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Smallpox eradication and Brazil: an interview with Donald A. Henderson

A erradicação da varíola e o Brasil: uma entrevista com Donald A. Henderson

Interview with/Entrevista com
Donald A. Henderson

Interview given to/Concedida a
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Abstract

Interview with Donald A. Henderson, the U.S. physician and epidemiologist who headed the World Health Organization's Smallpox Eradication Program from 1966 to 1977. The interviewer talks about the endemic nature of smallpox in Brazil; relations between WHO, the Pan American Health Organization, and the Brazilian government; the role of Connaught Laboratories in the quality of the Brazilian smallpox vaccine; the process that brought certification of smallpox eradication in Brazil; international cooperation in eradicating smallpox and the various strategies applied; the role played by Brazilians in eradicating smallpox in India, Bangladesh, and Africa; and the future of the notion of disease eradication.

Keywords: eradication; smallpox; vaccination; international cooperation; Brazil.

Resumo

Entrevista com Donald A. Henderson, médico e epidemiologista norte-americano que dirigiu o Programa de Erradicação da Varíola da Organização Mundial da Saúde (OMS) de 1966 a 1977. Aborda sobretudo o caráter endêmico da varíola no Brasil; as relações entre a OMS, a Organização Pan-Americana da Saúde e o governo brasileiro; o papel do Connaught Laboratories para a qualidade da vacina antivariólica brasileira; o processo de certificação da erradicação da varíola no Brasil; a cooperação internacional na erradicação da varíola; as diferentes estratégias para essa erradicação; o papel dos brasileiros na erradicação da varíola na Índia, em Bangladesh e na África; e o futuro da ideia de erradicação de doenças.

Palavras-chave: erradicação; varíola; vacinação ; cooperação internacional; Brasil.

Introduction

Doctor Donald A. Henderson directed the World Health Organization's smallpox eradication campaign from 1966 to 1977. The program famously succeeded, and the global eradication of smallpox was announced on May 8, 1980. It thus became the only disease eradication program in history to achieve its objective. Born in Cleveland in 1928 to parents who had immigrated to the United States from Canada, D.A. (as he is known to friends and colleagues) studied medicine at the University of Rochester. He then pursued a career as an epidemiologist with the United States Centers for Disease Control (CDC). Appointed director of the WHO smallpox program in 1966, Henderson faced a series of immense challenges with a relatively small budget, but ultimately managed to implement an effective vaccination and epidemiology program which concentrated its efforts on the smallpox-infected areas of Latin America, Africa, and Asia, working with a multinational team of public health professionals.

In 1974 Henderson was instrumental in initiating WHO's global program of immunization, which has vaccinated 80% of the world's children against six major diseases. Since directing the WHO global eradication program, he has held a number of senior U.S. government positions in the area of public health, most recently playing a leading role in the preparation of effective strategies to counter and prevent bio-terrorism. Among many other publications, Henderson is the co-author of the so-called Big Red Book, *Smallpox and its eradication* (1988), which is the official history of the smallpox eradication program by those who directed it, and most recently, author of a pointed, personal, and compelling account of the eradication campaign, *Smallpox: the death of a disease* (2009).

In recognition of his contribution to world health D.A., Henderson has received many honors, including the National Medal of Science, the Presidential Medal of Freedom, the Public Welfare Medal of the National Academy of Science, and the Edward Jenner Medal, bestowed by the Royal Society of Medicine. Henderson is University Distinguished Service Professor and Dean Emeritus of the Johns Hopkins School of Public Health, and was also the founding director of the Center for Civilian Bio-defense Studies at Hopkins (now the Center for Biosecurity of the University of Pittsburgh). He is currently professor of medicine and public health and distinguished scholar at the Center, which although part of the University of Pittsburgh, is located in Baltimore, Maryland. It was there, in Henderson's office overlooking the historic harbor, that the following interview took place.

NOTE

The interview with Donald A. Henderson was conducted by Gilberto Hochman and Steven Palmer, in Baltimore, Maryland, on November 11, 2008. The interview was carried out with the support of the Canada Research Chair in History of International Health at the University of Windsor, Brazil's National Council for Scientific Development (CNPq), and Casa de Oswaldo Cruz/Fundação Oswaldo Cruz. Thanks to Lauren Demaree for transcription assistance.

Introdução

O doutor Donald A. Henderson dirigiu a campanha de erradicação da varíola da Organização Mundial da Saúde (OMS) de 1966 a 1977. O programa foi notoriamente bem-sucedido e a erradicação global da varíola foi anunciada no dia 8 de maio de 1980. Assim, tornou-se o único programa de erradicação de uma doença, na história, a alcançar o seu objetivo. Nascido em Cleveland, Ohio, em 1928, de pais que imigraram para os Estados Unidos provenientes do Canadá, D.A. (como é conhecido pelos amigos e colegas) estudou medicina na Universidade de Rochester. Seguiu a carreira de epidemiologista no United States Centers for Disease Control (CDC). Nomeado diretor do programa da varíola da OMS em 1966, Henderson enfrentou uma série de imensos desafios contando com orçamento relativamente reduzido, mas, ao final, conseguiu implantar um programa efetivo de vacinação e vigilância epidemiológica que concentrou seus esforços nas regiões endêmicas infectadas pela varíola na América Latina, África e Ásia, trabalhando com equipe multinacional de profissionais de saúde pública.

