Measles Eradication in the Americas: Experience in Haiti

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On 8 March 2000 a case of laboratory-confirmed measles was detected in Haiti. Over the ensuing months, an explosive epidemic occurred that spread to 8 of the 9 departments of Haiti, including the nation’s capital, Port au Prince. After peaking in the last half of November 2000, the epidemic began a rapid decline. The date of onset for the last confirmed case was 26 September 2001. During the 18 months of the epidemic, 1149 cases were confirmed. To control the epidemic, various strategies were employed, including vaccination campaigns that used fixed posts and door-to-door activities. Critical factors in the success of these campaigns were thorough training and supervision of field staff; a high-quality door-to-door vaccination strategy; multiple visits to homes; and monitoring of vaccine coverage by household during the course of the campaigns.

In 1994 Haiti completed a nation-wide catch-up vaccination campaign against measles that resulted in an estimated level of vaccine coverage of >95% of children aged 9 months to 14 years. For 6 years after the campaign, Haiti remained free of measles but the level of routine immunization remained low, with measles vaccine coverage in 1-year-old children averaging 47% (range, 32%–85%) between 1995 and 1999. Consequently, there was an accumulation of >1 million susceptible children below age 5 years. Other vaccines had similar coverage. For example, during the same time period, 3 doses of diphtheria-tetanus toxoids–pertussis vaccines were given to 34%–59% of children <1 year old. A follow-up measles vaccination campaign was conducted in 1999, but the estimated coverage was only 70%–80% of the target population. As a result, Haiti was at risk for a measles epidemic. Furthermore, the Dominican Republic, which shares the island of Hispaniola with Haiti and receives thousands of visitors and immigrants from Haiti every year, experienced a large measles outbreak beginning in June 1999 [1].

In March 2000 a measles epidemic began in Haiti that would last for 18 months and result in 1149 confirmed cases and 2 known deaths. During the epidemic period, a number of strategies for mass immunization were employed with varying degrees of success. Here we describe the epidemic and the different vaccination strategies used and discuss the impact of each strategy on the course of the epidemic.

BACKGROUND

According to estimates by the Haitian Institute for Statistics for the year 2001, Haiti had a population of 8,131,513, with 36% living in urban areas and 64% in rural areas. About 40% (3.3 million children) were below age 15. The gross national product per capita was $401, and life expectancy at birth was estimated at 60.3 years. The infant mortality rate was estimated at 67.5 per 1000 live births, but registration of births and deaths is not common. By almost any measure, Haiti is the poorest country in the Western Hemisphere. The
country is divided into 9 departments that are subdivided into 133 communes; most of the latter have public health offices. The local health offices are directed by department public health offices, which are directed by the Ministry of Public Health and Population (MSPP) at the national level. Data used to describe the measles epidemic are from a number of sources, none complete. Surveillance data were used to identify the epidemic, to track its geographic and temporal progress in the country, and to determine when the epidemic ended.

PRIMARY DATA SOURCES

Routine reporting of cases. Measles is a reportable disease in Haiti. Each health institution with a suspected case is required to immediately notify the local health department and send a blood sample to the measles reference laboratory at the Haiti State University Hospital in Port-au-Prince. While not all cases were reported, active searches for cases in hospital admission log books showed that the majority of cases were in the routine surveillance system. During the 2-year epidemic, 2000–2001, 1145 suspected cases of measles were reported to the MSPP. On the basis of negative laboratory results, 232 cases were subsequently discarded.

Investigation of existing cases. Each case investigation included a search for related cases in the same area. During the beginning and the ending periods of the epidemic, all cases were investigated; during the epidemic’s peak, groups of cases were investigated. Of the 1149 confirmed cases, 21% (236) were confirmed through an epidemiologic link to a laboratory-confirmed case. The incidence rate of cases per 100,000 population was as follows: <6 months old, 2.9; 6–23 months, 51.0; 2–4 years, 54.2; 5–9 years, 31.6; 10–14 years, 3.7; and ≥15 years, <1.0.

Active searches for new cases. Periodic visits to health centers are done at intervals of 3–6 months. During and after the course of the epidemic, two surveys were conducted that attempted to reach most of the over 400 health institutions in the country, one in July and August 2001 and the other from February to April 2002.

Sentinel surveillance. A sentinel surveillance system set up in Haiti in the early 1990s included over 50 sites nationwide. Initial performance was excellent and most sites were visited weekly or monthly. Due to financial problems, however, by 2000 the visits had stopped and weekly reporting had fallen to well below 50%. A new system was established in early 2002 but has not yet reached high coverage. This system was not involved in tracking the epidemic.

Population data for Haiti is based on projections of census data from 1982, the most recent census year. The resulting estimates may be fairly accurate for the country as a whole but, due to high migration from rural to urban areas, tend to overestimate the population of rural communes and to underestimate those of urban communes.

