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SMALLPOX ERADICATION

1. Introduction

In successive resolutions, the Governing Bodies of the Pan American Health Organization have impressed on the countries of the Continent the need to finally eliminate smallpox from the Americas, a policy that was endorsed by the Presidents of the Americas at the Punta del Este meeting.

Similarly, the World Health Organization, from its Third Assembly onward, has continued to draw attention to the problem of smallpox in the world and at its Twentieth Assembly urged countries to intensify their efforts to eradicate the disease in the shortest possible time.

In the light of such recommendations, the countries of the Region have redoubled their efforts to achieve this objective, conducting active vaccination campaigns with a view to raising the immunity level of the population while organizing epidemiological surveillance services and seeking to develop maintenance programs.

The World Health Organization and the Pan American Health Organization have spared no effort to assist countries in their endeavor to eradicate the disease which, at the present time, is endemic in one country only.

2. The Problem of Smallpox in the Americas

During the five-year period 1965-1969, 22,389 cases of smallpox were reported in the Americas (See Table 1). In 1969, 7,381 cases of smallpox were reported, all in Brazil with the exception of three in Uruguay, of which one was indigenous and two imported from Brazil. During the past three years all the other countries of the Continent were free of smallpox. The last case in Argentina occurred in 1967, and there have been no cases in Colombia, Paraguay, and Peru since 1966.

TABLE 1
REPORTED CASES OF SMALLPOX IN THE AMERICAS
1965 - 1969

Country	Years					Total
	1965	1966	1967	1968	1969	
Argentina	15 ^a	21	23 ^a	-	-	59
Bolivia	-	-	-	-	-	-
Brazil	3,269	3,518	4,353	3,580	7,378	22,098
Chile	-	-	-	-	-	-
Colombia	149 ^c	8 ^b	-	-	-	157
Ecuador	-	-	-	-	-	-
French Guiana	-	-	-	1 ^d	-	1
Paraguay	32	5	-	-	-	37
Peru	18	13	-	-	-	31
Uruguay	1 ^d	-	-	2 ^a	3 ^a	6
Total	3,484	3,565	4,376	3,583	7,381	22,389

- a) Includes imported cases
- b) Confirmed cases only
- c) Includes 68 confirmed cases
- d) Imported case

The number of cases recorded in Brazil in 1969 (7,378), more than double the number for 1968, was the result of the better surveillance services that have been organized in the country, of speedier reporting, and of the more up-to-date information published regularly in the Campaign Epidemiological Bulletin. Graph 1 shows smallpox cases reported in Brazil by four-weekly periods in 1967, 1968, and 1969.

3. Difficulties Noted

a) Allotment of Funds

This continues to be the principal reason why some countries have been unable to carry out their eradication campaigns. The absence of budgetary funds has forced them to postpone or reduce approved operational plans.

b) Inadequate Maintenance Programs

The absence of permanent health services to provide for the maintenance of protection of the population at a high level is another point that should be emphasized. The low level of coverage for children under five years constitutes a potential danger if the disease should be reintroduced as a result of endemic foci.

c) Inadequate Epidemiological Surveillance

Inadequate attention is attached to epidemiological surveillance, and too little is done to ensure that contacts of all suspected cases are vaccinated. Inadequate supervision of a population group that is to be vaccinated and of the number of "takers" can lead to inaccurate data, as occurred in the case of a country in which the coverage has been described by the vaccination teams as being 100 per cent when it was in fact no more than 50 per cent.

