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Mass Preventive Medicine:

A Program for Smallpox Eradication and Measles Control Throughout West Africa

Henry M. Gelfand, M.D.*
and
Donald A. Henderson, M.D.*

Dr. Gelfand received his medical training at the University of Chicago and at Tulane. His experience in international health and epidemiology ranges widely from medical entomologist in India and Burma to a study of Spring-E Typhus vaccine in Peru. He has worked in West and Central Africa as well as in India. He currently is Chief of West African Operations of the Small Pox Eradication Program at the Communicable Disease Center, Atlanta, Georgia.

Dr. Henderson received his medical training at the University of Chicago and at Johns Hopkins. His travels include a smallpox vaccination study in the Tonga Islands, Oceania. Currently director of the Measles Control Program at the Communicable Disease Center, he very shortly will assume the post of Director of the Smallpox Program for WHO in Geneva.

"This Government is ready to work with other interested countries to see to it that smallpox is a thing of the past by 1975."

This pledge, made by President Lyndon Johnson on May 18, 1965, to the Eighteenth World Health Assembly, committed the United States to a role of dynamic leadership in the global smallpox eradication program of the World Health Organization. It was a major factor leading to an American decision to offer direct assistance to eradicate the disease in West Africa, one of its principal endemic centers.

A second factor leading to the development of this program has a somewhat longer history. In July 1961, Dr. Paul Lambin, Minister of Health of Upper Volta, visited the United States and learned of the development of a new attenuated live-virus vaccine against measles. Measles is notorious throughout West Africa as the principal acute killer

*Smallpox Eradication Program, Communicable Disease Center, Public Health Service, U.S. Department of Health, Education, and Welfare, Atlanta, Georgia 30333, U.S.A.

disease of young children. He invited the National Institutes of Health of the U.S. Public Health Service to conduct field trials in his country, and, later in 1961 one was organized by an NIH team. In 1962 a mass program was conducted in Upper Volta by the same team, and in 1963 small demonstration projects were put on in Dahomey, Guinea, Ivory Coast, Mali, Mauritania, Niger, and Senegal. In 1964 and 1965 the United States Agency for International Development concluded bilateral agreements with all of these countries (except Senegal), plus Cameroon, The Central African Republic, Chad, and Togo, for mass vaccination against measles of children 6 months to 6 years of age. The Communicable Disease Center of the U.S. Public Health Service provided short term technical consultants to assist many of these programs.

The measles vaccination campaigns were enthusiastically received by both the Governments and the peoples of these West African countries. Their effectiveness and popularity in the areas where they were conducted led to insistent requests for their continuation and expansion.

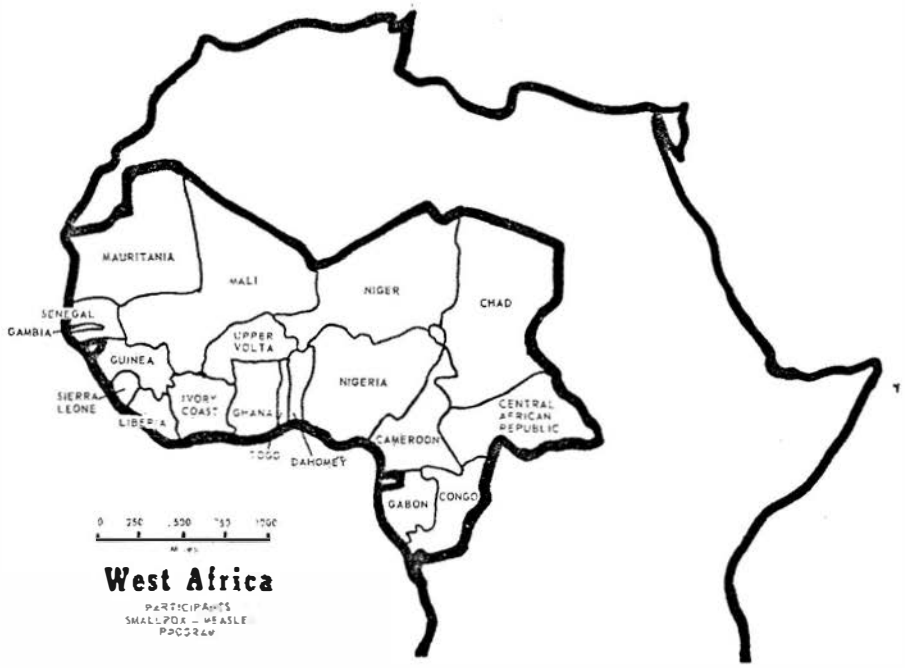
Mass measles vaccination in the vast, under-populated and understaffed countries of West Africa was possible only because the new jet injection apparatus provided a means for rapid inoculation of large numbers of children without need for a cumbersome kit of syringes and needles and with limited professional personnel. The rapid, mass campaigns did require, however, detailed preplanning, careful organization and extensive logistical support.

