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Epidemiology and economic impact of foot and mouth disease in Ethiopia: A review

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Abstract
Foot and mouth disease is an economically important trans-boundary viral infection of cloven-hoofed animals caused by virus belonging to genus Apthovirus and family Picornaviridae. FMD has direct and indirect economic consequences on animal production. Ethiopia is now endemic for FMD virus serotype O, A, SAT2 and SAT1 serotypes. The FMD outbreaks in Ethiopia showed a concentration in the central and northern parts of the country. Transmission occurs through direct animal contact and indirect routes, with the virus surviving in the contaminated environment for up to 14 days, indicating indirect transmission. It can cause high number of deaths among young animals and production losses in adult livestock. In Ethiopia, FMD outbreaks have cause to millions of Ethiopian birr losses due to the restriction or rejection of livestock products in the international market. There is no cross-immunity between serotypes, immunity to one type does not confer protection against the others, and this presents difficulties to vaccination programs. Due to the presence of diverse antigenic serotypes of FMD viruses in Ethiopia, regular and extensive molecular investigation of new field isolates is necessary to perform vaccine-matching studies to evaluate the protective potential of the vaccine strain in the country.

Keywords: Economic importance, epidemiology, Ethiopia, FMD, FMDV

Introduction
Foot and Mouth Disease (FMD) is an acute highly contagious, trans-boundary disease caused by foot and mouth disease virus (FMDV) [1]. Foot and mouth disease virus is classified as a minor positive-sense RNA virus in the Picornaviridae family and under genus Aphthovirus [2].This virus is classified into seven [7] different serotypes (O, A, C, Asia 1, SAT 1-3) on the basis of antigenic differences [3, 4, 5, 6]. Foot and mouth disease is classified as a 'listed disease' by the World Organization for Animal Health (WOAH) [7]. It disease affects various cloven-hoofed animals and causes huge economic losses in the livestock sector worldwide [8]. The disease remains one of the most significant trans-boundary animal health challenges, restricting trade in animals and animal-driven products leading to substantial socioeconomic disruptions [9]. An animal becomes a reservoir when the virus persists even after recovery from acute infection and carrier if the virus persists > 28 days post infection [10]. FMD is usually listed as the priority livestock disease for countries with developed commercial livestock sectors, where the presence of FMDV would block access to valuable export markets, and regular outbreaks undermine livestock productivity and profitability [9].
The optimal distance between carrier animals and susceptible hosts for the transmission of the FMD virus is influenced by various factors, including carrier transmission dynamics and environmental conditions [11]. The disease is characterized by fever and vesicular eruptions on the tongue, feet, snout, and teats [12]. Across eastern Africa, FMD has persisted as an endemic and cyclically recurrent disease throughout the past century [13]. FMD is one of the major endemic trans-boundary livestock diseases of socioeconomic importance in Ethiopia and in other parts of the globe [14]. Animals managed semi-intensively have greater FMD prevalence than intensively managed animals [15]. Prevalence had increased in densely populated than scattered one, so ventilation and animal density may cause for variation in occurrence and distribution of the disease [16]. Restrictions on livestock movement and trade bans can severely impact the income of farmers and traders and have broader economic repercussions due to the dependency of farmers on livestock for revenue [17].

Characteristics of FMD virus

FMDV is a non-enveloped virus of approximately 30nm in diameter, with a single-stranded genome of positive polarity (+) RNA of roughly 8400 nucleotides in length [18]. The FMDV genome comprises a long 5′ untranslated region (5′UTR), an open reading frame (ORF), and a short 3′UTR [3, 7]. There are 60 structural copies of proteins present in the FMDV capsid. Genetic variation can occur through mutation or homologous recombination between two different FMD virus strains, resulting in new FMDV variants which significantly affect vaccine strain selection [19]. The immunosuppression and virulence of viral proteins efficiently promote FMDV replication which also affects the host's resistance to other pathogens [20]. FMD virus can survive outside the host for extended periods, enabling indirect transmission through contaminated environments and interactions between domestic and wild animal populations [21].