Em 1974 Henderson desempenhou papel fundamental para o início do programa global de imunização da OMS, que já vacinou 80% das crianças de todo o mundo contra seis das principais doenças. Desde que dirigiu o programa global de erradicação da OMS, Henderson ocupou vários postos de alto escalão no governo dos Estados Unidos na área de saúde pública e, mais recentemente, tem desempenhado importante liderança na elaboração de estratégias efetivas para combater e prevenir o bioterrorismo. Entre inúmeras publicações, Henderson é co-autor do livro conhecido como o "Grande Livro Vermelho", cujo título é *Smallpox and its eradication* (1988), que é a história oficial do programa de erradicação do ponto de vista daqueles que o dirigiram, e, mais recentemente, publicou um relato pessoal, instigante e incisivo sobre a campanha de erradicação, intitulado *Smallpox: the death of a disease* (2009).

Como reconhecimento por sua contribuição para a saúde mundial, D.A. Henderson tem recebido muitas honrarias, incluindo a Medalha Nacional de Ciências, a Medalha Presidencial da Paz, a Medalha do Bem-Estar Público da Academia Nacional de Ciências e a Medalha Edward Jenner, oferecida pela Sociedade Real de Medicina. Henderson é Professor Honorário e Decano Emérito da Escola de Saúde Pública da Universidade de Johns Hopkins, e também foi diretor fundador do Centro de Estudos para Biodefesa Civil dessa Universidade (atualmente Centro de Biossegurança da Universidade de Pittsburgh, que, embora faça parte da Universidade de Pittsburgh, localiza-se em Baltimore, Maryland). Atualmente, é professor de medicina e saúde pública e *Distinguished Scholar* no Centro. Foi lá, no escritório de Henderson com vista para a histórica baía de Baltimore, em novembro de 2008, que ocorreu a entrevista que se segue.

NOTA

A entrevista com Donald A. Henderson foi realizada por Gilberto Hochman e Steven Palmer em Baltimore, Maryland (EUA) em 11 de novembro de 2008. Teve o apoio da Canada Research Chair in History of International Health, da University of Windsor, do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) e da Casa de Oswaldo Cruz/Fundação Oswaldo Cruz. Agradecemos a Lauren Demarre pelo apoio na transcrição da entrevista.

Smallpox in the shadow of the WHO malaria eradication program

Gilberto Hochman (GH): *At the beginning of the smallpox eradication program, the malaria eradication program was still in progress. How did this dynamic play out? Two eradication programs side by side in WHO?*

Donald A. Henderson (DAH): It is a very good question. The malaria program began in 1955, very optimistically. A significant part of WHO's budget went into it. There was also a large amount of money provided by the U.S. government, either through WHO or directly to the countries. In fact, over the course of about 12 years, $2 billion in international assistance was invested in malaria eradication. For a while the prospects for success looked hopeful because a number of countries were quite successful in stopping malaria transmission. However, most were predominantly temperate-climate countries. In the developing countries, especially the tropical areas, it proved to be far more expensive and difficult than had been anticipated. By 1966, 11 years into the program, there were a number of people who had their doubts about malaria eradication, and were asking "How long could this go on, and can we support it?"

It was at that time that there was a debate in the World Health Assembly as to whether WHO should undertake smallpox eradication. A number of countries said they didn't think it could succeed and wanted no part of it. Some of the wealthier countries expressed the view that the budget of WHO was large enough and stated that they did not want to contribute more. The debate continued for three days. A principal opponent was Marcolino Candau.

GH: *The Brazilian director general.*

DAH: Right. He was very straightforward: "Look, we've got problems with malaria eradication. If WHO has a second eradication program that does not succeed, the credibility of WHO will be compromised and the credibility of public health itself will be in doubt." His concern, up to the time he died, was that every last person in the world would have to be vaccinated if smallpox eradication was to succeed. He'd done a great deal of fieldwork himself and he knew there were tribal groups in Brazil that weren't seen for twenty to thirty years at a time. He knew they couldn't be vaccinated. So how could one get rid of smallpox?

GH: *But how did the smallpox program begin with so many people - and such important people like the DG - against the program*

DAH: It was difficult getting the program underway.

GH: *What about the Pan American Health Organization?*

DAH: PAHO was not particularly supportive. Soon after the program began, I managed to get additional money for the PAHO budget from unused funds in another region. I asked that this all should go to Brazil, the only endemic country in South America at the time. Instead, the PAHO director, Doctor Abraham Horwitz distributed the money to each of the countries in the region and paid very little attention to the program itself. The regional

director for Southeast Asia was very much opposed to the program and wouldn't even spend the money that was allotted to his region. The Regional Office in Africa was so disorganized, it was almost impossible to communicate with them or the countries in that region. The regional director in the Eastern Mediterranean frankly didn't give a darn. Our entire headquarters staff in Geneva consisted of only nine people, including secretaries. We needed the full cooperation of the regional offices as well as each of the countries. We were far too few to single-handedly initiate programs in countries throughout the world.

