

CONTROL AND PREVENTION OF FOOT-AND-MOUTH DISEASE IN THE WESTERN HEMISPHERE¹

Sir William Henderson, F.R.S.²

Current events are having a significant effect on the foot-and-mouth disease situation in the Americas. Impending completion of the Pan American Highway will remove a major barrier to land traffic between endemic areas of South America and the disease-free regions of Central and North America. On the other hand, success in controlling foot-and-mouth disease in Europe has demonstrated the effectiveness of the control and eradication doctrine long recommended for the Americas. This article describes that doctrine in its current context, referring specifically to control activities in countries with the disease, preventive work in disease-free countries, national and international responsibilities for control of trade between countries, and various types of international cooperation.

Introduction

I have addressed audiences on this subject many times in the past, and some may wonder if I have anything new to say. The control and prevention of foot-and-mouth disease was, of course, my theme during the nine years from 1957 to 1965 when I was at the Pan American Foot-and-Mouth Disease Center. Eleven years have passed since then, 11 years of continuing progress, and there is something new to say.

One new point is that we are now on the verge of penetrating the hills, swamps, and jungles of the Darién area, that substantial barrier between the endemic foot-and-mouth disease regions of South America and the disease-free regions of Panama, Central America, and North America. The presence of the disease in South America has been and is an ever-present threat to the livestock of the dis-

ease-free regions. But a land barrier has always existed, and the threat of infection has been associated only with sea and air traffic. The Pan American Highway will open the way for possible spread of the disease by land traffic.

Although the generally severe importation restrictions practiced by the countries in the regions free of foot-and-mouth disease must continue, as must their constant vigilance, the only long-term solution to the disease problem is progressive reduction of the prevalence of the disease in endemic areas. This reduction must be achieved by vaccination and sanitary control measures, until a stage is reached when final eradication becomes feasible and economically acceptable. The pending removal of the Darien land barrier adds an element of urgency to the general situation—a situation which has been the concern of the Pan American Foot-and-Mouth Disease Center ever since its creation 25 years ago.

In discussing the implications of the Pan American Highway, I wish to give specific attention to four topics: (1) control of foot-and-mouth disease in the affected countries; (2) prevention of the disease in the disease-free countries; (3) actions to be taken in the event of an outbreak in a disease-free country;

¹Paper presented at the X Inter-American Meeting, at the Ministerial Level, on Foot-and-Mouth Disease and Zoonoses Control (14-17 March 1977) and published in *Animal Health Programs and Trends in the Americas, 1977* (PAHO Scientific Publication No. 358, 1978). Also appearing in Spanish in *Boletín de la Oficina Sanitaria Panamericana*, 85(4), 1978.

²Secretary to the British Agricultural Research Council, London, U.K.

and (4) national and international responsibilities.

Control of Foot-and-Mouth Disease in the Affected Countries

In theory, endemic foot-and-mouth disease can be controlled by creating an immune population through vaccination and by adopting sanitary measures which reduce that population's chances of exposure to infection. There is nothing new about this. What is new, however, is that we now have examples confirming the validity of this approach.

I speak to you as head of the agricultural research service of a member country of the European Economic Community. We have controlled foot-and-mouth disease in Europe. Foot-and-mouth disease has been eradicated from a number of European countries and very effectively controlled in others. This has been accomplished by the rigorous application of sanitary control measures and, in many cases, by well-organized, systematic programs of vaccination using appropriate high-potency vaccines.

Foot-and-mouth disease is now an exceptional occurrence in the countries of the European Economic Community, and a number of countries have enjoyed years of freedom from the disease. This was not so a decade ago. Therefore, when I was expounding the doctrine of controlling and eradicating the disease in South America 10 to 20 years ago, these European successes could not be cited as examples. However, the actions needed to achieve success have long been known. In fact, it was my privilege to enumerate them (1) here in Washington in August 1966, at the PAHO-sponsored meeting of a working group on the subject of foot-and-mouth disease and participation by international credit agencies in financing control programs. This meeting preceded a very substantial investment by the Inter-American Development Bank.

Apart from the very heartening success of the program in Chile, effective control of

foot-and-mouth disease has not been achieved in South America. The main cause of weakness in the countries' programs have always been — and apparently continue to be:

1. The use of vaccines of unacceptably low potency;
2. Inefficient storage, distribution, and application of vaccines;
3. Inefficient control of disease outbreaks;
4. Ineffective epidemiologic surveillance; and
5. Inadequate organization and administration.

Vaccine Quality

Of the five points, the most critical is the first — namely, the potency of the vaccine. The most efficient planning and administration is powerless without an effective weapon, in this case an appropriate high-potency vaccine.