Administrative data on immunizations is based on the number of doses administered to children in a particular area. For routine immunization, these data are not reported routinely by many health centers, and the quality of these data is questionable. For immunization during vaccination campaigns, data are taken from vaccinator tally sheets. While the campaign data may be accurate, the data are usually divided by the estimated target population for the commune to obtain the percentage of children covered. This can be highly erroneous, often leading to vaccine coverage estimates well over 100%.

VACCINATION STRATEGIES IN HAITI

Vaccination in schools. If a substantial proportion of the target population attends school, time and efficiency can be gained by vaccinating all children in that age group while they are in the classroom.

Fixed-post campaigns. These campaigns rely on a series of vaccination posts scattered among the target population. Although they are the least expensive strategy and require the least planning and supervision, they depend first on parents being informed of their presence and hours of operation, and then on parents being willing and able to visit the post with their children.

Single-visit door-to-door campaigns. This strategy is traditional with an attempt made to visit each house in a target area. If there is a strong commitment by public health leaders that results in sufficient priority and resources being assigned to the campaign, supervisors can be trained to divide their areas into small sections and to follow vaccinators into the field to ensure that each house in each section is visited. However, if children or parents are absent during the single visit, those children will not be vaccinated during the campaign.

Multiple-visit door-to-door campaigns. This strategy requires at least two and sometimes three visits to a house to vaccinate the children present and to mark the house appropriately if a second visit is required. Each zone must be revisited at least one more time to vaccinate children missed during the first visit. Then a supervisor must visit each area to confirm that all houses were marked to indicate that all children were vaccinated. Finally, a sample of houses is visited to confirm that the marks are correct and that all children are vaccinated. This method is labor intensive, expensive, and requires constant supervision of the vaccinators.

Mixed strategy campaigns. This method combines fixed-post and door-to-door strategies, sometimes placing vaccine posts in densely populated urban areas where access is relatively easy and sometimes placing them in sparsely populated rural
areas where houses are too far apart for a vaccination team to visit them in 1 day.

THE MEASLES EPIDEMIC

On 8 March 2000, a case of laboratory-confirmed measles was detected in the provincial city of Gonaïves (figure 1) in the Department of Artibonite [2]. Over the next 2 months, an explosive epidemic occurred with over 150 confirmed cases (figure 2.) The epidemic in Gonaïves ended by the end of the second month after a rapid well-organized door-to-door vaccination campaign (see Response section). During the same period, the virus spread to other cities in the Department of Artibonite and to 20 other municipalities in 8 of the 9 departments of Haiti, including the metropolitan area of Port au Prince, where the onset of the first reported case was 1 May 2000.

Throughout the summer, cases occurred primarily in other cities of Artibonite and in Port au Prince, but by fall a major epidemic had begun in the capital. From the middle of August through the end of the year, 615 (92%) of the 666 cases reported in Haiti were in Port au Prince. Although scattered cases were reported from 19 other communes during the same period, continued circulation of the virus seemed to be occurring only in Port au Prince. At the peak of the epidemic, as many as 75 cases were confirmed each week [3].

Among the capital’s five communes, almost half of the measles cases occurred in the commune of Delmas, where 40% of the city’s children below age 10 lived. Within Delmas, the majority of cases occurred in the poor, densely populated neighborhoods of lower Delmas. This area had the lowest measles vaccine coverage in the capital and experienced formidable management problems in the follow-up vaccination campaign in 1999.

After peaking in the last half of November 2000, the epidemic began a rapid decline. By the end of March 2001, only sporadic cases were reported throughout Haiti. Although passive surveillance did not detect any cases after the beginning of June 2001, 3 laboratory-confirmed cases were found after June through active searches for new cases in major health care facilities throughout the country. The onset date for the last case was 26 September 2001. From September through the end of December 2001, 6 suspected measles cases were reported to the MSPP; all were negative. Finally, 18 months after its debut, the epidemic was over. In total, 1149 cases were confirmed during the epidemic, 1124 by laboratory findings and 25 on the basis of clinical description.

Each phase of the epidemic from its inception and spread to its ultimate decline provides valuable lessons for Haiti and elsewhere. These lessons are concerned with the quality and timing of vaccine campaigns during an epidemic, the critical importance of routine immunization and periodic catch-up campaigns for preventing future epidemics, and the need for both surveillance data and regular monitoring of vaccine coverage.

