

Public Attitudes Toward Vaccines
and our Experience With Smallpox

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Two hundred years ago, Edward Jenner wrote (SLIDE) "The annihilation of the Small Pox...must be the final result of this practise." And, of course, he proved to be right but it took 175 years.

The extraordinary delay in realizing his vision might seem surprising given the fact that from the beginning the vaccine itself was recognized to be highly protective; that there was widespread public interest in vaccination because of the severity of smallpox, and that news of the discovery, as well as strains of the virus were sent to countries on all continents within a matter of five years.

(SLIDE) Two challenges, however, had to be overcome before the vaccine was effectively utilized--two generic problems which even today are important challenges to obtaining full benefits from vaccination. First was the need to produce the vaccine in quantity and in a form suitable for widespread use. (SLIDE) At first, Jenner's vaccine had to be maintained by sequential vaccination of one person after another--arm to arm vaccination. If there were no susceptibles available or if the vaccine failed to produce a "take", it meant that a new source of cowpox had to be found. This was a problem given the fact that cowpox was native only to Europe and occurred only sporadically. Toward the end of the 19th century, it was discovered that cowpox could be grown in quantity on the scarified skin of a calf and thus, supplies of vaccine finally were assured. The vaccine, however, was very thermolabile--a problem especially in the tropics. Not until 1953 was a commercially practical method for freeze drying the vaccine perfected which rendered it stable for six months or more at 40 degrees Centigrade.

Indeed, until the freeze-dried vaccine became available, eradication was not a practicable objective. The moral is that the discovery of an effective vaccine is but a first

step. Working out methods for its production on a commercial scale and in a form in which it can be used widely may be as difficult and time-consuming as discovery of the vaccine itself.

The second challenge in vaccine utilization is being able to market and distribute the product so that high levels of coverage can be achieved. I was asked to look at public receptivity for vaccination and so I focus this morning on developments in the widespread application of vaccines and on the lessons learned to date in so doing.

(SLIDE) Except for smallpox vaccination, national commitments to nation-wide vaccination were limited in number until after World War II. At that time, smallpox vaccination efforts began to be strengthened and BCG campaigns were initiated first in Europe and, later, in some developing countries. In western Africa, yellow fever vaccine began to be applied in a number of French colonies. **(Diphtheria toxoid)**

In 1955, a new era in vaccination was inaugurated with the introduction of the first tissue cell culture vaccine--against polio, and other important vaccines based on this technology have followed.

The Salk vaccine was licensed in April 1955 amidst enthusiastic public acclaim and high levels of demand. For more than a year after licensure, the vaccine had to be rationed because of a shortage of supplies. However, interest soon waned. By 1957, with ample supplies available, the National Foundation found it necessary to mount special advertising programs in the United States to get the public to use the vaccine once so impatiently awaited. Efforts were made to mount special programs at schools and shopping malls but such efforts were resisted by medical societies who believed all vaccines must be administered in private offices or clinics. Indeed, on several occasions community-wide emergency vaccination campaigns were stopped when attempts were made to use school-based centers.

The licensure, in 1962, of oral polio vaccine offered the possibility of a quite different approach to vaccination. Sabin argued that the most effective method for application of the vaccine would be to administer it widely throughout the community in the shortest possible time. The theory was that if enough were vaccinated, circulating enteroviruses, including wild polio virus, would be totally displaced by the vaccine virus.

It was apparent that little professional expertise was required to put two drops of vaccine on a sugar cube and to place it in a child's mouth. The demand that vaccine had to be administered only in a physician's office was soon ignored. And so there was launched in many cities and states across North America a series of campaigns labelled "S.O.S." or "Sabin on Sunday". Various service organizations and volunteers of all types joined county medical societies and health department staff in dispensing oral polio vaccine at all manner of sites on a Sunday. With wide publicity and broad community support, the response was uniformly enthusiastic. The numbers of vaccine doses administered usually met or exceeded the total number in the target population. House to house surveys, even in the poorest socio-economic areas, showed coverage rates of 80% or more. It was apparent that if vaccination was actively promoted and provided at convenient locations and times, acceptance could be high. It was a lesson which has had to be relearned again and again.

Four years after oral polio vaccine was licensed, in 1966, the decision was made by the World Health Assembly to undertake global smallpox eradication. This was a landmark decision in the history of vaccine use because for the first time this effectively committed all countries to programs which required as part of the strategy, a systematic vaccination campaign extending throughout the population.

(SLIDE) We proposed that special teams be created to move systematically across the country, vaccinating individuals at so-called "collecting points" over a two to three-year period. Many in WHO and most of our public health colleagues were convinced that this was an approach doomed to fail. Many reasons were cited: among

these, that an uneducated population would reject a foreign procedure they could not understand and that there were large numbers of religious groups who refused all western medicines of any type.