Independently, CDC had pioneered in the adaptation of the jet injectors to smallpox vaccination, and had conducted practical field trials in the South Pacific Kingdom of Tonga and in Brazil. This provided the final link in a chain of coincidental developments. Starting with the desire of the United States Government to promote the goal of worldwide smallpox eradication, what could be more logical than to build upon the health benefits, public health organization and good will which had been essential elements of the measles program, add to it the experience and interest of the Communicable Disease Center in smallpox vaccination, and to create a regional program for smallpox eradication and measles control throughout West Africa? Thus was conceived the project to be described, encompassing a 19-country area, greater in size than the United States and extending from the Sahara Desert to the Congo River and from the shores of the Atlantic Ocean and the Gulf of Guinea to the borders of Sudan. It was born on July 1, 1966.

Description of the Project

The project embraces an area in which live an estimated 110,000,000 people, citizens of the following independent West

African nations (Figure 1): Mauritania, Senegal, The Gambia, Guinea, Sierra Leone, Liberia, Ivory Coast, Upper Volta, Ghana, Togo, Dahomey, Nigeria, Mali, Niger, Chad, Central African Republic, Cameroon, Gabon, and the Congo (Brazzaville). With the exception of Liberia, long independent and with a history of association with the United States, these countries are all former British or French colonies or protectorates. As such, they have developed two distinctive patterns of administrative organization and are often divided for convenience into two groups known as the francophone and anglophone countries.



The medical services of the 9 francophone countries of former French West Africa have formed an association known as "l'Organisation de Coordination et Cooperation pour la Lutte contre les Grandes Endemies" (OCCGE), and those of the 5 countries of former French Equatorial Africa, a similar group known as "l'Organisation de Coordination et Cooperation pour la Lutte contre les Grandes Endemies de l'Afrique Centrale" (OCEAC). The health services of these 14 nations are organized along generally similar lines. The rural areas are served by mobile teams of paramedical personnel, coordinated in each country by a "Service des Grandes

Endemies" (SGE) and responsible for a limited range of medical activities usually including the prevention and/or treatment of trypanosomiasis, onchocerciasis, leprosy, tuberculosis, cerebrospinal meningitis, and smallpox. Measures for the control of other diseases or sanitary activities are sometimes added. Typically, a mobile team visits any given area every third year; some more favored localities may be reached annually, and some may yet have no organized services at all. Fixed medical installations, dispensaries or small health centers, are few and far between, and serve only limited populations.

The 5 anglophone countries (including Liberia) do not have comprehensive nation-wide networks of multi-purpose mobile field health services. They do, however, have experience with mobile teams for specific purposes in restricted areas -- particularly for yaws, trypanosomiasis, and meningitis. Rural medicine generally is based upon extensive networks of small health installations usually manned only by a dispenser and/or a midwife. Preventive medicine receives some emphasis, and vaccination against smallpox has long been included among their activities.

