. Therefore, the objectives of this seminar are:

- To review the epidemiology of foot and mouth disease
- To review the major risk factors for transmission of disease
- To review the economic impact of foot and mouth disease
- To highlight the prevention and control measures

EPIDEMIOLOGY

In the last three decades there have been significant advances in the understanding of FMD epidemiology. These have largely been due to the application of the molecular Epidemiology. In the World Reference Laboratory for FMD (Pirbright, UK), a large sequence database has been built up. This database has been used to aid in the global tracing of virus movements. It has been possible to genetically group many FMDV's based on their geographic origin and this has led to their being referred to as top types. The implications of this are that interregional spread of viruses can often be easily recognized and any evolutionary changes which subsequently occur can be monitored. Molecular epidemiological studies have also contributed in planning control strategies by elucidating historical and current disease transmission patterns within and between countries. Furthermore, it is important to have data on the viral topotypes in both wildlife and domestic animals, information that should be heeded when planning FMD vaccination strategies. The molecular epidemiology of FMDV has been studied in some detail in different countries of the world using VP1 nucleotide sequencing of the main antigenic determinant of the virus and phylogenetic analysis. Analysis of the genetic distance and phylogenetic resolution of the sequence of VP1 encoding gene have provided crucial epidemiological information covering different degree of genetic relationships between isolates. Virus isolates from the same epizootic differ by ≤ 1%, viruses belonging to the same epizootics differ by <7%, viruses of the same genotype differ up to 15% and viruses from different genetic lineage, differ by ≥ 20%. Sequence data has also been instrumental in identifying outbreak resulting from improperly inactivated vaccine and for refuting vaccine involvement in outbreaks [10,11].

The disease is endemic to most countries in sub-Saharan Africa and will not be eradicated from southern and East Africa while infected buffalo are present. Disease-free areas are recognized mainly in southern Africa, where a number of countries have been able to control FMD by separating infected buffalo from livestock and by limited use of vaccination. Lack of movement control within countries and across international borders for both wildlife and domestic animals aggravates the problem, and gives credence to the fact that FMD will remain a problem on the sub-continent for the foreseeable future. With the increase in international travel, the threat from illegally smuggled bush meat and other livestock products cannot be ignored, and it is imperative to understand the current epidemiology of FMD to predict what strains are currently most likely to pose a threat to disease-free regions. Six of the seven serotypes of FMD virus occur on the African continent with the exception of Asia-1, which complicates control of the disease by vaccination. In sub-Saharan Africa, two cycles of FMD occur, one where virus circulates between wildlife hosts and domestic animals and the other where the virus spreads among domestic animals, without the involvement of wildlife. In southern Africa and to a large extent, eastern Africa, the cycle between wildlife and domestic animals occurs, while in West Africa, due to the low numbers of wildlife, the disease is maintained predominately in domestic animals. However, once disease crosses from wildlife into domestic animals, a domestic cycle could be maintained without the involvement of wildlife. As it is costly to sample wildlife, very little is known about the FMD virus populations circulating in these animals and most information outside southern Africa is based on isolates obtained from domestic animals [12].

Occurrence in Ethiopia

FMDVs are endemic in Ethiopia causing several outbreaks every year. Sero surveys in different parts of the country reported sero-prevalences of 9%-26% at the animal level and up to 48% at the herd level in cattle. Another research that covered broader areas of the country showed Sero-positivity of 44.2% with 1.6% and 8.9% mortality and case fatality rates. Serotypes A, O, C, SAT2, have been identified and characterized by the National Animal health research center at Sebeta and the world reference laboratory

for FMD at UK in the years 1969-1994 on samples submitted by Sholla disease investigation laboratory, but from the record of outbreak investigation in cattle by NVI between 1982-2000, three serotype O, A and SAT2 FMD were identified. Serotype O, A, C, SAT1 and SAT2 were identified in Ethiopia. Serotypes O and A are more prevalent and are the major causes of economic losses. the last reported outbreak due to serotype C FMDV in Ethiopia was during 2005 and so serotype C viruses may no longer exist outside of laboratories. FMD impedes export of livestock and livestock products and causes production losses and the number of outbreaks reported annually varies between 12 in 1997 and 198 in 1999. the predominant serotypes recently reported were FMDV serotype O (34.2%), followed by serotype A (17.1%), serotype SAT1 (4.9%) and serotype SAT 2 (2.4%). On average 93 numbers of FMD outbreaks were reported to MoLF annually. The outbreaks occurred every year, but most were reported in 2011 and 2012 each 124 and 205 outbreaks, respectively. However, considering the figures provided are definitely underestimated and do not reflect the reality of the epidemiological situation in the country due to endemic nature of the disease and the unreported cases by farmers.