Therefore, an essential feature of each national program must be a procedure for controlling the quality of vaccine production. This procedure must include monitoring of the virus type and subtype in the field. It is equally important that the procedure be scrupulously applied and that standards be maintained despite the temptation posed by pressing demands for increased supplies of vaccine. There have been many instances of failure to recognize such standards in the past.

Another significant feature of vaccination campaigns in South America has been the prejudicial pressure of commercial competition, because of which the vaccine producers have been forced to adjust their production costs and prices against a national standard that may have been unrealistically low.

Experience in Europe has shown that highly potent inactivated virus vaccines can be produced at acceptable cost and that their use in efficiently organized campaigns can completely dominate the disease situation. These techniques of vaccine production are applicable in South America, and in fact these vaccines are becoming increasingly available in South America. When there, I realized only too well that livestock production was carried

on under very different circumstances in South America than in Europe; but today we know that our precepts are correct, that the means are effective, and that, with efficient organization, they can be successfully applied.

Modified Live Virus Vaccine

All that I have said so far relates to the use of inactivated virus vaccines. In the 1950's and 1960's, those of us engaged in foot-and-mouth disease research had high hopes for live virus vaccines. We hoped that the immunity stimulated by a live but nonpathogenic virus would be stronger than that prompted by an inactivated virus and, in particular, we hoped that this immunity, if stronger, would protect better against different virus subtypes.

The vaccines then available, as then applied, did not fulfill these hopes; and although some spectacular results were obtained in halting the spread of disease epidemics, more general use of the vaccines was obviously inappropriate. The fact that the meat-importing countries of Europe took exception to the exporting countries' use of live virus vaccine to control foot-and-mouth disease imposed a severe constraint on its further development.

Continued research on this subject has nevertheless been encouraged. Fundamental research on genetic control of the biological characteristics of virus mutants is part of the program at the Animal Virus Research Institute in Pirbright, England. The development of modified virus strains and their use as vaccines has been a continuing part of the work at the Pan American Foot-and-Mouth Disease Center. And the use of such vaccines has long been a part of the disease control program in Venezuela.

Workers at the Pan American Foot-and-Mouth Disease Center recently suggested that modified live virus administered in the upper respiratory tract may stimulate the local defense mechanisms at the principal portal of entry. Discussions are currently taking place between scientists at Pirbright,

the Pan American Foot-and-Mouth Disease Center, and the United States Plum Island Animal Disease Center with the enthusiastic encouragement of Dr. Albert Sabin. Having had the opportunity of discussing this new development with a number of those concerned, I am pleased to find that the possible limitations on the use of a live virus vaccine in South America are fully recognized. In my opinion, this project merits support in view of the potential value of worldwide success against foot-and-mouth disease.

Other Control Problems

In this brief communication I do not propose to discuss the other control program difficulties. The solutions are well known in each case, improvements have been made, and the constraints of political and economic instability are recognized.

Preventing Foot-and-Mouth Disease in Disease-Free Countries

The risks of exposure to foot-and-mouth disease that a country runs are of two kinds: controllable and uncontrollable.

Controllable risks are those associated with trade and movement of susceptible livestock species, products of animal origin that may harbor the virus, and other products subject to contamination.

Uncontrollable risks are those associated with dissemination of the virus, frequently by passive carriage, as a result of movements of susceptible wild animals, airborne droplets, migratory birds, and pedestrian and vehicular traffic. Another risk which may be extremely difficult to control in remote areas is the clandestine movement of animals and products of animal origin.