However, data from well-conducted programs in Bolivia and West Africa demonstrated that well-organized large-scale programs had been able to reach 80% of their populations. Given the fact that other programs which depended on vaccination in clinics and hospitals never achieved better than 60% coverage, there was no alternative but mass campaigns.

The most effective approach, we discovered, was to utilize a two-person team to visit a week or so ahead of the vaccination team to meet with teachers, village and religious leaders to inform them of the nature of the program and to gain their cooperation. After vaccination had been carried out, assessment teams visited a five to ten percent sample of villages to assess coverage. Where 80% coverage was not achieved, the program was repeated.

Vaccination coverage bettered the most optimistic expectations--usually exceeding 90%. Vaccination teams which were scheduled to vaccinate between 50 and 150 persons per day per person soon exceeded 500 per day. To our surprise resistance to vaccination proved negligible except for a few small orthodox religious groups of little epidemiological significance.

Hospitals and clinics were, at least, reluctant participants. Illustrative was the experience at WHO's international demonstration site for primary health care, located in Iran. In 1971, epidemic smallpox broke out in Iran and this area, in particular, had been heavily affected. When I visited that region, I asked health center directors about their practise in administering vaccine--did they vaccinate everyone being seen at the center or only those without a vaccination scar? The consistent response was that they had so many sick persons to care for that they had no time to vaccinate.

By 1969, it was clear that the smallpox vaccination campaign was highly successful, being well-received everywhere and was popular with politicians. Indeed, program vehicles sometimes were obliged to carry posters with pictures of the head of state prominently displayed.

Given this success, it seemed logical to propose expanding the program's scope to incorporate other antigens. (SLIDE) In the 20 countries of western and central Africa, a program assisted by the United States, was successfully administering measles and smallpox vaccine in all countries. In some African countries, efforts had begun to combine the smallpox eradication and BCG vaccination programs.

At that time, DPT and polio vaccines, although universally used in the industrialized world, were all but unknown in the developing countries, and measles vaccine was known only to West Africa despite the fact that these vaccine-preventable diseases were all important problems. In 1970, we at WHO convened a meeting to develop recommendations as to which vaccines should be recommended for "An Expanded Program for Immunization" (EPI), i.e., an expanded program to include other antigens besides smallpox. It was recommended that BCG, DPT, measles and polio be basic to all programs and for areas at special risk other vaccines might be incorporated as well. In 1974, this program was endorsed by the World Health Assembly and gradually it gained momentum.

A significant challenge we faced both in the smallpox program and in EPI was vaccine availability. There had been so little money allotted by WHO for the smallpox program--specifically \$2.4 million per year--that we decided, as a matter of policy, that all smallpox vaccine would either have to be produced locally or donated. We couldn't afford to buy it. What we hadn't appreciated, however, was how little acceptable vaccine was being produced outside of the industrialized countries or how reluctant the industrialized world would be as donors. Production in the developing world seemed the

only answer. An expert group was convened to develop a detailed production manual and experts were sought to help producers in the third world. Help was immediately forthcoming from several laboratories--one of the most important being Connaught Laboratories. At Connaught, Bob Wilson (SLIDE) with Paul Fenje assumed overall consultative responsibility for smallpox vaccine production in Latin America, including vaccine quality control, on-site training in Toronto and frequent visits to laboratories throughout the Americas. With help such as this, it was possible within five years to assure fully acceptable, internationally certified smallpox vaccine for all countries, 80% of which was produced in the developing world.

The next major evolution in vaccine delivery systems occurred in the Americas in the 1980s, as Dr. de Quadros has described. The EPI program in the Americas had been unquestionably the world's most successful and, by 1985, had recorded such a dramatic decrease in polio incidence that a decision was taken to eradicate the disease. This relied heavily on the administration of polio vaccine being given throughout a country each year on "National Immunization Days" (NIDs). Characteristically, the NIDs were accompanied by extensive publicity; they drew extensively on voluntary community resources; and they provided for vaccination at many different sites throughout the country.

From their inception, the NIDs were an overwhelming success, customarily reaching 85-90% of the target population. (SLIDE-BRAZIL) As time progressed, other vaccines were included. Many argued that such events could not be sustained year after year. A Latin American physician pointed out, however, that Carnival is an annual event and that it has been remarkably sustainable. The NIDs in Brazil are now in their 16th year and continuing to reach 90% coverage of the target group. Now, other vaccines are given on NIDs and is being extended world-wide.

For the developing countries, the experience derived from the smallpox, polio and EPI campaigns seems clear--that when special programs are conducted which seek broad

community support and which provide for vaccination at convenient times and places, public acceptance of vaccination regularly exceeds 90%.