Several risk factors were identified by different studies for spread of FMD in Ethiopia which include; different species of animals, different age group of animals, animal composition and management system, season of the year, breed, geographic location, herd size, contact at communal grazing area, water point and market and contact with wildlife. Reports Statistically significant differences ($p<0.05$) among different species, with 13%, 5% and 3% seropositivity in cattle, sheep and goats, respectively Furthermore, they indicated cattle to be five times more likely to be infected with FMDV than goats. Abunna indicated as there is a tendency of progressively increased prevalence with increasing age and the odds of animals in age band of 3-4 years and above 4 years of age was 3.46 and 2.43 times at more risk of infection than young animals (age group less than 3 years) Bayissa et al. also found the highest seroprevalence of 32.6% in animals aged at least 4 years old, followed by 18.2% and 8.5% in animals aged between 2 and 4 years old, and less than 2 years old, respectively [2,5]. Beyene et al. also indicated that the risk of seropositivity increases every year as the animal gets older for the adult age group (3.5-5.5 years old) the risk increases 2.7 times with every advancing year, while in the old age group (>5.5 years old) the risk increases 3.4 times [7]. Similarly in study by Desissa et al. the highest seroprevalence was observed in in cattle aged greater than 4 years 24.22% followed by in group of animals aged less than 2 years 18.75% and between 2-4 years 16.51% [12].

In study the odds of seropositivity were 2.8 and 2.3 times higher in the adult (>4 years) and maturing animals (3-4 years) compared to young age category (<3 years). Mekonen revealed difference in age status to be statistically significant and higher prevalence being in adult 27.6% followed by heifer 16.8%. Mohamoud also indicated as prevalence of FMD was highest in adult cattle and lowest in calves with Seroposetivity for calves being (Zero), young (13.2%) and adult (18.9%) on the other hand Negusssie ndicated Morbidity rates of cattle in different age groups were 18.4%, 11.0%, and 5.4%, in calves, young, and in adult, respectively. Most recently, sero-positive of animals greater than 3 years old (32.9%) animal 2 to 3 years (18.18%) and animal less than 2 years (5.68%). In eastern Ethiopia also found statistically significantdifferences ($p<0.05$) in seropositivity between the three age groups, with adults recording the highest seroprevalence rates (16.3%) and young cattle the lowest (4.7%). Urge and reported recently that the risk of FMD infection was increased by 4.2 times (OR=4.2, 95% CI (1.925-8.810)) in calves than Adult cattle.

These show the complex situation of the disease which needs more detailed investigation. Another risk factor is Breed as confirmed by indicated statistically significant difference observed among different breeds of cattle with mortality and morbidity rates ($p<0.001$). The morbidity rate was 20.2%, 21.1%, and 8.9% in indigenous, exotic, and crossbred cattle, respectively. Similarly indicated sero-prevalence of antibodies against FMDV differed significantly ($p<0.05$) between local (12.69%, n=134) and crossbred (27,73%, n=440) cattle. Urge and reported recently that Cross bred cattle were three times more likely to be infected (OR=3.47, 95% CI: 2.10-5.74)) by FMD than local breeds. On the other hand Mazengia et al. (2014) indicated that the incidence rate in Fogera cattle (15.52%) was significantly ($p>0.05$) higher than that of Holstein-Friesian cross cattle (2.50%).

Animal composition and management system

In recent study by significant prevalence variation ($p<0.05$)with higher sero-prevalences of antibodies against FMDV was observed in cattle kept together with small ruminants. Megersa also indicated keeping cattle with small ruminants (OR=5.1, 95%CI 1.0-25.2) odd ratio increased when compared to one species kept alone also indicated that highly significant difference in sero-prevalence ($p<0.01$) was observed between pastoral and sedentary systems with 16 times higher likelihood of disease occurrence in pastoral than sedentary herds..

Season of the year

Difference in season is observed by Rufael who indicated the seasonal incidence of FMD to be increased during the dry season and were attributed to increased cattle movement to dry season grazing areas [12]. Likewise FMD outbreak frequencies were found to be significantly correlated to the length of extended dry season (r=0.377). Similarly Alemayehu et al. indicated statistically significant difference of seroprevalence between months of the year, with highest seropositivity on July (36.3%) and lowest was recorded on April (3.8%) [3]. On the other hand, Negusssie indicated in their questionaries' that from the total of 295 individuals subjected to questionnaires, 253 (85.8%) of them responded that the disease usually occurred as an epidemic and mostly occurred during the rainy season of the year (during short and long rainy seasons).

Geographical location

Geographical Location is also reported as witnessed by Zerabruk who found location (x=10.9, p=0.012) to be significantly associated with prevalence of FMD. Yahya also found Location and altitude, to be significant infection risk factors in their result cattle sampled in the lowlands had a significantly ($p<0.05$) higher FMDV seroprevalence (36.2%) than those in the highlands (3.4%). Similarly Megersa indicated Seroprevalence was progressively decreased with increasing altitude ranges animals from low altitude (<1500 m.a.s.l.) had significantly higher seroprevalence ($p<0.05$) than those from mid altitude and high altitude areas. Mekonen also found significantly higher prevalence was recorded in Borana 53.6% (82/153) compared to Guji 10.1% (31/307). From the various risk factors, geographical distribution ($p<0.05$) were seen to be significantly associated with the seroprevalence.