d) Lack of Administrative Continuity

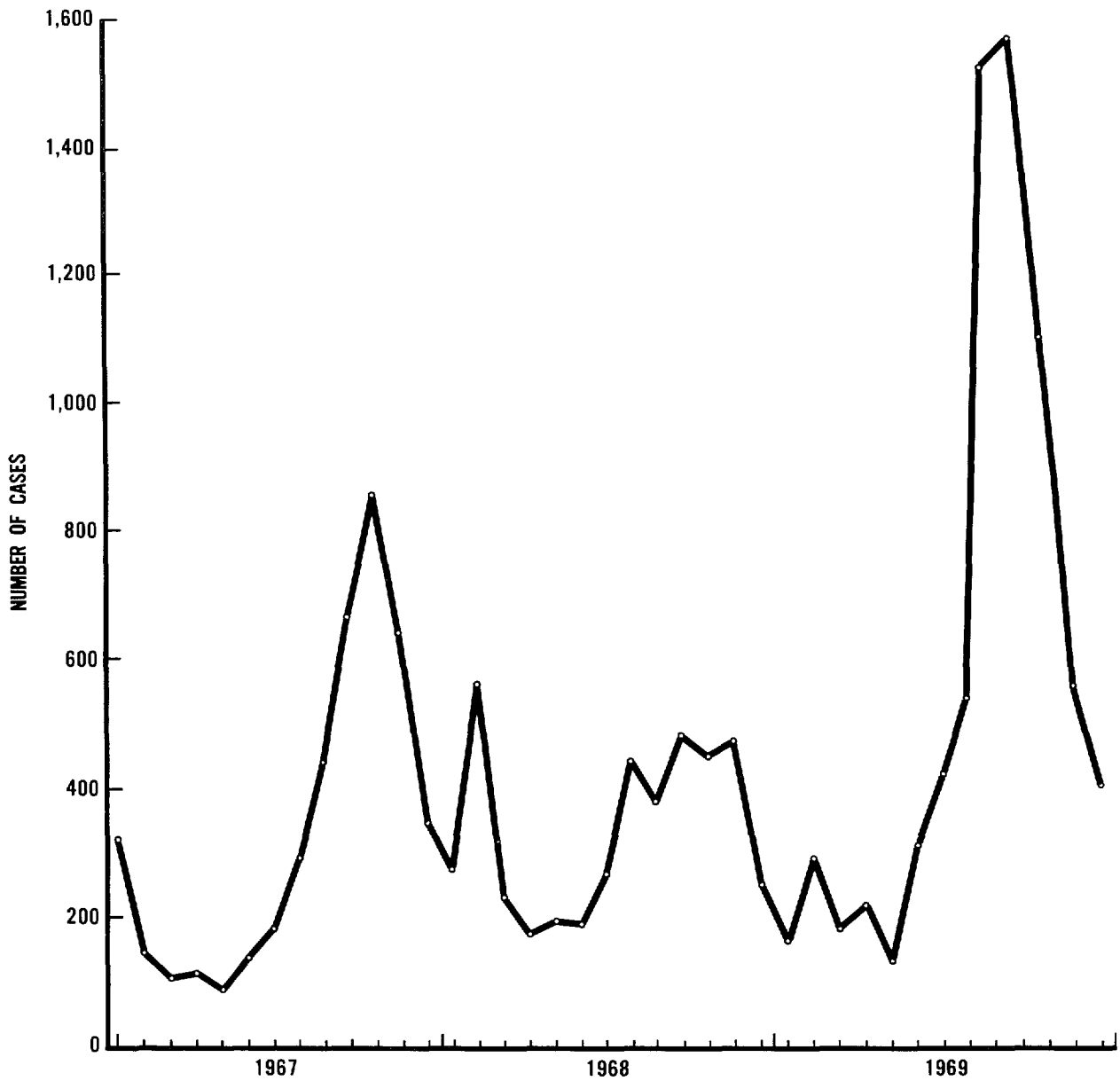
In a majority of the countries, the lack of administrative continuity leads to delays and hold-ups in programs, whose efficiency is reduced, jeopardizing their success. The repeated replacement of officials in charge of eradication campaigns and constant changes in operational and logistic plans have an unfavorable effect on the conduct of programs and make it necessary to extend them for a number of years, thereby greatly increasing their cost.

e) Availability of Freeze-dried Vaccine

The use of vaccine of low potency and little stability in some countries has reduced the efficiency of efforts to maintain a high immunity level in the population, with the result that a new coverage of the entire area has been necessary. For this reason, the Organization has urged all

Graph 1

**REPORTED CASES OF SMALLPOX BY 4-WEEKLY PERIODS
BRAZIL - 1967, 1968 AND 1969**



countries to replace glycerinated by freeze-dried vaccine, in conformity with the minimum requirements of the World Health Organization. Only freeze-dried vaccine is accepted by PAHO/WHO both for the attack phase and for maintenance programs. Special care is given to the distribution of vaccines to countries free of foot-and-mouth disease.

The Organization has assisted all countries interested in the production of smallpox vaccines and has entered into agreements with them for the supply of freeze-drying equipment. Up to the present such equipment has been made available to Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Mexico, Peru, Uruguay, and Venezuela.

Notwithstanding the technical advisory services provided by the Connaught Laboratories of Toronto, Canada, technical, financial, and other difficulties continue to prevent some of the countries producing freeze-dried vaccines from meeting the minimum requirements set by WHO for approval of the vaccine. Two of the countries producing freeze-dried vaccine have not yet met WHO standards. A freeze-dried vaccine bank established at Rio de Janeiro, Brazil covers the requirements of other countries when necessary.