VACCINATION CAMPAIGN RESPONSE

Targeted response in the Department of Artibonite. A door-to-door campaign with a single visit to each house to vaccinate all children aged 6 months to 14 years against measles was begun in Gonaïves on 2 April 2000 and was completed by 24 April. Administrative data indicated that coverage was >95%. This campaign was well organized and had intense field supervision and strong leadership from the local health department. Within 2 weeks of this campaign, the epidemic in Gonaïves ended. Despite active searches for new cases, the last case there had an onset date of 3 May 2000. Following this initial campaign, other cities in the Artibonite Department initiated similar vaccination campaigns with the same door-to-door strategy. These were also successful in ending measles virus circulation. The onset dates for the last cases in Dessalines and Desdunes were late July and early August, respectively (3 later cases occurred in Artibonite in December 2000 but these were linked to transmission in the Port au Prince area). Table 1 summarizes the vaccine campaigns.

General response in Port au Prince. In the metropolitan area of Port au Prince, the initial measles vaccination campaign took place over a longer period of time and generally lacked the intense supervision that was associated with the Artibonite campaigns. The campaign began in late May 2000 with the vaccination of children in schools and continued through July with door-to-door vaccination. After an interruption in vaccination activities due to administrative barriers, vaccination
began again in the four main communes in late August 2000 and used both fixed-post and single-visit door-to-door strategies. By early September the campaign had moved through all areas of the city but had reached only about 82% of the target population of 1.2 million children <15 years old. In some areas of the city, particularly in lower Delmas, coverage was far below this level. Cases continued to be reported from all communes of the city in September and October 2000, especially from localities with low vaccine coverage.

**Intensive supervision of multiple-visit door-to-door vaccinations.** In late November 2000, a new campaign was begun that focused on the lower area of the commune of Delmas. Strong leadership from the MSPP, the Pan American Health Organization, and the Ouest Department, which includes Port au Prince, characterized this campaign. The strategy that was developed for Delmas included dividing the commune into small sectors for sequential vaccinations; training supervisors to follow vaccinators through a sector to ensure that each home had a mark indicating that it had been visited and whether it required a repeat visit; returning promptly to each area to ensure that all children missed on the first visit were subsequently vaccinated; and independent monitoring of door-to-door coverage in a convenience sample of sectors to ensure that the children were vaccinated [3]. All of lower Delmas was covered by the campaign plus some sections in middle and upper Delmas. The Delmas campaign began at the peak of the epidemic. Within 2 weeks, cases began a sharp decline in Delmas and elsewhere in Port au Prince and Haiti (figure 2.) No further cases were reported from lower Delmas after the campaign ended.

**Fixed-post campaigns.** Following the successful Delmas campaign, a similar campaign was planned for the rest of the Haiti but had to be postponed because of an independent political decision to conduct fixed-post multivaccine national immunization days (NIDs) to deliver 5 different vaccines to all the children <15 years of age and tetanus vaccine to all women of child-bearing age in the country. The first NID was held in early January 2001 and the second in early March 2001. Planning and operational obstacles were significant as the period before the first campaign included national holidays and less than 1 month was allowed for distribution of promotional material and vaccines. Based on the estimated number of doses delivered, coverage for all vaccines was estimated to be 30% for the two campaigns combined.

**Emergence of polio caused by poliovirus vaccine.** Restart of the nationwide door-to-door measles vaccination was again delayed after the appearance in Haiti of polio cases caused by a vaccine-derived poliovirus [4]. Because this virus could spread to other countries and threaten the eradication of polio from the Americas, a campaign targeting only polio began in May 2001 with a vaccination schedule that rolled sequentially through groups of departments. This campaign, which continued into July 2001, was designed to halt the growing parallel polio epidemic. The campaign faced important logistic limitations: About half the health centers in Haiti lacked adequate cold chain equipment and most roads in the country were in

<table>
<thead>
<tr>
<th>Date</th>
<th>Areas covered</th>
<th>Antigens</th>
<th>Strategy</th>
<th>Estimated coverage</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Mar–Sept</td>
<td>Most departments</td>
<td>Measles</td>
<td>Door-to-door, fixed-post, school vaccination</td>
<td>65%–95%</td>
<td>Conducted by departments; measles stopped in Department of Artibonite</td>
</tr>
<tr>
<td>Oct–Dec</td>
<td>Delmas</td>
<td>Measles, polio</td>
<td>Door-to-door</td>
<td>80%–90%</td>
<td>Conducted by Ouest Department; MSPP, PAHO; reduced no. of cases in all departments</td>
</tr>
<tr>
<td>2001</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Jan</td>
<td>Entire country</td>
<td>Measles, polio, 3 other vaccines</td>
<td>Fixed-post</td>
<td>&lt;50%</td>
<td>Haiti-Cuba collaboration; conducted by MSPP, PAHO</td>
</tr>
<tr>
<td>Mar</td>
<td>Entire country</td>
<td>Measles, polio, 3 other vaccines</td>
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<td>Haiti-Cuba collaboration; conducted by MSPP, PAHO</td>
</tr>
<tr>
<td>Mar–May</td>
<td>Communes with polio cases</td>
<td>Polio</td>
<td>Door-to-door</td>
<td>90%–95%</td>
<td>Conducted by departments and communes, PAHO</td>
</tr>
<tr>
<td>May–July</td>
<td>Entire country</td>
<td>Polio</td>
<td>Door-to-door, school vaccination</td>
<td>90–95%</td>
<td>Conducted by MSPP/PAHO/NGO task force; stopped polio in Haiti</td>
</tr>
<tr>
<td>Sept–Dec</td>
<td>Entire country</td>
<td>Measles, polio</td>
<td>Door-to-door, school vaccination</td>
<td>Polio, &gt;90%; measles, &gt;85%</td>
<td>Conducted by MSPP/PAHO/NGO task force; stopped measles in Haiti</td>
</tr>
</tbody>
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NOTE. MSPP, Ministry of Public Health and Population; NGO, nongovernmental organizations; PAHO, Pan American Health Organization.

