Foot-and-Mouth Disease in the Americas

Epidemiology and Ecologic Changes Affecting Distribution

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ABSTRACT: Foot-and-mouth disease (FMD) was first recorded in South America (SA) circa 1870, in Buenos Aires, Argentina, in Uruguay, and in southern Brazil as a result of the introduction of cattle from Europe during the early days of colonization. Livestock production to trade with neighboring countries was established in the La Plata Region, and the trade of livestock and products with Chile, northeastern and central western states of Brazil, to Peru, Bolivia, and Paraguay spread FMD, which reached Venezuela and Colombia in the 1950s and finally Ecuador in 1961. The traditional forms of livestock husbandry influence the diffusion and maintenance of the FMD virus (FMDV) in different areas. Cattle production in SA depends mainly on a strong relation between cattle-calf operations and fattening operations in a complementary cycle, revealing the vulnerability and susceptibility of these areas to FMDV. Understanding the relationship between time-space behavior of the disease and the forms of production defines the FMD ecosystems, a key concept to elaborating the control/eradication strategies of national FMD eradication programs, which must be modified when trade opportunities between zones of differing sanitary status change. The role of other susceptible species besides bovines, including wildlife, in maintaining and spreading FMDV has been the subject of several studies, but in SA, bovines are so far considered to determine disease presentation. Buffalo (Bubalus bubalis) have been implicated in the spread of the disease between farms in at least one case in Brazil. Sheep are almost on a par with bovine in terms of number, especially in the Southern Cone, but their role in the maintenance of infection is not considered important, possibly owing to rearing practices. Camelid populations in the Andean region do not play an important role in the maintenance of FMD, because of short persistence of infection and low population densities in these species. The importance of wildlife is not clear, but it is accepted that animals are mostly affected as a spinoff during outbreaks in domestic species. Experimentally infected capybaras (Hydrochoerus hydrochoeris hydrochoeris) showed clinical signs and infected other susceptible species, but their role in the maintenance of infection in nature is so far not clear.

KEYWORDS: foot-and-mouth disease; epidemiology; distribution; ecologic changes

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INTRODUCTION

The introduction of cattle into South America dates back to the very early days of colonization when trade of livestock and livestock products was a monopoly of Spain and Portugal. South American countries under their rule were protected from the disease because the Iberian Peninsula was not affected by foot-and-mouth disease (FMD) until the late nineteenth century. Livestock production for trade with neighboring countries was first established in the great plains of Argentina, southern Brazil, and Uruguay, using the abundant local cattle of European origin for the production of tallow, leather, and salted meats.

However, development of industrial cold storage brought time and efficiency factors of food conversion to the fore, prompting the importation of cattle with better genetics to improve productivity. It is thus accepted that the virus reached South America circa 1870, being recorded almost at the same time in Buenos Aires, Argentina, Uruguay, and southern Brazil. Its epidemiology was unknown, and no actions were then taken to control the disease allowing the virus to spread to Chile as well as to the northeastern and central western states of Brazil, to Peru, Bolivia, and Paraguay, being registered in Venezuela and Colombia in the 1950s and in Ecuador in 1961. North American countries (United States in 1921; Mexico in 1947 and 1954; and Canada in 1952) conducted successful eradication campaigns, but the countries of South America did not act effectively until the early 1960s to prevent the entry and spread of FMD.

The closing of the North American markets to products of animal origin after World War II and the aforementioned introduction of FMD into Venezuela and Colombia in the early 1950s may be considered the main reasons behind the decision to wage an organized, continent-wide fight on the disease that included the creation of PANAFTOSA in Brazil in 1951.

EARLY NATIONAL FMD CONTROL PROGRAMS, ECOSYSTEMS, AND THE HEMISPHERIC FMD ERADICATION PLAN

The first plans for controlling the disease in South America were seen in the early 1960s in Argentina and the neighboring State of Rio Grande do Sul, in Brazil. Nationwide programs supported by international loans started by the mid-1970s and became the basis for many national animal health services in operation today. The FMD control method used by the national programs relied on a 3 cycles/year vaccination with aluminum hydroxide vaccines of the entire cattle herd of the country. This was supported by a transit control exerted without risk analysis and an outbreak control process that was not always effective. This approach did not rely on the epidemiologic studies about the ecosystems mentioned earlier, which set the basis for a regionalized approach. The ecologic changes affecting the distribution of the disease, mentioned in the title, are related to the productive system in place.

The traditional forms of raising, fattening, and processing livestock influence the diffusion and maintenance of infection in different areas of South America. There is a strong relation between range farming areas and fattening areas in a complementary cycle of production. Range farming areas, characterized by low rates of produc-
tivity but high outputs, produce steers for fattening in areas with better productive infrastructure, closer to the centers of processing and consumption.

The seasonal flow of animals is responsible for a concentration of susceptible and infected animals in the fattening areas. The vulnerability and susceptibility of these areas, due to their peculiar livestock structure and levels of immunity of animal populations, might eventually spur epidemic FMD outbreaks, commonly seen in the early stages of the programs (FIG. 1). The development of knowledge about the time-space behavior of the disease, based on the traditional trade relationship, known in South America as FMD ecosystems, was basic to elaborate control/eradication strategies of the national programs.