4. Results Obtained

a) Vaccine Production

Each year the production of vaccine increases. All the countries, with the exception of Mexico, Uruguay, and Venezuela, produce only freeze-dried vaccine. These three countries, however, already possess freeze-drying equipment, and it is expected that they will very shortly begin to produce freeze-dried vaccines. Table 2 and Graph 2 show the production of freeze-dried vaccine between 1966 and 1969 by country.

b) Diagnostic Laboratories

As a result of the courses that were formerly conducted at the Adolfo Lutz Institute at São Paulo in Brazil with the assistance of the National Center for Communicable Diseases of the United States of America, 18 laboratories in 13 countries were equipped to diagnose smallpox cases. The last to come into service was the one at Asuncion, Paraguay, in 1969. Figure 1 shows the location of these laboratories and of the NCDC, which acts as reference laboratory.

c) Maintenance and Surveillance

Since 1967 Brazil has been the only country on the American continent in which smallpox continues to be endemic. In 1968 only one case was reported in French Guiana and two in Uruguay, both imported. In 1969 two imported cases were reported in Uruguay, giving rise to one indigenous case. The Organization continues to actively assist countries to organize and maintain

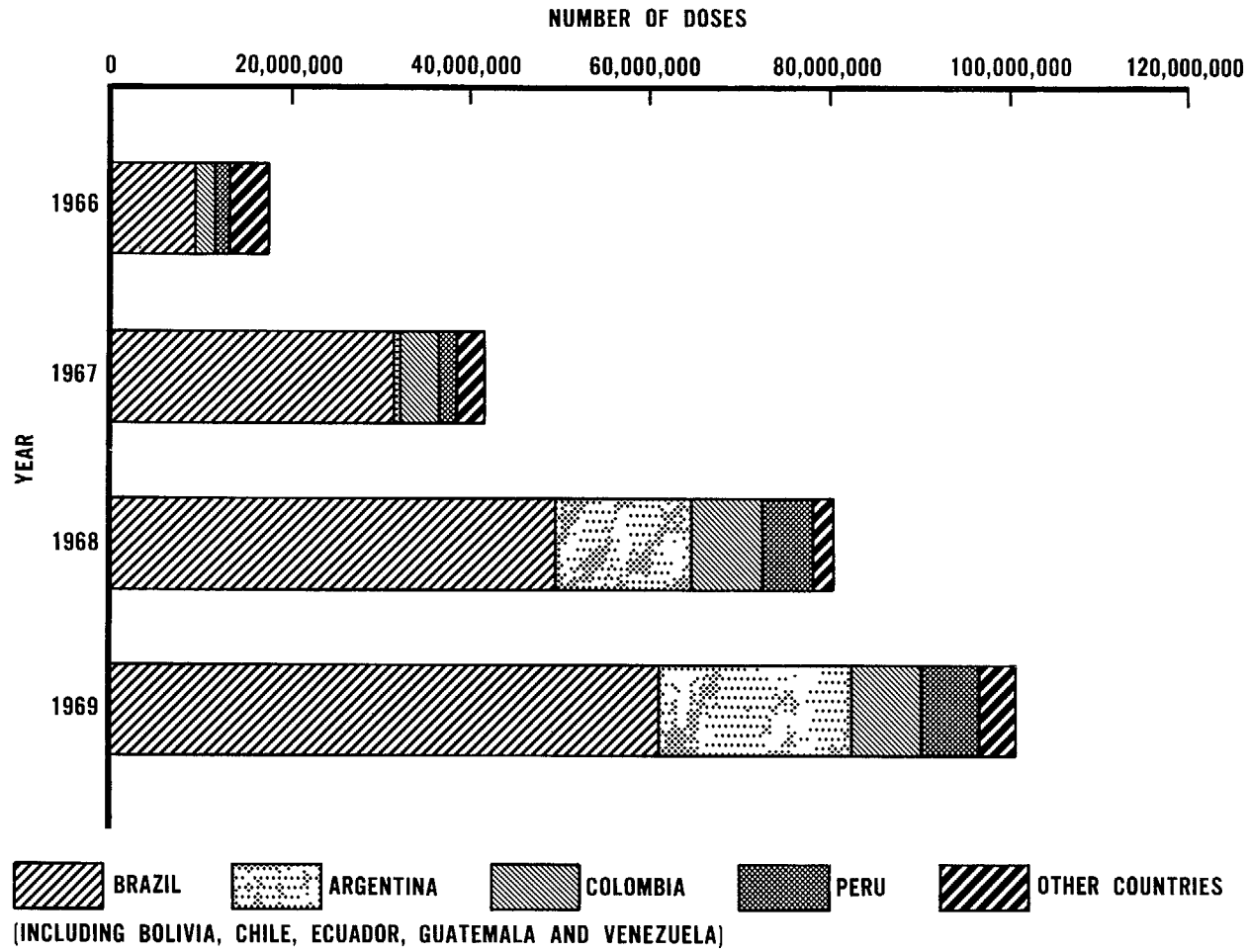
TABLE 2

PRODUCTION OF FREEZE-DRIED SMALLPOX VACCINE IN THE AMERICAS
1966 - 1969

Country	Year				
	1966	1967	1968	1969	Total
Argentina	-	560,000	14,944,800	21,427,850	36,932,650
Bolivia	1,800,000	400,000	-	230,000	2,430,000
Brazil	9,386,200	31,331,900	49,482,650	61,000,000	151,200,750
Chile	36,500	693,000	1,962,000	3,950,000	6,641,500
Colombia	2,535,000	4,504,502	7,992,200	7,586,500	22,618,202
Ecuador	2,019,800	1,559,740	-	-	3,579,540
Guatemala	-	-	263,300	-	263,300
Peru	1,033,100	2,220,000	5,848,750	6,527,200	15,629,050
Venezuela	747,000	624,000	-	-	1,371,000
Total	17,557,600	41,893,142	80,493,700	100,721,550	240,665,992

Graph 2

PRODUCTION OF SMALLPOX VACCINE IN THE AMERICAS 1966-1969



LABORATORIES FOR THE DIAGNOSIS OF SMALLPOX IN THE AMERICAS



effective maintenance programs, with a minimum of 20 per cent of the total population vaccinated and with special emphasis on children under five years of age. Epidemiological surveillance must be rigorously continued, particularly for as long as endemic foci continue to exist in the Continent. Table 3 shows the smallpox vaccinations administered between 1966 and 1969 by countries with agreements on smallpox eradication.

5. PAHO/WHO Participation