The turning point

Steven Palmer (SP): *What was the defining moment for you? How were things finally turned around?*

DAH: Things turned around slowly. One of the important developments was the West Africa program, which included smallpox eradication. It covered some twenty countries. That was a program that almost didn't get launched. The critical decision to undertake the program was made in November 1965. This came about when I was at Centers for Disease Control (CDC) - before coming to WHO. The United States Agency for International Development (Usaid) had wanted to support measles vaccination programs in nine Francophone countries in West Africa. It was a goodwill gesture. Usaid staff came to me and asked if I could assign one of my staff to each of the countries for a period of six months to get the programs started.

I didn't know what to do. My staff was small and to assign nine people for six months was a problem. More than this, I didn't think that a mass measles vaccination program was a good public health policy. The vaccine cost $1.75 a dose and these countries couldn't afford ten cents for a dose of yellow fever vaccine. Why begin a measles vaccine program that they could not sustain? We finally developed an alternative proposal: why not undertake smallpox eradication over a large, contiguous group of countries and make measles vaccine available to those countries that Usaid and the countries considered appropriate. Such a program could serve to eradicate smallpox from the area and could help the countries develop a disease control structure that they could sustain, what with smallpox vaccine costing only two cents a dose.

We submitted a detailed proposal to support programs for smallpox eradication and measles control in 18 countries of West Africa. (Two additional countries were later added to the list.) Usaid had been contemplating a much more limited program that would run around $5 or $6 million over five years. Our proposal would cost about $35 million. Usaid did what I thought they would do: they turned us down flat. Actually, all I had hoped for was time to negotiate a plan that would be practical, feasible for AID to accept, and that we could support.

Surprisingly, the proposal wound up on the desk of President Lyndon Johnson. There was a United Nations initiative to have nations celebrate 1965 as International Cooperation Year. The administration wanted to announce some type of specific U.S. initiative and the West Africa program seemed like a great idea. We were stunned when we learned that the entire program had suddenly been approved. My boss at CDC was understandably irate because

we had such a small group and CDC had never before been responsible for planning and providing technical support for any international program: "This would take 50, 55 people - our administrative staff couldn't begin to manage this. How did you get us into this?" And I said: "It wasn't supposed to be accepted." And he said: "Well, you're going to have to run this out of the Centers. You can't run it out of the Epidemiology Branch."

So, much to my surprise, I was suddenly in charge of a smallpox eradication-measles control program covering 18 countries in Africa. In November 1965, we began an overwhelming task of securing agreements from each country, recruiting and training a staff of 55, developing training manuals, and procuring equipment. It was a frantic period. Seven months later, in May 1966, the critical debate on smallpox eradication occurred at the World Health Assembly. It was decided to undertake global smallpox eradication.

Doctor Candau was furious because he felt that the announced contribution of the United States had been significant in persuading the Assembly to launch the program. I must note parenthetically, however, that the Soviet Union had actively promoted global smallpox eradication for a number of years but Candau felt that the U.S. was more to blame for what he considered to be a regrettable policy. He said: "I want an American to run the global program so that when it fails, it will be seen that the U.S. bore much of the responsibility." I was called to the office of the Surgeon General in Washington, and [he] said: "You're going to be assigned now to Geneva." And I said: "No, we've just started this West Africa program. I've got too much to do, I can't possibly go. Besides which there's very little money available in the WHO budget - $2.4 million." This was not enough even

Figure 1: Interview with Donald A. Henderson (right), conducted by Gilberto Hochman. Baltimore, Nov. 11, 2008

to buy the vaccine needed for the program. I also knew from experience how difficult it had been for WHO to operate a coordinated international program given its fragmented regional office structure. I declined to go. He said: "You're going." I pointed out that the Public Health Service did not arbitrarily transfer its staff from one place to another. Instead, it was customary to explore and discuss career options. And he said: "This is your career option." I declined. He said: "You resign." At that point I gathered that he was serious. We packed up our household goods, sold our house, and my wife, three children, and I departed for Geneva. I began an 11-year assignment in November 1966.

Meanwhile, the program in West Africa got started. It proved to be immensely successful. These countries had the world's highest incidence of smallpox and they were the least developed in terms of infrastructure. My feeling was that if the smallpox program could succeed there, it was possible everywhere. Within little more than three years, smallpox was gone from the whole of West Africa, an area inhabited by more than one hundred million people. With this victory, people began to believe that eradication might possibly be achievable, that maybe global eradication wasn't such an impossible idea after all. And with that the program began to pick up speed.

Smallpox in Latin America

GH: *Could you talk a little about Latin America and the smallpox problem in the 1960s, and in particular how you explain the place of Brazil in that problem?*

DAH: Smallpox eradication had its birth in the Americas with a man by the name of Fred Soper. He was the first director of what became the Pan American Health Organization (PAHO). Soper proposed in 1950 to eradicate smallpox throughout the Americas. PAHO was a very small operation then, with very few people and an almost negligible budget. Soper, however, was an articulate and ardent advocate. To foster eradication, he sought to introduce a better, more heat-stable vaccine to the Western hemisphere. The vaccine that had been in use was what we called liquid vaccine. Liquid vaccine was only potent for a few days if not kept refrigerated. Trying to keep it cold was a problem for most countries. Freeze-drying the vaccine was a new process which had been developed at the Lister Institute in London. Subsequent work was done in the Michigan Health Department laboratories. What Soper and PAHO did was to introduce the method for producing freeze-dried vaccine to vaccine production laboratories in the Americas.