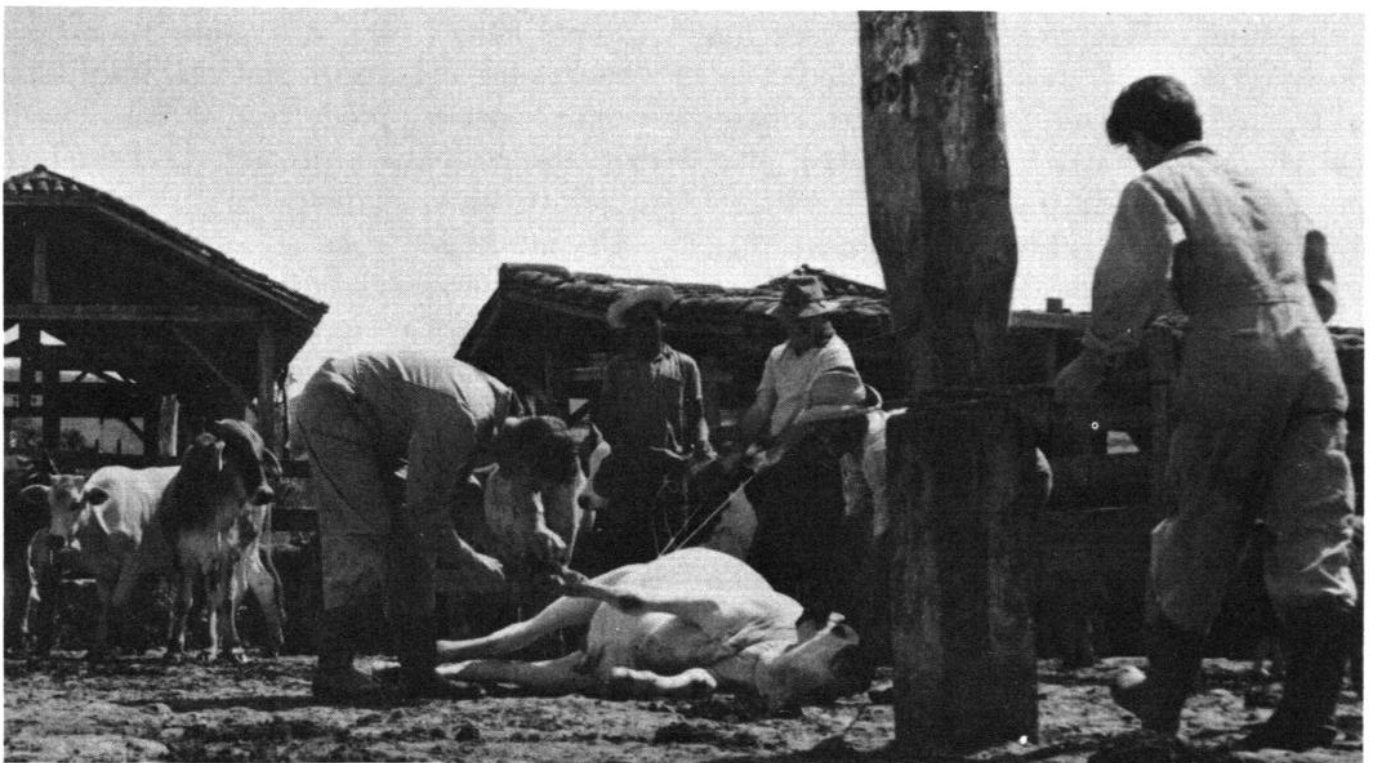
The excellent record maintained by the Hemisphere countries north of the Colombia-Panama border in preserving their freedom from foot-and-mouth disease is a satisfactory indication of the effectiveness of their

import restrictions. In addition, it provides evidence by which to assess the likelihood that uncontrollable risks will reintroduce the infection. As I have noted earlier, it must be assumed that this degree of likelihood will be increased by completion of the Pan American Highway. It is for this reason that the Pan American Foot-and-Mouth Disease Center initiated discussions with the authorities of Colombia and Panama some 13 or 14 years ago which resulted in special measures being taken to push the endemic areas of the disease in Colombia a safer distance away from the frontier. I repeat, however, that the only long-term solution is continuously and progressively to reduce the prevalence of the disease throughout the endemic regions of South America.

Response to an Outbreak in a Disease-Free Country

This subject is one that has preoccupied the Pan American Foot-and-Mouth Disease Center for many years. If foot-and-mouth disease is introduced into a country or territory hitherto free of the disease, there can be

no argument against immediate application of the slaughter policy at the earliest possible moment. The Center consolidated this policy in 1958 by preparing and providing all the disease-free countries with its "Plan of Action in the Event of an Outbreak of Foot-and-Mouth Disease." This "plan" was revised and expanded in 1966, so as to provide more detailed instructions, thereby keeping all concerned informed of the steps that should be taken in such an emergency. This preparedness, however, depends for its success upon rapid detection of any outbreak of vesicular disease in cattle, pigs, sheep, or goats; immediate dispatch of vesicular epithelium samples to the Pan American Foot-and-Mouth Disease Center (or to another laboratory, as exceptionally arranged); and implementation of a previously authorized national slaughtering procedure in case foot-and-mouth disease is diagnosed. The chances that an outbreak will be reported with sufficient speed are poor enough under some circumstances to suggest that alternative plans, such as containment by vaccination, may have to be used in the first instance. Also, experience has shown that in a certain



Examining cattle in Rio de Janeiro (photo: courtesy of the author).

proportion of cases there will be a deliberate attempt on the part of the livestock owner to conceal an outbreak. Because of these difficulties, which may prevent effective action from being taken with sufficient speed, the need to reduce the risk by attacking the disease in endemic areas must again be emphasized.