The Organization has signed agreements for the conduct of smallpox eradication programs with 11 of the countries of the Continent: Argentina, Bolivia, Brazil, Chile, Colombia, Cuba, Ecuador, Paraguay, Peru, Uruguay, and Venezuela. In those that have completed the first phase of the campaign with minimal initial protection for 80 per cent of the population, emphasis is laid on the need for maintenance and surveillance activities within the limits of each country's budgetary resources.

Between 1967 and 1969 the assistance provided by PAHO/WHO to the countries of the Americas amounted to \$2,248,692, allotted as follows:

a) Advisory services in epidemiology and statistics, with a view to furnishing guidance on and assistance with the conduct of vaccination campaigns and their evaluation and to providing similar aid with the organization of epidemiological maintenance and surveillance programs. Some changes in technical personnel were necessary as the result of the expiration of the contracts of the regional advisor on statistics, of two zone advisors on epidemiology, and of a zone statistician.

b) Advice on methods of production of smallpox vaccine and training of production personnel. Experts from the Connaught Laboratories continued to give assistance to the countries producing freeze-dried vaccines and to those that wanted to replace glycerinated by freeze-dried vaccines. Samples of the vaccine produced were regularly sent to Toronto for potency and stability tests and other technical requirements.

c) Short-term fellowships for directors of eradication campaigns to enable them to study the most efficient campaign methods on the spot. In 1969 directors of programs in Argentina, Ecuador, and Paraguay received fellowships. Other short-term fellowships were awarded to laboratory technicians responsible for vaccine production in Brazil, Ecuador, Mexico, and Peru.

d) Supplies and equipment for various laboratories engaged in vaccine production and smallpox diagnosis, vehicles, launches and jet injectors, refrigerators for vaccines, and other supplies required for field activities in smallpox eradication campaigns.

TABLE 3

SMALLPOX VACCINATIONS ADMINISTERED IN COUNTRIES THAT HAVE
ERADICATION AGREEMENTS WITH PAHO/WHO

1966 - 1969

Country	Year				Total
	1966	1967	1968	1969	
Argentina	1,249,904	2,441,629	323,952	453,468	4,468,953
Bolivia	1,037,883	1,141,991	212,116	295,355	2,687,345
Brazil	5,672,377	6,595,646	12,257,757	21,864,352	46,390,132
Chile	1,473,797	2,030,000	923,047	821,837	5,248,681
Colombia	1,626,576	3,965,141	5,543,507	3,280,096	14,415,320
Cuba	78,718	48,365	39,673	9,435	176,191
Ecuador	749,130	358,465	931,192	742,700	2,781,487
Paraguay	162,852	167,158	168,408	214,870	713,288
Peru	411,025	2,091,182	964,215	1,028,184	4,494,606
Uruguay	213,900	243,300	302,351	442,531	1,202,082
Venezuela	1,081,088	1,449,795	1,388,665	1,243,164	5,162,712
Total	13,757,250	20,532,672	23,054,883	30,395,992	87,740,797