These 19 countries comprise a geographic bloc, but they differ markedly in wealth (present or potential), physical geography and climate, political structure and democratic tradition, population density, religion, education, cultural patterns, etc. Many hundreds of self-contained, and sometimes mutually hostile, tribes are represented, and as many languages. Many tribes overlap the international boundaries, and their peoples move back and forth across these borders as if they did not exist. Nomadism is the normal way of life for extensive groups of cattle-raising peoples, such as the Fulani who move seasonally between northern Nigeria and Niger. At one extreme of population dispersion, the Moors of Mauritania and Mali and the Touaregs of Niger wander the vast reaches of the Sahara in family-size groups, gathering at oases only during the season of the date harvest. At the other extreme of population density is Ibadan, Nigeria, where perhaps a million persons live packed so closely together that many houses are not separated from one another. The terrain is equally variable, from sandy desert, through the almost limitless grasslands of the Sahel and Savannah, to dense tropical forests and the watery wastes of the coastal mangrove swamps.

In order to bring about reasonable uniformity in program goals and procedures and to help to coordinate plans and activities among this disparate assemblage of nations, a Regional Project Office has been established at a central site, Lagos, Nigeria. Here, in addition

to medical epidemiologists and administrative personnel, there will be a health educator, a statistician, an equipment specialist and a virologist, to provide specialized service and consultation to the national projects.

Backstopping the entire West African program is a headquarters group at the Communicable Disease Center in Atlanta. Its responsibilities will include procurement, major personal actions including recruitment, and coordination of the program with national and international agencies.

It must be emphasized that the smallpox element of the West African program will be closely coordinated with the global eradication plans of the World Health Organization. Staff of the WHO concerned with smallpox eradication have participated in all phases of the planning, and the West African Inter-country Advisor will maintain close liaison with the Regional Project Office in Lagos.

The project will have a lifetime of 5 years, extending from July, 1966, through June, 1971. Within 3 to 4 years, it is anticipated that indigenous transmission of smallpox will have ceased; cases reported thereafter should, on investigation, be demonstrated to have been importations or misdiagnoses. It is not anticipated that measles will have been eradicated, but the incidence of the disease will have been vastly reduced, and no major outbreaks should be possible. Secondary benefits to the West African countries will be substantial; there should be well developed systems for mass programs of communicable disease prophylaxis or control, for morbidity reporting and acute communicable disease surveillance, for immunization of infants, for disease and program evaluation using the technique of sample surveys, and for the rapid laboratory diagnosis of smallpox.

Nature of U. S. Assistance

The Smallpox Eradication/Measles Control Program in each country is a national responsibility and will be nationally directed in each instance. United States personnel will not direct these projects, but will act as advisors and consultants to their counterparts in the national health services. Their specialized training and their knowledge of American equipment and CDC's techniques in disease surveillance and control will be essential elements in the success of these eradication plans. Equally irreplaceable, however, is the local knowledge and know-how of the national health authorities. Every effort will be made to see that the two contributions are welded into one smoothly functioning whole.

Two types of American technical personnel are to be provided by our government — medical epidemiologists and non-medical public health officers, who have been designated Operations Officers. The Epidemiologist is the senior advisor, and will participate in all phases of program planning and implementation, with specific emphasis on program assessment, disease surveillance, and international coordination and cooperation. The Operat ons Officer serves as the assistant to the Epidemiologist in all of his activities, and also has specific responsibility for administration, equipment maintenance, and training of local vaccination personnel.

One Operations Officer is assigned to each country (except in Nigeria, as described below). An Epidemiologist is assigned either to a single country or to a group where physical and political circumstances permit. Such sharing occurs in Senegal-Mauritania-Gambia, Ivory Coast - Upper Volta, Cameroon - Gabon, and Chad- Central African Republic.

Nigeria is by far the most populous of the countries in West Africa, with fully half of the entire regional population. It is, furthermore, an intensely endemic area for smallpox, and the success or failure of its program may determine the success or failure of the whole. Therefore, American technical support is greatest for this focal country. An Epidemiologist and an Operations Officer are assigned to the central government in Lagos and a similar pair to the Western and Eastern Provinces. An Operations Officer only is assigned to the Midwestern Province (responsible to the centrally assigned Epidemiologist), but a medical officer and two Operations Officers will assist in the Northern Provinces program.