In the Americas, by 1967, the beginning of the global program, the only endemic smallpox country was Brazil. The reason was that many countries did develop vaccine production facilities to produce freeze-dried vaccine and had conducted repeated mass vaccination campaigns. Brazil, for reasons that are not known to me, was not producing the freeze-dried vaccine and was not particularly active in trying to get rid of smallpox. One important reason for its disinterest was that the type of smallpox in Brazil was the very mild form of smallpox, called alastrim. This mild form of smallpox came to the Americas about 1900, and gradually spread across the United States and Canada and into many countries of Latin America. The authorities in Brazil were not that concerned about alastrim; they regarded it much as they regarded chickenpox - a mild disease with only a few deaths.

As the global program began, we knew we would have to set priorities - to support programs in some countries and, as they became smallpox-free, to shift support to others. We decided that Indonesia and Brazil would be high priority. Each was geographically separate from other smallpox-infected areas. Once they got rid of smallpox, importations were unlikely. Thus, when they had succeeded in stopping smallpox, we could shift their annual allocation of program funds to support endemic programs in Africa and Asia. I was anxious that both programs move ahead as fast as possible.

The program in Brazil began with great difficulty. There were political problems, there were changes in government, the budget fluctuated, and directors of the program were regularly changing. At that time the director of the Pan American Health Organization…

GH: *Abraham Horwitz, a Chilean.*

DAH: Yes, he was neither very effective nor interested. Not surprisingly, we had considerable difficulties trying to initiate meaningful programs in Brazil and in the Americas.

The smallpox eradication program in Brazil

GH: *Did you visit Brazil during the smallpox eradication, and if so, do you remember your visits to Brazil?*

DAH: I visited Brazil probably five … six times between 1966 and about 1972. Mainly I was in Rio [de Janeiro]. We went up to Brasília at one point and I made a visit to Paraná - a very fortunate visit for me.

GH: *A lot of smallpox cases in Paraná state.*

DAH: There were a lot of cases. The government had recruited for Paraná a young epidemiologist, Ciro de Quadros, who had trained at a school of public health and had a year working in the Amazon. The secretary of Health, Nelson de Moraes, assigned him to develop a surveillance program in Paraná. At the time, I was having trouble persuading Brazil - as well as other countries - of the importance of surveillance. This meant getting regular reports of smallpox cases every week from every health center and hospital and then to send teams out to stop the outbreaks. This was a technique we called surveillance and containment. Most of the countries at that time only kept track of how many people they were vaccinating. They paid little attention to where or how many cases they had.

This young doctor, Ciro, took the assignment seriously. He had one vehicle, he was given a driver, and he had a vaccinator. He decided that he would get rid of smallpox before the teams could mobilize to begin a mass vaccination program in Paraná - just by use of the surveillance and containment mechanism. He worked tirelessly with his small team aided by staff from hospitals that could be persuaded to help. In little more than six months, there was no more smallpox in Paraná - and the mass vaccination campaign was only beginning!

GH: *It is a story related to your first visit to Brazil, to Paraná?*

DAH: I had been to Brazil on several occasions, trying to persuade the government to set up surveillance and containment programs, and finding it very difficult. When I met

with Ciro, he spoke almost no English; my Portuguese was severely deficient. However, I could read his reports and understand them pretty well. He showed me one report which was magnificent. Cases were enumerated by age, by date, so forth, all laid out with graphs and other epidemiological data. I said: "Ciro, this is admirable but you know I wouldn't waste my time writing up all of this material in the detail you have. It's more important that you spend the time in the field." He looked at me wistfully and said: "Well, I come in on Saturday night … to get supplies and so forth. I write the report on Sunday, and I go out Sunday night." What could I say? I was dumbfounded.

GH: *Do you remember the names of these colleagues?*

DAH: Nilton Arnt and Eduardo Costa. They did a fantastic job. After they began their work, the numbers of reported smallpox cases increased dramatically because completeness of reporting improved. The director of the respective public health departments became worried, as did governors, and the president. They decided to allot more money for smallpox. About this time they decided for political reasons that they would terminate the three epidemiologists, and so Ciro and Nilton were recruited for the WHO program. Ciro became the chief of field operations in Ethiopia and began learning English en route. It was not too long before he spoke English almost as well as I - and he proved to be one of the best field epidemiologists that we had in WHO or, in fact, with whom I have ever worked.

GH: *Do you remember the institutions that you visited during your stay in Brazil?*

DAH: I visited the Oswaldo Cruz and Butantan Institutes.

GH: *What was your feeling about vaccine production in these institutes?*

DAH: At that time there were problems. There were three, maybe four different institutes in Brazil endeavoring to produce vaccine but they were not doing well.