HERD SIZE

Studies in different regions of Ethiopia have also reported a direct association between FMDV infection and herd size indicated that

the seroprevalence of FMD increase as the herd size increase. In recent study by Beyene et al. there is positive relationship between FMD seroprevalence and herd size: as herd size increase, the risk of there being seropositive animals in the herd increase [7]. Furthermore they showed that herds in communal grazing areas to be 3.2 times more likely to become infected with FMDV than herds that grazed separately. Indicated FMD outbreaks are known to occur especially during the dry period when cattle have to move long distance in search of pasture and water, possibly leading to immunosuppression resulting in higher disease susceptibility as well as increased animal contact rates.

Contact with wild animal

Showed a statistically significant ($p<0.05$) association of FMD seropositivity and contact between livestock and ungulate wildlife also indicated in their questionaries that (11.5%) individuals answered that there is presence of contact with wild animals especially with wart hogs. Foot and mouth disease remains one of the most important livestock diseases of the world, given its highly infectious nature, its broad economic impacts on animal wellbeing and productivity, and its implications for successful access to domestic and export markets for livestock and products. The impacts of the disease vary markedly between developed and developing countries, and also within many developing countries depending on the species involved, the genotype of animal, the level of productivity, the significance of livestock to livelihoods, and the effectiveness of indigenous coping mechanisms for controlling the effects of FMD. At farm or individual level, the direct effects of an outbreak of FMD in terms of morbidity, mortality, expenditure to treat the disease, and measures taken to avoid further spread can substantially lower farm incomes, particularly in susceptible highly productive animals. The recovered animals remain in poor physical condition over long periods of time leading to economic losses for livestock industries loss of flesh, diminished milk production mastitis, calf mortality etc. This combined with the time and money spent treating animals and their long convalescence contributes to consider it the single most important animal disease in a worldwide contes. Moreover, death of very young animals, culling of unproductive and chronically infected animals, and loss of valuable breeding stock and disruption of livestock improvement programs are also attributed to the direct effect of the disease.

In less commercialized production systems in Africa and Asia where indigenous breeds predominate, these direct effects may be minor. However, livestock often serve multiple purposes in these systems, such as providing draught power, so that the temporary lameness reported up to 60%-70% of working buffalo and cattle caused by FMD can also lower farm income by reducing crop production or transport services. Furthermore, if the disease affects livestock kept by the poor who have few such productive assets, the impact on their livelihoods can be especially devastating and similarly pastoralists severely suffer by the direct impact of the disease since their livelihood directly depend on livestock production. From a current global perspective, the indirect effect and the risk of the disease has a much greater impact than that of the disease itself. Much of the burden (cost) of containing outbreaks, as well as maintaining the ongoing capacity and measures intended to reduce the risk of FMD such as vaccination, surveillance, movement control and so on can incur an extremely high additional economic cost. In developed nations containment measures especially stamping out policies are seen to be associated with animal welfare and environmental impacts that increasingly draw attention. Measures taken to contain an outbreak can also affect other sectors, such as the impact on tourism in the UK outbrea. The presence of FMD has also a negative impact on the integration of livestock and wildlife based activities, which is believed by many to be ecologically and financially desirable. Thus the disease can exert considerable influence on the development of integrated land use policies in South African countries.

Economic impact of FMD on Ethiopia

FMD is a potential threat to Ethiopia's live animal export trade to Middle East and North Africa (MENA) which accounts for about 140 thousand heads, 23.9 million USD. The Egyptian ban 2005-2006 on cattle alone cost Ethiopia a market lose ranging 12.36 million USD (36%) of the total market to MENA. Hence, FMD is the number one TAD which is impeding export of live cattle (SPS/LMM, 2008). The total annual (2011) economic loss due to bulls rejection from international market was estimated to be 3,322,269 USD which is equivalent to 56,345,682.24 ETB (1 USD=16.96 ETB).

Currently, the single largest impact of FMD is undoubtedly its critical role as a restriction to international trade. The highest value markets for livestock products are in FMD free countries, and these countries are allowed to restrict or ban imports of livestock products and sometimes other products as well as a potential risk of introducing FMD. Pastoralists are severely affected by the direct impact of the disease since their livelihood is directly linked to livestock production. Owing to the low productivity of pastoral herds as compared with commercial or semi-commercial diary units, FMD infection in pastoral areas is considered relatively as minor disease. However, pastoralists severely suffered by impact of the disease on milk yield since they rely more on milk as a subsistence food than any other population in the country.

Milk losses due to the disease are not clearly stated. The disease is also associated with abortion and mortality in calves in acute cases and "chronic FMD" cases showing heat intolerance, reduced fertility. FMD has a high economic impact in Ethiopia. Its control is predicted to be economically profitable even without a full consideration of gains from export. The targeted vaccination strategy is shown to provide the largest economic return with a relatively low risk of losses. The annual costs of FMD were assessed based on production losses, export loss and control costs. The total annual costs of FMD under the current status quo of no official control were estimated at 1,354 (90% CR: 864-2,042) million birr. The major cost (94%) was due to production losses.

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