The Lagos Regional Office and Atlanta headquarters have already been mentioned; these are staffed exclusively by Americans.

The material input of the United States Government includes the lyophilized vaccines, jet inoculation equipment, transport vehicles (cars, trucks and motorbikes for land use and launches and outboards for the "creeks" of the Niger delta), refrigerators and freezers, field equipment and miscellaneous supplies.

The contributions of the host governments will also be substantial; all local costs will be borne by them. They will provide the administrative facilities and overhead, pay the salaries and travel allowances of nationals engaged in the program, and be responsible for the operation and maintenance of all vehicles and equipment.

Plan of Operations

Detailed planning could not be realistic before the commencement of actual operations and the accumulation of experience in the field, and only general plans have been made to date (July 1966). Overall policies have been established, to be adapted to existing circumstances country by country.

In the OCEAC countries, and in Dahomey, Ivory Coast and Upper Volta of the OCCGE group, smallpox and measles vaccination activities will be completely integrated into the operations of the existing SGE mobile teams, their schedules and scope of operations more or less modified to accommodate the added immunization activity. In Niger, Mauritania and Senegal, the vaccination teams will be new creations, but will function within the framework of the SGE and will be attached to existing mobile teams. In the anglophone countries and in Togo and Mali, completely independent organizations will be established, under separate direction and distinct from existing health structures. The patterns in Guinea and Congo (Brazzaville) have yet to be determined.

The goal of the smallpox component of the program being eradication, an attempt will be made to vaccinate the entire population, regardless of age or previous vaccinal status, in as short a time as possible. This will usually take 2 to 3 years. Because of the extensive mobility of many African populations, because 100 per cent coverage cannot realistically be expected, and in order to establish the most solid immunity possible, a second mass cycle of vaccination will probably be carried out within the 5-year lifetime of the program.

Smallpox vaccination will be on a mass basis; mobile teams will visit designated posts on a schedule, and will immunize groups of people gathered from throughout the village or groups of villages. Vaccinators will not work door-to-door except under very special and unusual circumstances. No time will be wasted on detailed record keeping, by individual or by family. Instead, the teams will move quickly, and will be satisfied with a coverage of 80 to 90 per cent based on the best local estimate of the total population in the localities visited. More precise estimates of percentages vaccinated, together with estimates of percentage of successful vaccination "take", will be a function of program assessment (see below), and this will determine whether individual localities have been adequately

covered or whether they must be revisited and techniques of public mobilization improved. Daily records of team accomplishments will, of course, be kept – by age, sex and locality.

The route and schedule of each team will be carefully planned in advance. Locally produced, large scale maps will be used to plot team itineraries and insure that no village is omitted. General publicity will be intensive, and each community will be notified of the date and time of team arrival so that its people may be brought together with the least possible effort.

Measles vaccination will be provided for children 6 months to 6 years old in most instances, since this delimits the age group in which the vast majority of cases occurs. In some programs, the upper limit will be even more restricted if local experience indicates that few cases occur above 4 or 5 years of age.

With few exceptions, smallpox and measles vaccination activities will be combined; the two vaccines administered simultaneously to those children scheduled to receive both, but by separate inoculation in both arms. All measles vaccine and a large proportion of the smallpox vaccine will be given by jet inoculation. Previous experience in West Africa has indicated that a trained and disciplined team should be able to vaccinate one-half million persons against smallpox and 100,000 children against measles during a year of jet injector operations. For small and remote communities, the multiple pressure or scarification technique for smallpox vaccination may be just as efficient as jet inoculation, but the advantage of the latter for needle-less measles immunization may justify its use even under these circumstances.

The greatest difficulty is anticipated with the establishment of continuing, routine immunization of infants. Every effort will be made to utilize fixed medical installations for this purpose, but the paucity of such facilities may restrict their use to a comparatively small segment of the population. It may be necessary to organize small, highly mobile teams to cover an entire country on an annual cycle. Only actual experience in the future will show how this essential activity can best be established, and the method will undoubtedly differ markedly from country to country.