GH: *One was Recife, capital of the state of Pernambuco…*

DAH: Yes, they were in different parts of Brazil but none apparently had the expertise that they had at the Oswaldo Cruz Institute. They were trying to produce the vaccine at Oswaldo Cruz by growing it in fertile eggs. The traditional method was to grow the vaccinia virus on the scarified flank of a calf. After seven or eight days, the calf would be sacrificed and the vaccinia virus would be harvested by scraping it off the hide. Whatever steps were taken in cleanliness, bacteria were inevitably present. Accordingly, they began growing the virus in fertile eggs - a technique then in use in Sweden. This reduced the contamination, but it was difficult to get a sufficiently high titer of virus. Moreover, it proved to be more difficult to freeze-dry. It was a difficult period for the laboratory. Clearly, it was one of the most experienced and best equipped laboratories but it was regularly failing to produce a vaccine that was sufficiently potent and stable.

GH: *Do you remember your meetings with the health ministry about it? I'm asking this to understand the shift between some resistance to go into the campaign, and then in 1967, 1968, 1969, the government put in money and decided to eradicate. Why this change?*

DAH: After a series of early failures, they appointed as head of the smallpox program an experienced man who had directed the malaria program - Doctor Oswaldo da Silva. He brought order into the vaccination campaign but his orientation resembled that for malaria eradication in focusing entirely on mass vaccination, leaving surveillance operations until after vaccination control measures had been completed. The concept of the need for surveillance and containment from the inception of the program was difficult to get across.

When I was at the CDC, immediately before going to WHO, I had been in charge of the surveillance section. There, we were conducting surveillance programs on a number of different diseases. My right-hand person was a statistician by the name of Leo Morris. Soon after the global program began, WHO and the Brazilian government signed an agreement with regard to cooperation in the Brazilian effort. This provided for a position for a statistician and I persuaded PAHO that Morris would be an excellent candidate. Within six months after his arrival, he had developed a weekly surveillance report called the *Boletim Semanal*. It provided a weekly report of all reported cases of smallpox and described special outbreak investigations and other activities of the program. It was sent to health officials throughout the country so everyone knew what was going on - and what was not going on. It had a great impact. WHO also assigned three physician epidemiologists from other countries, none of whom exhibited much interest in the program nor contributed much to it. There was also one senior physician who was recruited to serve as senior smallpox adviser for the region. He was based at the PAHO Regional Office in Washington. He was a Brazilian who seldom traveled much beyond his Washington home and his permanent residence in Brazil but he took an active role in resisting the implementation of the surveillance and containment strategy and resented having me or anyone in my office visit the program.

GH: *About this question of search and containment, in my conversations with Brazilian protagonists - your colleagues in Brazil - they remember tensions between the search and containment strategy and the mass vaccination strategy. They remember this as the big problem in the Brazilian program. In your opinion, was this a real tension? Did it become a problem?*

DAH: It was an enormous problem not only in Brazil but in many countries. The previous strategy for smallpox control had been solely that of mass vaccination. Progress was charted in terms of the numbers vaccinated. There was little interest in knowing how many cases were occurring. Thus, there was no measurement to assess how well the vaccination effort was succeeding in stopping disease. What we endeavored to establish was a system whereby every health center, every hospital, reported once a week as to how many cases of smallpox they had. This was a new idea. Many health centers and hospitals were responsible for providing monthly reports, although few reports were sent promptly and some units never reported anything at all. It took a while to establish this new routine. The idea of having special teams to investigate and contain outbreaks that were reported was not enthusiastically received. The directors of health services and the heads of programs said: "Why do we have special teams doing nothing but investigating outbreaks and cases? This is a great waste of manpower. They should be part of the mass campaign in which they could vaccinate a lot more people in the same period of time."

There was a similar attitude toward constituting teams who could monitor the quality of the vaccination programs. We had sought to have a team of two or three to visit a few villages in each of the vaccinated areas after seven to ten days to check for successful vaccinations. Program directors argued that they needed their full staff to provide vaccination in the mass campaign and could not divert staff to 'just check on the work of others.' The failure to divert staff for this purpose became evident early in the program during investigation of an outbreak in Barranquinas, a town in Brazil which had approximately 6,500 people. The vaccination teams reported doing something like 6,700 vaccinations - more vaccinations than there were people. Leo Morris decided to do a study to see how well vaccinated they really were, and to see if there were other cases. He took a small team to investigate. They discovered that only about 50% of the people had actually been vaccinated and the cases numbered in the hundreds. This was the episode that resulted in the departure of the first program director and the appointment of Doctor da Silva.

Mahler and the changes in WHO

GH: *I have a question about Candau and you anticipated the answer, but it's interesting… This change with the retirement of Candau - because Candau retired as a director general at the beginning of the seventies.*

DAH: Candau retired in 1973 and at that time Halfdan Mahler, who's from Denmark, became director general.

GH: *But did the retirement of Candau change the direction of the program?*

DAH: When Doctor Mahler took office, we had, I believe, only five countries with smallpox but they were among our biggest problems. Mahler was very helpful, and acted forcefully to get more money into the program, and he would sometimes intervene directly with heads of state in certain countries that were not cooperating particularly well.

