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Society of Hygiene

Today I will try to sketch for you from a personal vantage point, the saga of smallpox eradication as it developed over the past ~~11~~ years - to provide to you some sense of the dimensions of the problem, of why the programme was undertaken, a few of the difficulties we faced and, lastly, an indication of where we go from here.

A decisive point in time was May, 1966, when the World Health Assembly decided to undertake a coordinated intensified program to eradicate smallpox from the face of the earth in a 10-year period. The program was to commence on January 1, 1967 - the "hope" was expressed that the last case would be discovered and isolated by December 31, 1976. The rhetoric at that 1966 Assembly was optimistic and confident - privately. I believe it is fair to say that not more than a handful believed the project to be a practical objective even if theoretically possible. In fact, no disease had ever before been eradicated. Moreover, and realistically, one could foresee the practical difficulties in achieving a reasonable degree of cooperation among the 50 or so nations which would be required to undertake special programs. Not to be dealt with lightly were the technical and logistical difficulties of executing a program which would inevitably have to be conducted in some of the most inhospitable places on earth. Better control of smallpox was envisaged - but eradication was another dimension.

The 10 year time limit proposed was not grounded in an elaborate operations research process or, for that matter, in any other planning process. Quite simply, Kennedy, as you will recall, had said some years before "we will land a man on the moon in 10 years" - the delegates reasoned that if one could land a man on the moon in 10 years, surely one could eradicate smallpox on earth in 10 years.

The then Director-General of WHO, Dr. Marcelino Candau, a Brazilian, was then and remained staunchly opposed to the program, expressing absolute certainty that eradication in the Amazon basin, let alone anywhere else, was absolutely impossible. And being a Brazilian, the Amazon basin he knew well.

With WHO's only other eradication program - that for malaria - foundering seriously at that time, the Director General simply did not want another albatross about his neck. The Assembly's action, he felt, had been precipitated by the United States as it had (in concert with the USSR and a number of developing countries) and so he turned to the Surgeon General and said "You got the Organization into this, you provide the man to run the program." I was summoned to Washington from CDC, Atlanta, and told that I was to be that man and that in itself was the result of a strange series of events.

My work at CDC had been that of Chief of the Surveillance Section and, in the course of this, we had done a great deal of work in disease surveillance in vaccine evaluation and in delivery systems beginning with polio vaccine and extending to work with measles, influenza, DPT and others. In the early 1960's, I had created a smallpox unit to assess smallpox vaccine complication rates; to assess the jet injector as a possible tool for administering the vaccine; and to be prepared to cope with smallpox cases should they be imported into the USA. ~~This unit seemed to attract staff such as John Neff and so I, as a division chief, devoted most of my time to other problems. Such was our expertise.~~

USAID, in the early 60's, had promoted a series of catastrophically bad measles vaccination programs in Francophone Western Africa and in 1965 asked CDC to help. Not wanting to damage our AID international relationships, we countered with a vastly more extensive plan for smallpox eradication in a bloc of 18 west and central African states with a proposal that measles vaccination be offered simultaneously wherever it was desired politically. We expected that the plan would be rejected but our AID relationships would not be damaged. However, and to our astonishment, on November 23, 1965, in a White House decision, the plan was accepted and I was asked to organize and plan the effort. We were little more than six months on the way in recruitment, procurement of supplies, etc., when the Assembly made its fateful decision to undertake global eradication. Suddenly, as such things do happen, I was an authority in the smallpox field and with no practical experience was on my way to Geneva as the global director. I had seen precisely 12 cases

of smallpox in Argentina in 1957 and one in Canada in 1962. It was understood, however, that it would only be for perhaps 9 to 18 months. Half of our household goods were left in storage - including a new television set and washing machine - and so inauspiciously began an incredible 10 year adventure.

I recount all of this to dispel any notion that this - no less than so many other memorable enterprises - developed logically and coherently within the political-planning process. Such are the realities and such are the difficulties in comprehensive, logical health planning and development.

Why smallpox - why, among all the afflictions besetting mankind, select this disease? As McNeill has so well described in his recent book "Plagues and People" which relates history and disease, smallpox, throughout written history, has been preeminent as the most devastating disease known to mankind. The disease which more than any other has again and again altered the course of history. Diseases such as plague or cholera or yellow fever are, in fact, of minor consequence. Health officials feared this disease as no other.