6. Current Status of Programs on the Continent

The falling behind of some campaigns as the result of budgetary difficulties and the consequent modifications in plans of operations make it difficult to determine the targets that should be set for the next few years. The current status of programs in countries in the maintenance phase or in course of intensive vaccination campaigns is as follows:

Argentina - The original operational plan provided for a term of three years commencing in 1968 and ending in 1970, with a vaccination target of 15,600,933 persons in 14 of the 24 provinces of which the country is composed.

The campaign began in 1968 in the northeastern region of the country, especially in Misiones, as a result of a smallpox outbreak that occurred in the neighborhood of San Javier, in the Province of San Javier, an outbreak that was the result of cases imported from Brazil. In addition, vaccination programs were initiated in Corrientes, Formosa, Chaco, and Jujuy, but as a result of budgetary difficulties field activities had been suspended by March, 1969, except in Corrientes, where routine vaccinations continued.

The situation did not substantially change in 1969. The campaign was extended to the provinces forming the Patagonian Region (Chubut, Santa Cruz, and Tierra del Fuego); in the central region activities were confined to San Luis. There were no activities in any of the provinces of the northeastern region. At the end of the year the Government made 85,000,000 pesos available to the 12 provinces. Administrative problems made cooperation between the central and provincial authorities difficult, and, as a result, only 453,468 persons were vaccinated in 1969. If to this number are added the 323,952 vaccinations administered in 1968, actual coverage is seen to represent only 14.23 per cent of the coverage planned.

Nevertheless, the production of freeze-dried vaccine rose from 560,000 doses in 1967 to 14,944,800 in 1968 and 21,427,850 in 1969, enough to meet the needs of the program as well as to provide assistance to other countries and to the vaccine bank established at Rio de Janeiro.

Bolivia - On the completion of the attack phase in 1969, an attempt was made to adapt health units gradually to the maintenance phase, but unfortunately this proved unsuccessful for administrative reasons and because of lack of supervision. Since then maintenance has been carried out vertically in a joint smallpox and tuberculosis program, with a monthly output of 32,707 vaccinations. By the end of the year, 295,355 vaccinations had been administered, only 52 per cent of the target program for 1969.

The attack phase was completed in 1969 with an 81.1 per cent coverage of the national population, and evaluation is now being introduced as a routine program activity.

The regular production of freeze-dried vaccine fell to 230,000 doses in 1969 for budgetary reasons. The vaccine used in the program came from the PAHO Vaccine Bank.

Brazil - The only country in the Continent with smallpox began the second stage of its vaccination program on 30 November 1966 with the State of Alagoas, followed by Paraíba in February 1967 and later in the same year by the western central region and the State of Rio de Janeiro.

Table 4 shows vaccinations carried out at various stages of the campaign. During the five-year period 1962-1966, 6,400,000 persons were vaccinated; in 1967 when the smallpox eradication program was organized, 6,600,000 persons were vaccinated, a number that was almost doubled in 1968 with 12,200,000 vaccinations. In 1969 the annual target set was exceeded for the first time, and 21,864,352 vaccinations were carried out. Graph 3 shows the vaccinations administered by four-weekly periods in 1968-1969. In addition to the vaccinations carried out by the smallpox eradication campaign, 3,949,037 maintenance vaccinations were administered by the regular health services.

In those states where the attack phase has been completed, the incidence of the disease fell by 84.8 per cent and epidemiological surveillance and containment activities have been organized. All reported or suspected cases were investigated, such investigations including laboratory tests, but no indigenous cases were found.

The areas that are at present in the attack phase comprise the States of Bahia, Minas Gerais, Paraná, Rio Grande do Sul, and São Paulo, in which some 50 per cent of the population live. The intensification of reporting procedures and of systematic investigation has produced a significant increase in the number of smallpox cases, in addition to those discovered by the vaccination teams when they enter areas in which there have previously been no reported cases. For example, the ratio of reported to probable cases rose to 1:40 in the State of Paraná, where 16 out of 18 reported cases were confirmed, resulting in a total of 637 reported cases. This is the reason for the increase to 7,378 known smallpox cases in 1969, 71.2 per cent more than those recorded in 1968.