GH: *Moving to operational area decisions, I was surprised by viewing photos and reading all kind of reports, by the widespread use of jet injectors in Brazil and the use of the bifurcated needle in only a few areas. Do you have any recollection as to why this decision was taken? I think in India this was different from Brazil in the sense of the use of needles or use of the jet injector.*

DAH: When the program began, we did not have bifurcated needles. The needle itself had only recently been invented and we hadn't yet received any for experimental use. When I was at CDC, we had worked with the U.S. Army in an attempt to develop a jet injector that would permit many people to be vaccinated quickly and inexpensively. We had done studies in a number of different countries, including Brazil, which showed that one could vaccinate one thousand people per hour with a high proportion of successful vaccinations. Thus, it was a very good device for large-scale vaccination. As you will recall, our primary priorities were Brazil and Indonesia, feeling that if they could become smallpox-free reasonably quickly, we could shift resources to priority areas of Africa and Asia. WHO funds were being used to buy the jet injectors.

The trouble with the jet injectors was that they were problematic to use in the field. Originally, they were driven by electricity. We worked with the inventor to make them so they could be activated hydraulically, with a foot pump. But there was a distressing problem in that injectors needed a good deal of maintenance and repair. Thus, trained technicians had to travel with the guns and usually one or two backup guns were needed for every one in operation. In Brazil the guns were much less of a problem than in Central Africa, for example, because there were many Brazilian technicians who could readily be taught to repair the guns. Jet injectors were also used throughout West Africa where CDC staff served as advisers to the programs. All had to be trained in maintenance and repair of the guns.

When the bifurcated needle came along, it was a tremendous development. This was one of the great inventions. It was only invented in 1966 but as soon as we finished field studies to test its use for a multiple puncture technique, we began introducing it into countries in most parts of the world. The needles were inexpensive, easy to use, produced more successful vaccinations than the older technique of scarification, required one-fourth the amount of vaccine and had no moving parts that required maintenance and repair. However, by the time they were ready for field use, Brazil was well-equipped with the jet injectors and mass vaccination programs were in progress.

Connaught Laboratories cooperation

SP: *We've been looking at the role of Connaught Laboratories at the University of Toronto in providing technical oversight for quality control of vaccines produced in Latin American laboratories during the smallpox eradication program. They also did some training and quite a number of field visits to Latin America; also, Latin American scientists came and trained at Connaught. How did it come about that a Canadian laboratory was chosen to play this role?*

DAH: When the program began in January of 1967, we thought we had enough vaccine. The United States was willing to supply the vaccine for West Africa. The Soviet government pledged 25 million doses a year. There were some forty laboratories producing smallpox vaccine in various countries of the world. We assumed that most of the vaccine would meet standards. However, we wanted to have an independent laboratory to check the quality of the vaccine Robert [Bob] Wilson - who at that time was scientific director [of Connaught Laboratories] - had volunteered their laboratory to be of help. I had met Bob at a number of professional meetings - a very agreeable person and very capable. Canada volunteered to test vaccines for the Americas, and the Rijks Institute in the Netherlands, for other countries.

We learned very soon that almost none of the vaccine in use met international standards. Some had no virus in it at all and yet countries were using it. It was urgent that we begin work with the laboratories in the different countries. Recall we didn't have enough money to buy vaccine, so we had to help the countries themselves to produce better vaccine. We called a meeting in Moscow and we brought in laboratory directors from the Soviet Union, from Holland (the Rijks Institute), from Wyeth Laboratories, from the Lister Institute (U.K.), and Bob Wilson.

Over the course of a week, they developed a simple, standard manual of procedures on which they could all agree and that incorporated the best methods. The object was to

have a simple manual that even I could understand. They did that and then they themselves went to the different laboratories to help them improve their vaccine production.

Some of the laboratories were in terrible shape and eventually had to close down. It was important that the large countries be able to supply their own needs - Brazil, Indonesia, India. Pakistan and Nigeria were the ones that seemed most capable and were already engaged in some vaccine production. Thus, special efforts were made to assist them in producing quality vaccine that met international standards. All except Nigeria succeeded in making substantial progress. By 1972 - five years into the program - all of the vaccines in use met international standards. More than 80% of the vaccine used was being produced in the developing countries themselves so that the vaccine donations from Canada, from Russia, from other countries could be used for those countries that didn't have their own vaccine production. The certainty of quality vaccine everywhere made a huge difference to the success of the program.

SP: *As historians, we look at the fact that a Canadian laboratory was involved in Latin America, and we wonder perhaps if there was a political motivation there, because of the tendency for some nationalist reactions when a U.S. institution is given oversight responsibilities in Latin America. We wondered if that factored into the decision to look to Connaught.*

DAH: No, it did not. Bear in mind that the only commercial producer in the world was Wyeth Laboratories. It supplied all vaccine for the U.S. and to the Usaid West Africa program. Wyeth was quite generous with their resources but they received no government financing to help them assist the development of laboratories in other countries. Connaught at that time was under the aegis of the Ontario provincial government and closely tied to the University of Toronto. With government support, they were in the best position to provide assistance for the Americas. Frankly, I don't think it ever occurred to me that there was an alternative at that point. Connaught was a first-class laboratory and both Wilson and Paul Fenje [the other Connaught specialist who collaborated on the vaccine program] were both Canadian citizens.

