3rd DRAFT
05/18/95

SMALLPOX ERADICATION

D.A. Henderson, M.D., M.P.H.
University Distinguished Service Professor
The Johns Hopkins University
MAY 23-24 TALLOIRES, FRANCE

In May 1980, it was possible for the first time to affirm that a disease had been eradicated throughout the world. (Fenner, et al.) That the disease was smallpox was singularly appropriate. For more than three centuries, smallpox had been the most universally feared of all diseases, responsible globally for more deaths than any other infection. Even for the 20th century, one contrasts the estimated 100 million deaths caused by armed conflict with a figure at least two to three times greater than this for which smallpox alone was responsible. And, finally, we should recall, it was Jenner's effort to protect against smallpox that we celebrate as the dawn of the science of immunology.

What is little appreciated, however, is that the smallpox eradication program was begun reluctantly and almost died a stillborn. From a contemporary vantage point, it would seem obvious that smallpox, of all human diseases, was the best possible candidate for eradication. Man was the only host; a highly effective and inexpensive vaccine was available; and detection of cases was easy, given its unique clinical presentation. Moreover, governments across the world had been conducting vaccination programs and controlling outbreaks for more than a century. Nevertheless, the belief that smallpox, as a practical

---

*Presented at the Gunner Marcel Merieux Symposium, "Microbe Hunters: Then and Now," at Chavoires, France, on May 23, 1995.

matter, might be eradicated from a defined geographical area was not even proposed until the 1950's and not endorsed, in fact, until a decade later.

This seems surprising but then global policy-making in health often appears to be as much quixotic as rational. Thus, preceding smallpox in a parade of failed eradication attempts was a hookworm campaign begun in 1909; yellow fever in 1913; yaws in the 1950s; and malaria in 1955. Each was launched on premises as much based on evangelistic conviction as dispassionate scientific assessment, and each was eventually destined to collapse.

While such as Jenner and Jefferson had expressed hopes early in the 19th century that smallpox might someday be conquered, the first serious proposal to undertake smallpox eradication as a practical matter was advanced in 1953 by Dr. Brock Chisholm, WHO's first director general. In his fifth and last year as Director General, he proposed that smallpox eradication be undertaken as a global effort, an overarching campaign which would demonstrate the importance of WHO to every member state. In the discussion which ensued at the Assembly, virtually every industrialized country, and several developing ones as well, argued that such a program would be too vast and complicated and the matter was unceremoniously dropped. Instead, malaria eradication was launched the following year.

The one country which was not party to these early discussions was the USSR, which for many years had not actively participated in WHO. In 1958, it resumed active

participation and immediately dropped a figurative bombshell. Its principal delegate, the distinguished Academician and Vice Minister of Health Victor Zhdanov proposed a 10 year program for the eradication of smallpox. He reasoned that the USSR had succeeded in eradicating smallpox over its vast and ethnically heterogeneous country and saw no reason why other countries around the world could not do likewise. WHO estimated that the cost of such a program would be $100 million. The Assembly voted to accept the program and to provide, from its regular budget, $100,000. Fiscal annihilation was diplomatically more polite than outright rejection. Not surprisingly, little was achieved over the next 7 years.

Meanwhile, between 1957 and 1967, WHO and its member countries invested nearly $1500 million in a steadily failing malaria eradication effort. As frustration heightened, the very concept of eradication came increasingly to be doubted by scientists and public administrators alike. The prevalent mood was well captured by the literate and widely read Dr. René Dubos who, referring to smallpox and malaria eradication in particular, wrote in 1965 in his book, Man Adapting: "Social considerations, in fact, make it probably useless to discuss the theoretical flaws and technical difficulties of eradication programs, because more earthy factors will certainly bring them soon to a gentle and silent death . . . eradication programs will eventually become a curiosity item on library shelves, just as have all social utopias."

Meanwhile, Russian delegates to successive World Health Assemblies increasingly protested the lack of progress in the smallpox program. But, the allocation for smallpox in

WHO's regular budget remained small; volumtary contributions for smallpox activities were few; and UNICEF, disturbed by the costly and failing malaria experience, refused to assign any funds to a new eradication effort.

Until 1966, the problem appeared to be insoluble. A substantial increase in WHO's regular budget was out of the question because of growing resistance of most industrialized countries, the principal contributor to WHO, to further increases in the budget. The Director General, for his part, was committed to malaria eradication and diverted whatever discretionary funds he could to deal with mounting difficulties in that program.

Under pressure to do more for smallpox eradication, WHO's Director General Marcelino Candau in 1966 took an ingenious tack — a two part budget proposal. The conventional budget was presented as part A; a special budget of $2.4 million specifically for smallpox eradication was offered as part B. It was basically a statement to the Assembly: "If you want a smallpox eradication program, you will have to vote a much larger overall budget." The overall increase, if both parts were accepted, would be 16%. As expected, almost every industrialized country vehemently protested the size of the increase; many others expressed doubts about the wisdom of the program. Given the previous unhappy experiences with preceding eradication efforts, there were understandable reservations about the credibility of its public health proponents. After a lengthy contentious debate, the budget was finally accepted by a margin of only two votes, the narrowest vote in the history of the World Health Assembly.