The reporting system has improved considerably since the publication of the weekly bulletin. In December 1969 weekly reports were being received from all Brazilian states except one. This is the result of a publication that, for the first time, provides regular reports on the epidemiological surveillance of a disease in the country. Table 5 shows reported cases, rates of incidence, and the ratio of reported cases to deaths in the 1956-1969 period.

TABLE 4

SMALLPOX ERADICATION CAMPAIGN IN BRAZIL - VACCINATIONS ADMINISTERED IN THE ATTACK PHASE
1962-66, 1967, 1968 AND 1969 (DATA SUBJECT TO AMENDMENT)

Federal Units	Estimated Population (a)	1962-1966 (b)	1967 (c)	1968	1969	Grand Total
<u>Northeast</u>						
Maranhão	(d) 3,615(e)	-	-	1,106,633	1,186,059	2,292,692
Piauí	(d) 1,438	980,044	326,170	-	-	1,306,214
Ceará	(d) 3,914	-	2,528,610	1,180,433	-	3,709,043
Rio Grande do Norte	(d) 1,312	954,812	-	-	-	954,812
Paraíba	(d) 2,287	-	1,525,083	794,501	-	2,319,584
Pernambuco	(d) 4,817	3,837,202	-	-	-	3,837,202
Alagoas	(d) 1,420	-	1,263,293	-	-	1,263,293
Fernando de Noronha	(d) 2	-	-	1,240	-	1,240
Sergipe	(d) 864	665,776	-	-	-	665,776
Bahía	(d) 7,054	-	-	1,355,157	2,193,609	3,543,766
<u>Southeast</u>						
Minas Gerais	11,735	-	-	995,926	5,241,195	6,237,121
Espírito Santo	(d) 1,537	-	-	-	1,455,393	1,455,393
Rio de Janeiro	(d) 4,678	-	69,698	3,483,458	396,595	3,949,751
São Paulo	17,186	-	-	1,693,341	5,943,675	7,637,016
<u>South</u>						
Paraná	7,723	-	-	-	3,338,199	3,338,199
Rio Grande do Sul	6,728	-	-	-	1,132,218	1,132,218
<u>West Central</u>						
Goiás	(d) 2,865	-	507,878	1,613,237	-	2,121,115
Federal District	(d) 410	-	374,914	-	-	374,914
T O T A L		6,437,834	6,595,646	12,223,926	20,886,943	46,144,349

Notes: (a) Estimated population (in thousands) on 1 July 1969; Brazilian Statistical Yearbook (1969); Brazilian Institute of Statistics, Rio de Janeiro. (b) State vaccinations administered in association with the former Smallpox Campaign of the Ministry of Health and regarded as epidemiological surveillance and maintenance areas. (c) The total figure for Alagoas includes 452,093 vaccinations carried out in December 1966. (d) Completed. (e) Population of the State according to the smallpox eradication campaign census was 2,419,396 inhabitants.