The certification

GH: *I've been reading some of the records of the Brazilian smallpox eradication program. In reading newspaper reports, I had the sense that after the certification in Brazil in '73 a sense of doubt or uncertainty still lingered. I wonder, did you feel at any time during the campaign that WHO would not achieve the goal of eradication?*

DAH: I think there were many who doubted that it was possible to eradicate smallpox and to know that it had actually been accomplished. There were times when that struck me as well. One was in Calcutta, India, and traveling on a bus from the air terminal to the center of the city. One passed millions and millions of people, crowds teeming everywhere. How were we ever going to know that there was no smallpox in an area like this? It was just mind-boggling. I had the same feeling flying over Africa looking at vast expanses of territory and realizing that in many areas, there were only scattered villages, no health centers, and many hostile groups. How in heavens name could we deal with these areas?

Certainly, there were many moments when I wondered if it was going to be possible to know that for certain there was no more smallpox.

As we got more experience, we became more confident. The key factor is that smallpox, to keep going, has to infect one person after another. If the chain of infection is broken, it dies out because there's no animal reservoir for the virus. It doesn't persist in the environment. Every person infected with smallpox is going to have a rash. There are no subclinical infections. If smallpox is to persist, there has to be a steady occurrence of obviously infected people - a chain of infection. Most of those who have recovered will bear the permanent scars of smallpox on their faces. Thus, searches throughout different areas provide a history of where smallpox has been, and if it is still present, one can detect persons with the typical rash.

The footprint of smallpox was important. After the severe form of smallpox in Asia and in a good part of Africa, 80% of the people were left with permanent scars on their faces. So that if one went into a village, let's say in the Himalayas, one could quickly check to see who had scars of smallpox. If no one under the age of, say, ten years had facial pock marks, one could feel reasonably certain that there had been no smallpox in that village for at least that time. We did many surveys for facial scars of smallpox. How long did smallpox persist in any country when we thought it had been eliminated and yet it still was being transmitted? Eventually, we found that the maximum was about eight months. So we set the goal for continuing surveillance after the last smallpox case to be two years - that is, good surveillance had to be conducted for at least two years before an international commission could certify eradication. This approach turned out to be very effective. When we did the last certifications, I believe the world community was confident that there really wasn't any smallpox.

GH: *I was surprised. I searched all national Brazilian newspapers: August 1973, September 1973. One or two news items about it but not a great surprise, with no big news in the newspapers about the certification.*

DAH: This, in part, reflected our difficulty in persuading the government and PAHO of the importance of the program and getting the support that really was needed. South America, including Brazil, was the first area to be certified as having eradicated smallpox. Doctor Horwitz, the PAHO director, appointed as chairman of the commission a man by the name of Doctor Alfredo Bica, a Brazilian. The commission was supposed to have been entirely independent and thus no one on the Commission was supposed to be from Brazil or elsewhere in South America. The independence of the commission was critical if the findings were to be fully accepted by health ministers throughout the world. After the South American Commission had met, one of the members of the commission told me: "You know, we had a grand good time. It was very jovial and we really didn't do very much." After very little examination, the commission basically said: "No problem, there's no smallpox here, we're not worried." Once, we had hoped that this first commission would set the tone for subsequent ones. I was really angry. Bichat Rodriguez, the PAHO regional smallpox adviser, and Abraham Horwitz, really let us down.

The next certification commission was for Indonesia. That was rigorous and very well handled by the WHO Regional Office and by the government. So now you can appreciate why so little notice was taken of the certification of eradication in South America. The disease itself was not considered to be a serious one and the program, as it was conducted, was not particularly noteworthy. Contrast this with India where the Prime Minister Indira Gandhi, on August 15, India's Independence Day, took this as an occasion to announce that India had freedom from smallpox. As she said: "For the first time in our recorded history, we have no smallpox." It was really a memorable ceremony. This was worldwide news. And the prime minister then presented to WHO a magnificent eight-foot-high cast bronze statue which stands in one of the rooms in WHO's Geneva headquarters. The achievement was regarded differently in Brazil.

The Brazilians in India and Africa

GH: *Some of the Brazilians who participated in the national program - I'm thinking especially of Doctors Claudio Amaral and Ciro de Quadros, and there were others - some were hired to work on the smallpox program in India and Africa. How did this come about? You told us about Ciro de Quadros. What about other Brazilians who worked in India, in Africa?*

DAH: A pertinent question was why did we recruit so many different personnel, some to serve for several years but many of whom could spend only three to six months working with us. We were anxious to recruit staff who had proven themselves to be capable in the field and were willing to work hard. A number were from Brazil. In Candour, we found that a number of the WHO advisors who had been recruited by regional directors had been hired for extraneous attributes - a number because the regional directors were indebted to national politicians. Some of the advisors worked well but there were a number who were disinterested in the program and rarely left their offices. By the time programs had succeeded in West Africa, Indonesia, and Brazil, we were recruiting staff who had proven to be effective in the field. We had a rule that all staff had to be in the field at least one-third of the time. I myself was in the field a third of the time, and this meant sleeping out in hotels which were borderline, eating local foods, and periodically being in dangerous areas. We had outstanding staff. In addition to our Brazilian contingent, we had some from other previously endemic countries - CDC staff who had worked in West Africa and quite a number from the Soviet Union, Poland, Czechoslovakia, Britain, Holland, Sweden, France. Senior people at institutes often nominated their very good young graduates. A lot of extraordinary people - young people - who made a very big difference.