Smallpox eradication was thus launched — but barely — albeit with grave reservations about both the prospects for success and the wisdom of the investment. One cannot help but wonder what might have eventuated had two countries at the Assembly voted differently and terminated the smallpox eradication effort, for it was this program which provided both the foundation and courage for launch of the global program on immunization. And, from that effort, the polio eradication campaign, as well as the more recent Childrens Vaccine Initiative, arose.

The basic strategy of smallpox eradication was comparatively straight forward. First, it set as a goal the protection by immunization of 80% of the population through systematic vaccination campaigns. Second, it called for the development of national surveillance programs which would involve weekly reporting of all cases of smallpox, investigation of cases which occurred and their containment. Third, it stipulated that a research program be undertaken from the outset which would address a range of questions extending from the bench to the bush.

The immunization program exceeded all expectations in almost every country. Achievement of better than 90% coverage was common; resistance to vaccination was infrequent. Given reasonable organization, vaccinators could readily average more than 100 vaccinations each per day even in areas where travel was largely by horseback or on foot. A quality control program was stipulated. In simple terms, an assessment team of two persons would check a 5 to 10 percent sample of villages, some 7 to 10 days after mass

vaccination. This served as an important stimulus to do a better job — especially so if, when poor results were registered, the teams were obliged to repeat the effort, but without payment of per diem allowances. Not all countries agreed to the quality control component, arguing that it was a waste to assign personnel and transport simply for checking the work of others.

Surveillance proved to be, by far, the most critical element of the strategy but the most difficult to persuade countries to implement. The foundation of a surveillance system is a reporting network of health posts and hospitals which report new cases once each week and an epidemiological unit to investigate and contain outbreaks. By knowing where the cases were and in what groups, immunization activities could be redirected to maximum effect and progress in the campaign monitored. However, many government and international staff protested the diversion of staff from doing mass vaccination and insisted that complex reporting networks could never be established in developing countries. In fact, such networks were regularly able to be established within 12 to 18 months and the data greatly facilitated the work everywhere. Still, the concept was and remains a difficult and elusive one as witness the fact that global surveillance for other vaccine preventable diseases, even poliomyelitis, has yet to be implemented in many countries, now more than 20 years after the expanded program on immunization began.

Finally, it is important to say a word about research. From the beginning of the program, we had made a commitment to a wide-ranging research agenda — from

improvements in vaccine production and quality, to field epidemiology in order to better understand the natural disease, to elaborate ecological studies intended to confirm the absence of an animal reservoir of smallpox. The budgeted WHO funds for research were minuscule but sufficient to regularly convene a multidisciplinary scientific group. This group, on its own initiative, undertook to answer many questions defined in the course of the meetings. The impact of the research findings is best summarized by stating simply that virtually every premise of the program significantly changed from what it was at the outset — from our understanding of the epidemiology of the disease, to the way vaccine was produced and tested, to the techniques of vaccination to the actual implementation of the program in the field.

The smallpox eradication campaign, so tentatively launched in January 1967, exceeded all expectations. During a period of just over 10 years, programs were conducted in more than 50 countries with a population of more than 1000 million persons. Smallpox cases which numbered 10-15 million per year with 2 to 3 million deaths dropped to '0' in a period of only 10 years and 9 months. As many as 200,000 national staff and more than 700 international staff participated in the effort. Success can be attributed to many factors, an international organization which could unite such an effort as well as countless acts of dedication, sacrifice and imagination by all its participants. But the program fulfilled, as well, three important principles:

1. A clearly defined ultimate goal with ongoing measurements to evaluate progress. Smallpox eradication clearly meant '0' cases of smallpox; the surveillance program provided the needed data to measure success in reaching that objective.

2. Clearly defined procedural objectives with quantitative measurements for monitoring progress on a continuing basis. In brief, systematic immunization programs with specific time-targets and systems for quality control.

3. A broad-ranging research agenda, closely linked to the program, which continually asked the questions: "Could this program or any of its components be conducted better, faster, more efficiently or with greater certainty through use of other means, other tools, other approaches?"

The one international program which today closely follows the three principles is the program for Guinea Worm eradication, a program now making extraordinary progress; the program for poliomyelitis eradication in beginning to fulfill these requisites and is rapidly gaining momentum. Hopefully, there may soon be others.

References:

Fenner, F., Henderson, D.A., et al. (1988) Smallpox and Its Eradication, World Health Organization, Geneva. Chapters 9, 10 and 31 include the information presented in this paper.