- Last case in USA occurred in 1949 and yet through 1971, more than 15 million were vaccinated each year
- United Kingdom - 8 isolation hospitals
- International certificate of vaccination

Smallpox - as you know, caused by virus ^① - transmitted person to person - droplets from nose and mouth. Inhaled - after 10 to 12 days, high fever - 2-4 days rash over face.

② ③ ④

SLIDES

These are cases of variola major, the Asian form of smallpox, which throughout the world caused death in 20 to 30% of those afflicted.

There is no treatment. Importations into Europe were no less serious. Blindness was a common complication.

But smallpox has certain special characteristics which facilitate eradication:

- Man - only reservoir;
- To persist, must pass person-to-person, each with rash, in continuing chain of infection; smallpox leaves its footprints wherever it has been.
- Presence detectable any area - even illiterate populations (M.D. vs. granny);
- Spreads by close contact - focus of teams;
- Infected individual transmits for only 3 to 4 weeks - rash and scabs off;
- Dies out in more remote areas;
- Good vaccine.

When I say the program started in 1967, I am slightly misstating the situation. Eight years before this, the World Health Assembly had decided that an eradication program should be undertaken on an entirely voluntary basis - voluntary in the sense that it would be entirely financed by voluntary donations and each endemic country was asked to do its best.

- \$100,000/ year contributions
- Strategy - "mass vaccination" to create hard immunity - when India 80% "vaccinated" and smallpox still persisted Expert Committee said "100% vaccination"

In truth and underlying the events of this period was the fact that few believed eradication was possible. However, in the 1966 resolution, a budget of \$2.5 million was voted as a last gesture to the effort before it was abandoned. \$2.5 million for programs in 50 countries - ~~a sum which would not begin to meet the payroll at this School of Hygiene.~~

So began our program on 1 January 1967 - the objective, that the last case occur by 31 December 1976.

When the programme began, we immediately faced two problems -

1. Provision of suitable vaccine and vaccination devices - the guns and bullets of the campaign, if you will.
2. The selection of a suitable strategy - mass vaccination was not the answer but what was?

Vaccine Supply -

⑤

Vaccine obtained from diverse sources - two testing laboratories - results appalling.

Virtually no vaccine met accepted standards - some with no virus.

250 million doses required each year - at 1¢/dose - our total budget.

No choice but to develop production in the endemic areas and to ask for contributions

Manual - consultants - Vaccine testing

Contributors - mainly USSR (140×10^6) USA (40×10^6) and 20 other countries.

1970 - all vaccine met standards. 1973 - 80% produced in developing countries.

Vaccination Technique

⑥

Since Jenner's time - some sort of scratch technique.

⑦ - Jet injector

⑧ - Bifurcated needle - the ultimate solution

Wyeth Labs. - multipressure - exp. with multipuncture vaccination.

Dip and apply - higher percentage of takes.

With one vial of vaccine we were able to vaccinate up to 100 instead of 25.

Teaching time.

Needles redesigned to be made of harder steel - reused 100's of times.

⑨ - *Vontaines*

- Further problems - alcohol and cotton sponge. Savings - petrol costs.

⑩ - Vaccinator equipment.

Thus the solution of vaccine and vaccination technique - what should be the strategy?

Previously - progress measured in terms of millions of vaccinations performed.

Vaccination programme was important. But objective was "0" cases of smallpox. This, a two-prong strategy developed:

1. Vaccination. In most countries, vaccination immunity was low - systematic campaigns to vaccinate 80%. Different in different countries - ill. Afghanistan.

1. Villages mapped - advance man - find unmapped villages.

2. Vaccination team - house by house.

3. Assessment team - 10% sample - if less than 80%, no per diem was given. A picture of an Afghan vaccination team in action might be of interest.

Surveillance - how was it developed?

Reporting was essential to know where the cases were so that outbreaks could be contained. In 1967, reporting was a shambles. Some countries reported to WHO not at all; some sporadically; some suppressed reports.

Problems at local - district - state level. 131,000 cases officially reported - within countries less than 1% of cases were reported - more likely 10 to 15 million cases.

Best solution - we felt - mobile team of 2 to 4 people for each 2 to 5 million population. Traveled to each hospital and health center to get them to send report each week. Investigated and contained outbreaks reported.

Fact that any higher health staff visited health center was a unique event. That anyone took action on a report sent was viewed everywhere as something of a miracle.