The future of the idea of eradication

SP: *With the success of the program, at the time of certification and global eradication, what did you and other leaders of the program feel was in store for the future?*

DAH: There were different views as to what should be the future. The future that I envisaged for the program was in immunization. What had been so impressive to me was how many were able to be vaccinated so rapidly in West Africa, Brazil, and East Africa in large-scale

vaccination programs. They were programs which could readily be monitored for quality and performance. In setting up the vaccination programs, we provided for independent teams that would check the quality of the work as it was being done. There was a plan to work with local leaders to mobilize participation. We found that in Africa, for example, an average vaccinator could perform five hundred or more vaccinations a day. In one country vaccinators averaged 1200 inoculations per day. With a trained team and its supervisor working with local people and getting their support, we believed that 80% coverage would be possible. We found instead that we were regularly documenting 90% coverage, even in places as difficult as Afghanistan and the Democratic Republic of the Congo. During the early phases of the program, I regularly visited infectious disease hospitals. I saw lots of kids with tetanus, with diphtheria, with polio, with measles. And yet as of that time, there were vaccines against each of these diseases and all were in use in industrialized countries. What of the developing countries? I soon learned that many were not giving any vaccine other than BCG, the tuberculosis vaccine - when it was made available by Unicef - and the smallpox vaccine; that was it.

In December 1970, we convened a WHO meeting which was held in Washington to advise on what vaccines should be in routine use in all countries. We organized two committees: one to advise on what should be a minimum vaccination program for developing countries, and one for the industrialized countries. I served as secretary for the developing country subcommittee; the chairman was Doctor Julie Sulianta Sarosa from Indonesia. This committee produced a report that proposed the development of mobile teams for all developing countries that could administer DPT, measles, polio, BCG, and smallpox. The name Expanded Program on Immunization (EPI) was proposed. In 1974, the concept was accepted by the World Health Assembly. Initially, only two Geneva-based staff were assigned to the program - far too few to have any significant impact. However, after the program was accepted by the Assembly, the number increased to twelve - which for WHO headquarters, was quite a large staff.

In the early 1980s, Jim Grant, Director of Unicef, made EPI a priority for his organization and Rotary offered to raise $100 million for polio vaccine. A goal was set to reach 80% of the children in the developing world by 1990. Effectively, this was achieved. You know of the changes in Latin America that have taken place. Polio is gone, measles is gone, rubella is almost gone, diphtheria cases are few in number, and cases of neonatal tetanus are becoming rare. During this time, mortality rates plummeted for those under five years old, faster than at any other time in history. Certainly, other factors in addition to vaccination played a role but disease prevention through immunization was a key one. Now, there are many more companies and research laboratories interested in developing other vaccines and other methods for administering vaccines - orally, transdermally, by aerosol, and perhaps in foods. The vaccine age has only begun.

There are others who believe that there is a different lesson to be drawn from the success of smallpox eradication; basically, they believed that if we could eradicate one disease so rapidly and economically, other diseases could be eradicated as well. The eradication of smallpox was announced in May of 1980 at the World Health Assembly. By autumn, a meeting was convened at the U.S. National Institutes of Health. It was a meeting

to decide on what next should be eradicated. I was one of the keynote speakers. I pointed out at the meeting that we had never discussed among our senior staff the possible eradication of any other disease. We knew how difficult smallpox eradication had been and we knew that we had just barely achieved success. No other disease came close to having the attributes that would make eradication possible, nor the effective tools to prevent the disease. However, at the autumn meeting, many alternatives were earnestly discussed - polio and measles and tetanus and urban rabies and famine and many others. It was a bizarre meeting.

SP: *A Pasteurian dream.*

DAH: As keynote speaker, I said in so many words: "There is one thing we need to eradicate." "Oh, and what's that?" "The word 'eradication'." That was the last time I was invited to an eradication meeting, many of which are still more evangelistic than scientific. More than 21 years have elapsed since the polio eradication program began, but still there is a long way to go. It is now nine years beyond its target completion date. More than $6 billion of international assistance funds have been expended and at least an equivalent amount in national funds. This is more than fifty times what was spent on smallpox. The end is still not in sight. There is also a global Guinea worm eradication program which began two years before the polio eradication program. Steady progress has been made but there are serious problems still, especially in the Southern Sudan were active fighting continues, as it has for years. What we need are good control programs using vaccines and not more eradication programs. Their effect has proved to distort prevention priorities.

SP: *Well, Doctor Henderson, thank you very much. It has been very enlightening and a great privilege for us to hear your views in such detail. In case we don't see you before 2010, happy 30th eradication anniversary, and we certainly hope you get the recognition for the program that you think is due.*

GH: *Thank you.*

DAH: Very nice to be with you, but let's bear in mind - and I've reminded people again and again - that there are a lot of people from many different countries that did an enormous amount and were real heroes and heroines in this program. It is they who deserve the thanks of all of us.

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