In order to assure adequate and uniform coverage by the vaccination teams, and to control the potency of the vaccines and the

effectiveness of the inoculation technique, program assessments will be built in as integral components. At the team level, concurrent assessment one week after the visit of the vaccinators to any given locality will be a regular, daily activity. At the national (or provincial) level, the central program directorate and the American advisors will make unannounced spot checks. At the international level, personnel of the Lagos Regional Office will make spot checks on the occasions of their visits. Finally, terminal assessment and evaluation may be made by independent teams, perhaps from WHO, in order to certify the satisfactory completion of sectors, or ultimately, of entire national programs.

Disease surveillance, as that term is understood in the U. S., does not exist in West Africa. Passive morbidity and mortality reporting is grossly incomplete and inaccurate, and little follow-up results from case notification. There is no organized system for aggressive case *seeking*, such as is necessary if the complete interruption of smallpox virus transmission is to be achieved. The American epidemiologists will be intimately concerned with the mobilization of every available reporting source – medical installations and personnel, other government agencies at the local level, school teachers, religious leaders, village chiefs, shopkeepers, and market women – so that no case of smallpox will go unreported and uninvestigated.

Significance of the Project

The word "eradication" has much current appeal, and is widely used and abused. It is unlikely, in the present state of our knowledge and social organization, that many diseases of world-wide importance can be eradicated. Among those where the ecology of the disease and the available medical tools do permit this goal, smallpox is preeminent. Many factors combine to make it a serious possibility: man is the only known host of the smallpox virus and there is no other reservoir; subclinical infections are rare or non-existent and every host can therefore be identified; the infection is acute and the period of communicability brief; post-infection immunity is solid and the disease tends to "burn itself out" in small communities; the incubation period is almost two weeks long and provides time for case detection and action to prevent spread; and, finally, an effective vaccine is available for mass administration.

Smallpox has already been "eradicated" from large areas where is was previously endemic, thus proving, by experience, that it can

be done. Moreover, the elimination of the disease from the United States and western Europe resulted from widespread, but unorganized vaccination, made possible by the large number of medical practitioners, a receptive public, and some stimulation from the law. By substituting *organized* and well-supported campaigns for the extensive cadre of private physicians that is lacking, eradication can also be achieved in the poorer, underdeveloped parts of the world.

It might be of interest to indicate what the authors think are the more important new elements to be provided by the program outlined above, which represent additions to the present control efforts of the West African authorities. First and foremost is the regional concept. The very effective work done in this geographic area by some countries, such as Ivory Coast, Senegal, Chad, and Ghana, will always be inadequate and under constant threat because they are surrounded by virus reservoirs in mobile populations. Simultaneous, coordinated campaigns throughout the entire area will result in mutual protection. Secondly, the use of lyophilized vaccine and the jet inoculation apparatus will assure a much higher percentage of vaccine efficacy than has been possible heretofore. Thirdly, the new or reinforced emphasis on systematic program assessment and disease surveillance will assure better organization and continuous monitoring of the national programs. And, finally, there will be money – to provide enough vaccine, inoculators, and vehicles to complete the job.

The importance of smallpox eradication (and measles control) to the countries of West Africa is simple and straightforward, and the desire of the American people to help is itself sufficient justification for this program. The immediate advantages of global eradication to the non-endemic countries, such as the United States, are perhaps less obvious. It is estimated that approximately 20 million dollars are expended each year in the United States to prevent the introduction of and to protect its people against a disease which has not occurred there since 1949. Furthermore, the approximately 14,000,000 vaccinations administered each year are associated with a small but significant risk. A recent review of the subject at CDC demonstrated that 12 cases of post-vaccinal encephalitis, 9 cases of vaccinia necrosum, and over 100 cases of eczema vaccinatum were produced in 1963. Seven persons died. Many less serious complications also occurred, some of which resulted in hospitalization. These costs, in dollars and pain, must probably continue indefinitely until smallpox is eradicated from throughout the world.