National and International Responsibilities

Since infectious diseases don't respect political boundaries, it has long been accepted that the best policy to follow for control of foot-and-mouth disease in South America is that of attacking the disease within epidemiologic areas. This demands coordinated national action by all the countries in each epidemiologic area.

Also, where overriding demands of trade require movement of animals or products of animal origin—one is thinking especially of cattle or carcasses—the exporting country has an obligation to the importing country, which is to ensure that the required standards of animal health are rigorously observed. Another national obligation of the affected countries is to monitor continuously the virus type and subtypes involved in field outbreaks and to pass this information rapidly to all concerned.

One of the most important responsibilities of the countries in disease-free regions is that of always maintaining a high and uniform level of import restrictions. It may be of interest to know that the Commission of the European Communities recently requested

the British Agricultural Research Council to undertake a study of the scientific bases for control procedures to prevent entry of certain viruses into the European Economic Community. Community legislation is being formulated for regulation of animal and animal product imports from third countries. It was thought appropriate to choose an organization in the United Kingdom to make this study, because of that nation's many years of experience in maintaining freedom or relative freedom from a number of infections which cause problems in other countries. This particular study (2) includes African swine fever, bluetongue, Teschen disease, foot-and-mouth disease, lumpyskin disease, Newcastle disease, rabies, rinderpest, sheep pox, swine fever, swine vesicular disease, and vesicular stomatitis. This type of international approach is of course already known in the Americas, and is well exemplified by the work of the Regional International Organization for Plant and Animal Health of Central America and Panama.

Another eventuality that must be mentioned is the possible occurrence of foot-and-mouth disease in a currently disease-free country. The international responsibility then becomes that of providing mutual assistance—such as knowledge and experience, trained manpower, financing, supplies, and equipment. Fortunately we have an organization—the Pan American Health Organization—which stands ready to stimulate and coordinate the provision of such assistance, aided by the strong support which it enjoys from its Member Countries.

SUMMARY

Current events are having a significant impact on the foot-and-mouth disease situation in the Americas. Completion of the Pan American Highway across Eastern Panama and Northern Colombia will remove a major barrier to land traffic between endemic parts of South America and the disease-free regions of Middle and North America. On the other hand, success in controlling the disease in Europe has shown the control

and eradication doctrine long recommended for the Americas to be effective. These two developments give a special relevance to review of this doctrine as it applies to the Western Hemisphere today.

As demonstrated by the recent European experience, endemic foot-and-mouth disease can be controlled by creating an immune population through vaccination and adopting sanitary

measures which reduce that population's exposure to infection. Though there are many reasons why this approach has failed to achieve clear-cut success in South America, the most important seems to be the unacceptably low potency of vaccines. This means that in the future an essential feature of every national program should be effective quality control of vaccine production—a control maintained despite pressing demands for more vaccine and the exigencies of commercial competition.

Another possible way to overcome limitations of available inactivated virus vaccines would be to develop a satisfactory live virus vaccine. Exploring this possibility, researchers at the Pan American Foot-and-Mouth Disease Center in Brazil recently found that modified live virus administered in the upper respiratory tract stimulates local defense mechanisms at the principal portal of entry. Collaborative studies are now being considered to determine the practical significance of this observation.

Regarding disease-free countries and territories, there is no perfect way of assuring that their freedom from the disease will be maintained. Therefore, should the disease be intro-

duced, it is absolutely essential that the slaughter policy be applied at the earliest possible moment. Moreover, the chances that an outbreak will be diagnosed with sufficient speed seem poor enough at times to suggest that alternative plans, such as containment by vaccination, may have to be used in the first instance. In general, the lack of a sure overall solution clearly demonstrates the need to reduce the risk by attacking the disease in endemic areas.

Efforts of this kind, however, require a good deal of international collaboration. Since the disease does not respect political boundaries, countries in a given endemic area need to coordinate their work against it. In addition, endemic countries having a need to export susceptible animals or their products must continue to see that the required animal health standards are rigorously maintained. It is also essential that countries in disease-free regions maintain a high and uniform level of import restrictions. Finally, should an outbreak occur in a disease-free country, the Governments of the Americas and PAHO must be ready to provide and coordinate whatever assistance is required to bring the situation under control.

REFERENCES

(1) Pan American Health Organization. *Criteria for the Analysis and Evaluation of Loan Requests for Programs for the Control of Foot-and-Mouth Disease*. Washington, D.C., 1966.

(2) European Economic Community. *Methods for the Detection of the Viruses of Certain Diseases in Animals and Animal Products*. (Information on Agriculture, No. 16). Brussels, 1976.