bad condition. As a result of cold chain problems, some vaccine vials were spoiled and were destroyed and vaccination activities in certain areas were rescheduled. Nonetheless, the campaign was successful. According to coverage estimates that used official denominators, the campaign reached 130% coverage. Door-to-door monitoring of coverage after the campaign (interviews by independent monitors) showed that about 88% of the children below age 10 had been vaccinated [5]. The lack of new cases of paralytic polio uncovered in a search for additional cases in health centers throughout the country also confirmed the success of the vaccination campaign in halting the polio epidemic.

**Door-to-door measles and polio vaccination campaign.**

Door-to-door vaccination with multiple visits to each house was the strategy chosen for the second national vaccination round that began in September and ended in December 2001. The campaign also included vaccination in schools and combined both polio and measles vaccines. Monitoring of vaccine status of over 30,000 children <5 years old living in hard-to-reach areas indicated that coverage among the children interviewed was about 91% for measles vaccine and 93% for polio vaccine.

**LESSONS LEARNED**

**Vaccine campaign strategies.** Perhaps the most important lesson learned from Haiti’s experience is that door-to-door vaccination is necessary to reach target coverage levels for measles. In addition, as shown by positive experiences in Gonaïves and Delmas and the negative experience in most of Port au Prince, the quality of training and supervision in the campaign is critical. Finally, multiple visits to each home and door-to-door monitoring of results are powerful tools that help to guarantee high coverage for such campaigns.

High-quality campaigns in less developed countries require considerable resources that usually must be provided from outside the country. In Haiti, for example, after excluding the cost of vaccines, a single-antigen door-to-door vaccination campaign to immunize all children between the ages of 6 months and 5 years against measles would cost about $500,000 (US) or $0.38 per child. All resources for the campaigns discussed here, including the vaccine itself, were provided by agencies outside Haiti (see table 1).

**Haiti’s experience with routine immunization.** Another important reminder from Haiti’s experience is that as long as measles virus continues to circulate in the world and as the number of susceptible children grows because of low routine coverage combined with poor catch-up campaigns, an epidemic can occur [6]. During the period when routine immunization was allowed to decline in Haiti, there was no plan to reestablish adequate vaccine coverage levels, and therefore no annual action plan could be used as a management tool within the health departments. The low routine coverage was a result of failures at all levels of the vaccine system: missed opportunities to vaccinate children when they visited health centers for other reasons; lack of vaccine in some areas; poor maintenance of the cold chain equipment and insufficient number of health centers equipped with functioning cold chain equipment resulting in
either vaccine wastage or, worse, administration of nonpotent vaccine; and general deterioration of the services and facilities of health centers.

**Catch-up campaigns.** Even though vaccine coverage after the 1999 measles catch-up campaign was below 80% in most municipalities, the data were not used to direct mop-up campaigns in specific areas or additional catch-up campaigns for the entire country. In general, there was a lack of commitment at the local level to implement catch-up campaigns when the disease was not actually present in that community.

**RECOMMENDATIONS**

Based on the experience in Haiti, which is similar to that for other countries, the following steps are necessary to eliminate measles. Develop and follow a national plan to achieve and maintain high vaccine coverage through routine immunization. Conduct active and passive surveillance for measles cases and conduct vaccine coverage surveys in all areas of the country. Use surveillance and coverage data to direct mop-up and catch-up campaigns. Use a high-quality door-to-door vaccination strategy that includes intense training and supervision of vaccinators. Monitor movement of vaccinators on a zone-by-zone basis where they mark each house visited and whether all eligible children have been vaccinated and return to each area to vaccinate children missed on the first visit. Monitor coverage levels in zones where the coverage is suspected to be low and revaccinate if monitoring reveals problems with the vaccination effort. Of most importance is to give priority to the recuperation of cold chain equipment.

**References**