The Hemispheric Plan for the Eradication of Foot-and-Mouth Disease (PHEFA) was developed late in the 1980s, with three main objectives: create and maintain FMD-free areas; increase availability of meat and milk by increasing efficiency of livestock operations; and improve the access of animals and products from originally affected countries to international markets.

Foot-and-mouth-disease eradication programs had their activities reoriented with a regional focus, and national animal health services were strengthened in nearly all the South American countries. Experiences in joint administration of the FMD programs between the government and the livestock sector were developed in some countries, usually to manage the vaccination cycles. This was effective in increasing vaccination coverage, resulting in better immunization due to closer control. Vaccination, outbreak control, and restricted animal movement resulted in a decrease in the number of FMD outbreaks from an average of 1,200 outbreaks in 1990 to about 130 in 1999.

The strategy of the Plan still relies today on regionalization of the countries with a special focus on the forms of production mentioned earlier. Different levels of risk
require specific disease control/eradication strategies based on twice-a-year cyclic vaccination and emergency vaccinations, when needed, with oil-adjuvanted vaccines. Other species such as sheep, goats, and pigs usually are not vaccinated except when under serious risk. This policy proved helpful when seroepidemiologic surveys were carried out, as these species acted like negative controls. Strict animal movement control and expedited outbreak attention based on a surveillance system were also enforced.

To preserve activities from interruptions due to political interference, social and inter-sector participation was stressed in the administration of the campaigns as well as differentiated attention to small livestock owners, usually resistant to animal health programs. The Plan was created in 1987 and is expected to fulfill its goals by 2009.

**ROLE OF SPECIES IN THE MAINTENANCE AND DIFFUSION OF FMD**

The forms of livestock production described previously are considered determinants of FMD endemism and causative of epidemic outburst in highly concentrated areas, as seen in the past. The participation of susceptible species in the maintenance and diffusion of FMDV in South America has been the subject of several studies, and bovines are accepted as the species mainly responsible. Even when the ovine population was equal to the bovine one, specially in the Southern Cone of South America, its role in the maintenance of infection was not regarded as important, and the species were not compulsorily vaccinated. The importance of the small species in the maintenance of infection through longer periods has yet to be evaluated.

The importance of the camelid populations in the spread of the disease in the Andean region is also limited to small ranges, and persistence studies showed that infection is short-lived in camels. The importance of wildlife in the maintenance of infection is yet undetermined. Nevertheless, it is known that wild species can be affected during outbreaks in South America, as a spinoff. There is, though, one case in which buffalo (*Bubalus bubalis*) seemed implicated in the spread of the disease in Brazil, when the introduction of this species to a controlled farm brought in FMDV A, which eventually spread to another farm in SA.

**FUTURE FOCUS**

We have seen that eradication of FMD is indeed attainable in the countries of South America. Maintaining a disease-free status without vaccination for some countries while others in the region remain infected became a special challenge to the governments and veterinary authorities in the region.

Nevertheless, the recent resurgence of FMD in the Southern Cone of South America might reflect three situations: the urgency of the process adopted by some of the countries in the liberation of zones, which did not allow for the consolidation of the achievements in disease control, before advancing to the eradication step in the process. The second could be the existence of unnoticed “niches of infection,” which, added to the end of vaccination, allowed diffusion of the agent within the herds. An-
other possibility is that the existing trade relations at border areas between countries with different sanitary status might have brought the agent to previously clear areas.

It may be argued that it resulted from the failure of authorities to recognize that continuing high levels of prevention and surveillance are cornerstones of the effort to maintain FMD-free status. Political and economic pressures to achieve disease-free status rapidly are constant and intense, but support and investment wither when FMD is declared eradicated in a country, and the government usually shifts resources to support other high-priority needs. The veterinary infrastructure collapses and the cooperative effort with the private sector ends when vaccination is suspended. There is little interest in maintaining FMD awareness in the minds of the producers, trade people, and the public.

The Plan of Action of PHEFA for 2003–2009 is being restructured and focuses on prevention, strengthening community participation, and concentrating efforts on border zones between the countries. In this aspect, a study carried out by PANAFTOSA and countries in South America described international zones where the agent can cross by means of transit of animals and products.

National programs must have their strategy reoriented under a regional focus based on the use of risk analysis method. Vaccination should be homogeneous in coverage and in timing. Primary prevention activities, such as surveillance for high-risk operations, should be included in the regional program. Border areas should be a priority for animal health programs with well-defined territorial coverage, joint programming, execution, and evaluation of control/eradication activities. This would create an “epidemiologic border” to protect against reintroduction of the agent in areas considered to be free.

Another area of interest is the development of new experiences in joint administration of programs between the public and private sectors. Strategic alliances should be developed with other sectors of the economy interested in the improvement of the sanitary situation of the livestock industry and its impact on international trade, bearing in mind cultural and economic idiosyncrasies.

The small producer in some areas became an important risk factor for the completion of the PHEFA objectives and must be brought into the program by the inclusion of FMD-related activities in packages of veterinary attention that takes into account the sanitary problems that cause the major impact on their production.

It is extremely unlikely that any country or zone in South America achieving free status will be able to “isolate” itself and thereby insulate its national herd from the effects of an FMD-infected neighbor or trading partner. FMD in South America is not any one country’s challenge. It is a transboundary disease and demands that countries avoid focusing only on national programs and instead develop and implement regional eradication strategies.

REFERENCES