Graph 3

**VACCINATIONS ADMINISTERED IN THE ATTACK PHASE
BY 4 WEEKLY PERIOD - 1968-1969**

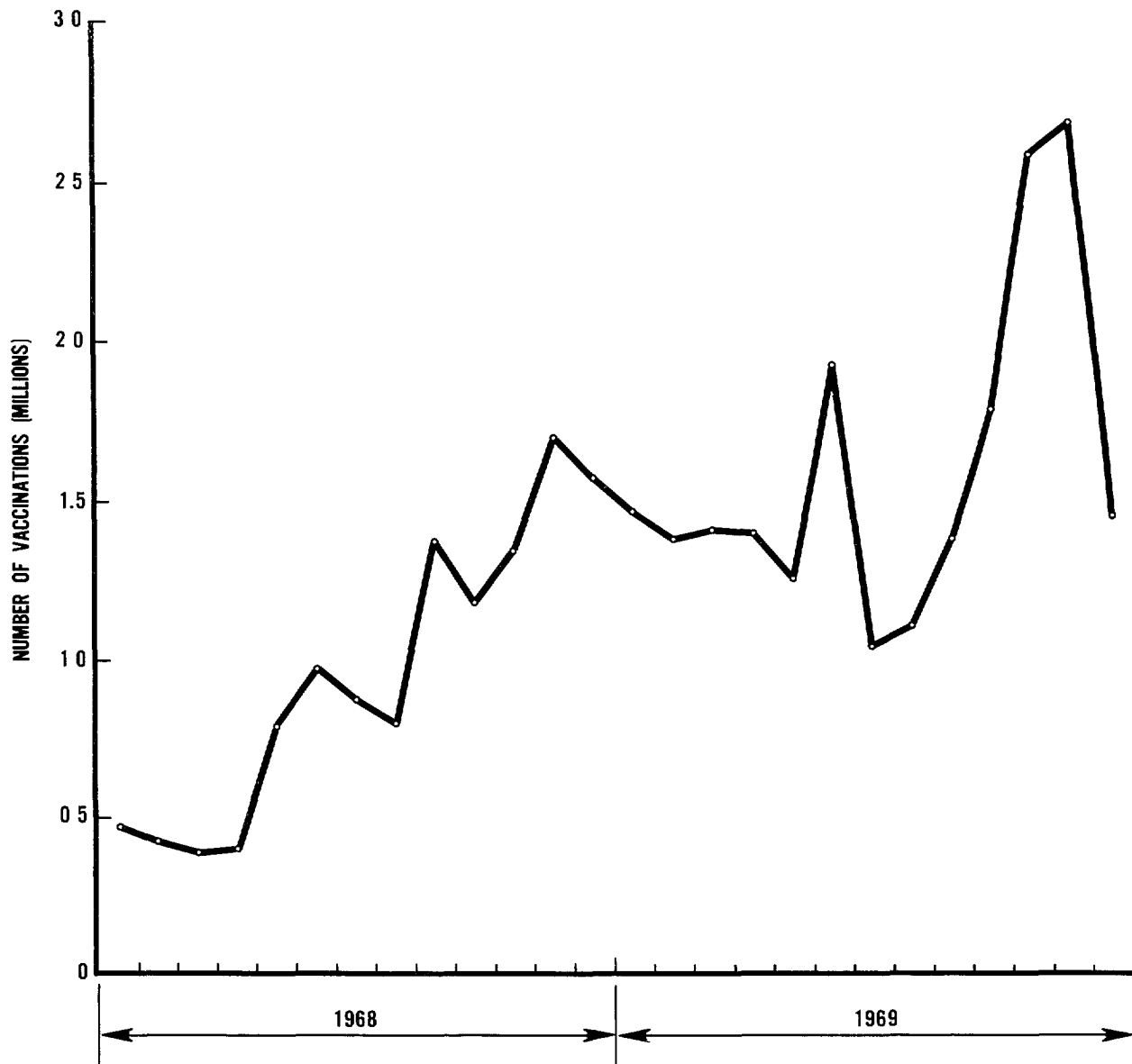


TABLE 5

REPORTED SMALLPOX CASES AND DEATHS
Brazil - 1956-1969

Year	Population (a)	Number of Cases	Rates of Incidence (b)	Number of Deaths	Ratio of Cases to Deaths (%)
1956	26,646	4,718	17.7	55	1.2
1957	27,313	2,661	9.7	36	1.4
1958	30,694	2,190	7.1	72	3.3
1959	29,467	4,840	16.4	93	1.9
1960	45,371	6,561	14.5	173	2.6
1961	67,952	8,526	12.5	143	1.7
1962	73,087	9,763	13.4	165	1.7
1963	76,409	6,467	8.5	163	2.5
1964	76,211	3,168	4.2	69	2.2
1965	78,587	3,417	4.3	45	1.3
1966	77,492	3,623	4.7	29	0.8
1967	86,580	4,514	5.2	70	1.6
1968	89,376	4,372	4.9	38	0.9
1969(c)	90,892	7,377	8.2	37	0.5

Notes: a) Estimated population of reporting areas
b) Per 100,000 inhabitants
c) Provisional

By the end of 1969, 46,115,381 persons had been vaccinated, i.e., 50 per cent of the estimated total population of the country of 92,282,000. The ratio of "takes" consistently remained at over 90 per cent. Coverage fluctuated between 75 and 90 per cent for children under five years of age, between 90 and 95 per cent for school children, and between 70 and 85 per cent for the 15-44 year age group. These data are based on field evaluations made by specially trained groups in accordance with the handbook prepared for this purpose, using sampling methods. Each evaluation group consists of two persons who visit urban and rural areas seven to ten days after the vaccination teams have moved out. When the dwellings that are to be examined for the evaluation have been drawn by lot, the vaccination coverage of all residents, especially first vaccinations of children under five years of age, is checked. Since 1968, when the training of evaluators was first organized, courses have been held in ten Brazilian states. Notwithstanding this, field inspection of evaluators should be made at least once a year, in addition to the regular supervision activities.

Up to 1969, epidemiological surveillance was virtually nonexistent. During the year two courses were organized, one in epidemiology at the Emilio Ribas Hospital at São Paulo and one in epidemiology and epidemiological surveillance at Rio de Janeiro for physicians of the SESP Foundation who would be responsible for epidemiological surveillance in different states throughout the country.