What of industrialized countries, such as the United States, Canada and the United Kingdom which abound in both the availability of health facilities and health care professionals? National Immunization Days such as conducted in the developing countries have not been attempted but notable successes have been registered by other means. Broad public acceptance of vaccination has been achieved and this success has related specifically to the level of priority given to immunization by health care providers.

This might seem obvious but it was not in 1991, when the National Vaccine Advisory Committee in the United States took up the question of why major measles epidemics were occurring. It was our *a priori* judgement that the lack of resources would almost certainly be established as the principal cause. However, as the Committee probed, it became increasingly apparent that the public was generally interested in having their children vaccinated. The problem lay primarily with health care providers, many of whom made little effort to keep vaccination records for children they were seeing or to remind parents when it was time for children to return for vaccination. Many interposed a variety of barriers to the process--clinic hours which were inconvenient to working parents, failing to vaccinate even when indicated at the time of a well-child visit, making demands that children have full physical exams before any vaccination was given, and many others. Even the HMOs with good record systems were scarcely reaching 70%. Thus, as elsewhere in the world, the challenge was primarily that of having staff who were motivated to provide vaccine as a priority service and providing vaccination at convenient times and places.

The United Kingdom provided the clearest indication that the principal variable was the motivation of health care providers. Immunization has never been compulsory in the United Kingdom and until the 1980s, immunization levels hovered around 60%. This was to be expected said a senior health official who asserted that British parents were

well-informed as to the benefits and disadvantages of vaccination and that this level of coverage simply reflected the considered judgement of a well-informed public.

During the 1980s, Britain introduced for use a computer registry in which the names of all newborns are entered into a national file which monitors progress in immunization, which sends notices to physicians and parents to remind when vaccination is due and which regularly compiles vaccination status reports of children by school, by district and by care-givers. (SLIDE) As the system became operative, a bonus was offered to physicians achieving 75% vaccination coverage of children for whom they were responsible and a larger bonus for those reaching 90%. (SLIDE) Within less than five years, overall immunization coverage in Britain exceeded 90% and today it surpasses 95% for most antigens. Somehow or other a very large number of British parents seem to have changed their views on vaccination.

Efforts have now begun in the United States to develop similar registry systems. Although progress to date has been slow, the concept of using computers to develop registries and to use these appropriately is gaining in popularity. My veterinarian now maintains a registry for my cat and regularly sends notices when vaccinations are needed; even my local car lubrication operator maintains a registry for my car and sends me a notice when it is time to bring it in. Given such progress, surely there is hope for medicine.

We've progressed over the past forty years from vaccine use in the tens of millions of doses annually to the use of hundreds of millions of doses to the use of billions of doses. A further log increase should be apparent with the decade. There is no question but that a public, properly approached, is basically receptive and given the negligible cost of vaccines compared to curative therapy, resources should not, in fact, be an obstacle. The question is one of getting priorities and strategies right within a medical system whose principal concern has historically been sickness care delivered patient by patient in an office setting.

**“The annihilation of the Small Pox...must
be the final result of this practise”**

E. Jenner 1801

EFFECTIVE VACCINE USE CHALLENGES IN PRODUCTION

1) QUANTITY

**2) CHARACTERISTICS SUITABLE FOR
WIDESPREAD DISTRIBUTION**

SMALLPOX VACCINE

CHANGES IN PRODUCTION

1796 Arm to arm inoculation

Late 1800s

Growth on scarified calf skin

1953
Commercial freeze-drying

POPULATION -WIDE VACCINATION

- o Pre World War II
- o 1945-1955
 - Smallpox
 - BCG
 - Yellow fever
- o 1955 Inactivated Poliovaccine (Salk)
- o 1962 Oral Poliovaccine (Sabin)
Sabin on Sunday (S.O.S.)
- o 1966 Smallpox Eradication *begun*

SMALLPOX VACCINATION STRATEGIES

- o Village by village mass vaccination**

 - +Collecting points**

 - + Advance team**

 - + Assessment team**

- o Productivity**

 - +500 + vaccinations per day**

 - +90%+ coverage**

 - +95%+ take rate**

THE “EXPANDED” PROGRAM ON IMMUNIZATION

Pre-1970

**Smallpox-measles vaccines
West Africa**

**Smallpox-BCG
Central and Southern Africa**

1970 Plan for an Expanded Program

**Smallpox, BCG, Measles
DPT, Polio**

1974 WHA adopts EPI

COMPLETED PRIMARY VACCINATIONS 24 Months

UNITED KINGDOM, 1996
U.S.A., 1995

	<u>U.K.</u>	<u>U.S.</u>
DPT 3	96	94
Polio 3	96	84
Hib 3	95	90
MMR	91	88

Source: MMWR 45:146,1966

1996 Immunization against Infectious Disease , London, HMSO