Epidemiology

The distribution of FMDV is characterized by seven geographical endemic pools that maintain discrete viral lineages comprising, Pool 1: East Asia, Pool 2: South Asia, Pool 3: West Eurasia, Pool 4: East Africa, Pool 5: West Africa, Pool 6: Southern Africa and Pool 7: South America [4]. The epidemiology of FMD is further complicated by the presence of infection reservoirs among both domestic and wild populations [7]. FMD type O is the most widely prevalent serotype worldwide and it contains eight topotypes [19]. The risk of airborne transmission will vary between geographical areas depending on factors such as species present, local climate, animal density and management systems [22]. The FMDV serotype SAT2 is the most widely distributed and frequently associated with livestock [6]. African buffalo (Syncerus caffer) is known to be the main wildlife reservoir for the SAT sero-types in the Africa based on the species and virus strain development of the infection varies [23]. The complex epidemiology of FMD, driven by diverse hosts, rapid virus evolution, high transmissibility, and subclinical maintenance, shapes international trade policies and presents continued obstacles to effective control and eradication efforts [9]. Cattle are the main hosts for FMDV and the most vulnerable to infection. However, some FMDV strains (serotype O) can adapt to pigs after being isolated in cell culture [8].

Mode of transmission

The optimal distance between carrier animals and susceptible hosts for the transmission of the FMD virus is influenced by various factors, including carrier transmission dynamics and environmental condition [11]. Initial viral replication occurs in the respiratory system, particularly the pharynx and lungs, after which viral dissemination occurs throughout the body [7]. Transmission of the virus through the air or respiratory system is frequent and causes rapid spread [19]. The virus may infect feed, standing water, clothing and skin of animal handlers, motor vehicles, and food supplements that contain infected animal products [24]. Environmental contamination arises from viral shedding by infected animals, while feedback mechanisms allow for reinfection of susceptible hosts [21]. A common assumption about the circulation of FMDV in wild/domestic systems is that the virus transmitted from maintenance wild hosts buffalo to the most documented respective species cattle [25]. Airborne transmission is the most probable cause of several historic FMD outbreaks. Aerosols from infected farms may carry varying levels of virus which will depend on the characteristics (particle size and composition) of the dust particles generated within a farm [22]. Environmental factors such as wind direction, humidity, and temperature influence the likelihood of long-distance spread [26]. FMD is a directly transmitted disease with the predominant means of spread being direct or close contact between infected and susceptible animals [27].

Pathogenesis

The virus starts to multiply in the epithelial cells at the beginning of the invasion in the cattle [20]. The heart is the most severely affected organ and may be the leading cause of death in young calves under six months. Non-suppurative myocarditis, in the form of hyaline degeneration and necrosis of myocytes (hyalinization) with mononuclear cell infiltrations, were the main observed pathological lesions in the heart [28]. The anatomic site of primary FMDV infection varies depending on host species and may also vary depending on the route of exposure [18].

Clinical sign

Infected animals can spread the virus one to two days prior to the onset of the clinical signs and seven to ten days after the presentation of clinical sign [23]. Inability to masticate makes the animal cachexic and generalized loss of appetite is observed [24]. The virus can be found in various body fluids before and after the systems of FMD appear. The virus can also stay in the oral cavity of infected animals for a long time [8]. Affected animals develop a fever and show reluctance to walk, sometimes separating themselves from the rest of the flock [29]. The disease is characterized by high fever within two to three days, formation of vesicles and erosions inside the mouth leading to drooling of saliva. Vesicles are also on the nose, teats and when on the feet may rupture and cause lameness [1]. Lameness is caused by foot lesions, namely erosions on the coronary bands and interdigital spaces [30]. Vesicles, irregular-shaped erosions/ulcers of variable size, were typically found on the torus lingua and anterior third of the tongue and more frequently on the gingiva, lip, and dental pad. Hyperemia, ulceration, heel bulb detachment, and sole separation are identified. Calves exhibited moderate to the severe oral cavity, omasum, abomasum, and rumen erosions and ulcers [28].

Diagnosis

Foot and mouth disease virus is found in the secretions and excretions of acutely infected animals, such as air, milk, saliva, urine, feces, semen, fluid in vesicle lesions, amniotic fluid, and fetuses resulting from abortion [19]. Various diagnostic methods, including the viral neutralization test (VNT), complement fixation test (CFT), sandwich-ELISA, virus isolation (VI), RT-PCR, real-time/quantitative RT-PCR and liquid-phase blocking ELISA are used to confirm FMD presence [7].