The production of freeze-dried vaccine has presented problems with respect to both quantities and stability which can only be solved with guidance from the Connaught Laboratory and the National Bacteriological Laboratory of Sweden, in the latter case with regards to production of egg vaccine of which Brazil is the only producer in the Americas.

The estimated cost of the program in 1970 is NCr\$17,000,000 or approximately US\$3,700,000, to cover the vaccination of a minimum of 30,000,000 persons and to undertake epidemiological surveillance programs as well as the production of adequate quantities of vaccine. Figure 2 shows the sequence of vaccination programs in the various regions of Brazil.

Chile - Smallpox has not been present in Chile since 1959. The maintenance program continues, and measles and smallpox vaccines are now being combined. Using this technique, 821,837 persons were vaccinated in 1969. New freeze-drying equipment was sent to the National Institute of Hygiene at Santiago in 1969.

Colombia - The large-scale vaccination campaign continues in Colombia, and in 1969, 3,280,096 persons were vaccinated, representing 96.0 per cent of the target program for the year. The campaign began in 1967, and up to the present 63.7 per cent of the population has been covered, with maintenance activities reaching about 29.5 per cent. Evaluation techniques have

Figure 2
SMALLPOX ERADICATION CAMPAIGN
STATUS OF VACCINATION UP TO 31 DECEMBER 1969



been introduced to increase the low coverage of children under five years of age that had been noted in some provinces. The "take" rate was 92.8 per cent in primary vaccinations and 79.2 per cent in revaccinations.

The production of smallpox vaccine continues to meet the country's needs, providing an average monthly output of 742,000 doses of good quality vaccine. In 1969, 6,586,500 doses were distributed, a proportion of which was delivered to the Organization's vaccine bank.

Colombian and Venezuelan experts meet annually to discuss common problems of protection against smallpox and the action that needs to be taken with respect to epidemiological surveillance and maintenance.

The central laboratory for smallpox diagnosis has examined 60 specimens from suspected cases under investigation, all with negative results.

Ecuador - Free of smallpox since 1964, Ecuador is continuing its program of vertical maintenance, in the absence of an infrastructure providing effective coverage of susceptible persons. In 1969, 530,618 persons were vaccinated, with 95 per cent of primary vaccinations having taken. The "take" rate among revaccinations was found to be low, but this defect was corrected by supervisory action in the field. Evaluation of vaccination activities has been introduced as a routine part of the program, with epidemiological surveillance at sea and airports.

The vaccine produced at the National Institute gave rise to problems of potency and stability. A new technician is being trained, and it is expected that in the course of 1970 the country will be able to produce all the vaccine it needs to meet its own requirements. In this year a new phase in the coverage of the population against smallpox will be introduced, with special emphasis on children under five years of age.

The zone statistician for the smallpox project was located in Ecuador.

Paraguay - Budgetary difficulties made it impossible to start the program as planned, and a new operational plan has been prepared which will provide funds for the program in 1970 from the national lottery. Personnel have been trained and guidelines and procedures formulated; the program chief has visited Brazil on a fellowship from the Organization to observe the campaign being conducted in that country.

The smallpox diagnostic laboratory has finally come into service and made tests of samples sent after the investigation of an outbreak in Torocuay. These showed negative smallpox reactions. The general health services vaccinated 214,870 persons in 1969. Equipment, vehicles, and supplies for the program were furnished to the Government by the Organization.

Peru - As a result of the reorganization of the Ministry of Health and of budgetary limitations, the programmed monthly output of 320,000 vaccinations were not achieved. Average monthly vaccinations amounted to 65,398, and by December 1969, 598,584 persons had been vaccinated, 96.8 per cent of primary vaccinations and 73.2 per cent of revaccinations having taken. The official responsible for the laboratory producing smallpox vaccines visited the Connaught Laboratories with the assistance of a fellowship from the Organization. The vaccine produced amounted to 6,527,200 doses and is of very good quality.

Uruguay - The operational plan drawn up in 1968 provides for the vaccination of the country's population over a period of two years, but the eradication project has suffered from the effect of the country's financial position. In 1969, 442,531 persons in seven provinces were vaccinated, and from the outset of the program in 1967 activities covered 11 of the 19 provinces in the country. Coverage is generally low, and this is due to government regulation prohibiting the vaccination of persons possessing a certificate of vaccination issued since 1967. Only glycerinated vaccine has been employed, as the production of freeze-dried vaccine has not yet begun, although the Organization has provided the Ministry of Health with freeze-drying equipment.

In 1969 three cases of smallpox were reported, two imported from Brazil and one indigenous, which had been in contact with the imported cases.