Socioeconomic impact

FMD leads to loss of draught power and can result in abortions [7]. Impact on the economy results in both direct and indirect losses. A loss due to death, vigor loss, milk production, and the value of livestock products are all examples of direct losses. The increased costs for vaccination, movement control, diagnostic and surveillance, and treatment of secondary bacterial infections in diseased herds are the causes of the indirect losses [31]. Although

FMD has a low mortality rate in adult animals, it has debilitating symptoms such as weight loss, decreased milk production, reproductive failure, and loss of draught power, which ultimately lower productivity and result in economic losses [6]. FMD have a significant impact not only on the agricultural industry but also on the wider economy and society [32].

Prevention and Control

FMD is not zoonotic disease, but even so, it can cause significant economic losses, so efforts need to be made to prevent and control the disease [19]. Vaccine is important tools, among other used to control FMD and eventually achieve freedom from virus circulation [33]. In the Ethiopia context, control of FMD is practiced by involvement of quarantine, isolation of infected cattle's, restriction of cattle movement, vaccination programs, proper removal of infected carcass and other methods which are feasible to Ethiopian economy [23].

Epidemiology of FMD in Ethiopia

FMD is one of the major endemic trans-boundary livestock diseases of socioeconomic importance in Ethiopia and in other parts of the globe [14]. Ethiopia is now endemic for FMD virus serotype O, A, SAT2 and SAT1 serotypes [34]. Geographic variation, the timing of an infection, the production system, the mobility of the herd in search of pasture and water, animal mixing at watering spots, the size of the herd and regular interactions with other animals and wildlife could all be contributing factors to epidemiology of FMD in Ethiopia [35, 36, 37]. The central, southern, and southeastern regions of Ethiopia have a higher incidence of outbreaks than the northern and western regions, which may be related to wildlife reservoirs and climatic factors [8]. Outbreak numbers increased during December, January, February and March (reaching peak in March). This might be coinciding with the increased animal transports due to the increased meat demand during the impending Christmas (at the end of December) and Easter festival (March-April) celebrations of the Christian population in Ethiopia which the two big religious festivals for Orthodox [38]. FMD prevalence had increased in densely populated than scattered one, so ventilation and animal density may cause for variation in occurrence and distribution of the disease [16]. The movement of cattle for marketing in most parts of Ethiopia is by trekking to the main town, and movement of cattle for searching of grazing areas and watering points in the dry season of the year in pastoral area suits for the dissemination [39]. FMD prevalence is higher in local breeds than exotic cross-breed which might be associated with their free movement as well as management [40]. In pastoral production systems where animals travel significant distances to find water and pasture, having a mixture of different age groups in the herd, along with the lack of regular vaccination against FMD, may result in varying levels of exposure to FMD virus [36]. Serotype O as a dominant serotype in Ethiopia and throughout the world [30].

Economic impact of foot and mouth disease in Ethiopia

Foot and mouth disease is endemic in Ethiopia and poses a significant economic burden on the country [11]. FMD causes severe economic losses due to reduced animal productivity, trade restrictions, and control costs [8]. FMD stands as one of the most economically consequential trans-boundary animal diseases, particularly in regions where livestock production is central to food security and rural livelihoods [26]. FMD is a potential threat to Ethiopia's live animal export trade to Middle East and North Africa which accounts for about 140 thousand heads, 23.9 million USD [34]. FMD infection affects the fertility of mature females, the economic losses due to FMD infections in cattle [41]. Restrictions on livestock movement and trade bans can severely impact the income of farmers and traders and have broader economic repercussions due to the dependency of farmers on livestock for revenue [17]. The economic costs due to FMD in Ethiopia mainly associated with milk losses, animal traction loss, vaccination costs, treatment costs and mortality losses. In the commercial dairy farms, the largest loss at infected animal level is due to milk production loss [42].

Conclusion

FMD outbreaks occur frequently across the country, with higher frequently and intensity during the dry season. Foot and mouth disease is endemic in Ethiopia. Wildlife may serve as a reservoir of FMDV and disease transmission to cattle population. The economic impact of FMD on the national and international trade of livestock and livestock products is so huge which should significantly surpass the direct economic impact estimations. A regular vaccination program against the identified circulating FMDV serotypes with sufficient coverage is required to avoid future outbreaks.

Competing Interests

the author declared not any competing of interests

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