1967+

⑪ Since 1967, progress in the program has been gratifying. In 1967, 33 countries were considered to be endemic and 11 others experienced

importations; by 1970, the number which were endemic had decreased to 17 and by 1973, to six. However, these six included India, Pakistan, Bangladesh and Nepal with a total population of nearly 700 million persons. Traditional vaccination programmes had been in progress for fully 10 years. Reporting was poor; the containment of outbreaks was ignored; and throughout the sub-continent, there was profound pessimism.

In the summer of 1973, a plan was developed in India to utilize for one week each month all health workers in a village-by-village, later house-by-house search for cases. Once discovered, containment teams (called fire-fighting units) would move in to stop the outbreaks. As with the vaccination programme, special assessment teams visited a sample of the villages to determine whether, in fact, the search had been properly performed. To facilitate the discovery of cases, a reward was offered to anyone who reported a case. The number of reported cases skyrocketed. In the State of Uttar Pradesh which in October 1973 had been reporting only 100 to 300 cases weekly, some 7,000 cases were discovered during the first search. But once discovered, they could be contained. The system steadily improved and was extended to Pakistan and Bangladesh.

To appreciate the magnitude of the undertaking - in India alone some 110,000 health staff participated in national searches of approximately 120 million households. Some eight tons of forms were required. Assessment was done at three levels by three separate groups - District, State and National - the separate assessments serving to cross-check each other. Recent assessment shows that in every State of India, more than 80 percent know of the reward and know where to report a case. The figures for Bangladesh are comparable.

October 1974 - the last known case of smallpox occurred in Pakistan
April 1975 - Nepal
May 1975 - India

16

The last known case of smallpox in Asia - the last known case of variola major occurred in a 3 year old girl Rahima Banu on Bhola Island, Bangladesh. The date - 16 October 1975 - almost 2 years ago.

Final Phases

17

The last battle ground proved to be Ethiopia where variola minor was prevalent. Death rates were only 1% - the program started later there than in any other country - 1971 - three years later than any other endemic country. Despite coups; kidnappings; the loss of 6 helicopters due to hand grenades, fire and crash; revolutions; and some of the most difficult inaccessible country on the face of the earth, good progress was made. To illustrate, one has to appreciate the road system.

18 19 1976

The last case occurred in August ~~last year~~. Seven weeks of active search employing over 500 Ethiopian searchers and WHO staff failed to disclose further cases. However, after 7 weeks - in late 20 September - a Soviet physician discovered 2 cases in Mogadishu, the capital of Somalia - the outbreak had resulted from cases imported in late May or early June but suppressed by government officials. Smallpox transmission in Somalia had been interrupted in 1963 but a WHO-sponsored program had been inaugurated in 1968 because of Somalia's long common border with Ethiopia. The objective was to strengthen surveillance and to conduct systematic vaccination. Almost 700,000 of 3 million persons were being vaccinated annually. Surveys consistently show vaccine immunity levels of 80% or higher throughout the country. Importations had been rapidly identified and contained.

Somali government cooperation, however, gradually deteriorated as it became more revolutionary. ~~By last summer, it could better be defined as non-cooperation.~~ Not until mid-January 1977 ~~this year~~ was transmission stopped in Mogadishu. Again we thought that perhaps we had detected the last case. In mid-March, a cooperative plan of

intensive search was decided upon by Somalia, Kenya and Ethiopia. The Somalis, obviously stimulated and humiliated by their neighbors, decided at last on full cooperation. In late March, more cases were found in the Somali desert. Somali health officials we now know had concealed 3, possibly 4 foci which were known to exist in the desert areas. Unfortunately, however, in January and March, the movement of nomads is explosive as they search for fast dwindling forage. The disease spread rapidly - in all some 800 cases have occurred. However, on 1 April, heavy rains began, the nomads stopped moving - 20 experienced WHO staff from previous campaigns were assigned and ~~now~~ almost 1000 workers ^{Cinland} are ~~combing~~ the desert. ^{On October 26, 1977 (2-1)} This month, I expect the last case ~~to be~~ found and isolated. The 10 year target unfortunately missed - by ¹² 6 months.

To confirm that eradication has been achieved, two full years of intensive search must be conducted to be certain that no transmission is occurring. Only then can an international commission be convened to determine through field visits that they are satisfied. So far, Commissions have certified eradication in South America, 15 countries of western Africa and by the end of the year - all of the Asian subcontinent and Indonesia. Hopefully, the last areas will be able to be certified in May 1979.

Meanwhile, extensive research studies have been conducted to determine if we would find naturally-occurring transmission elsewhere in nature. None has been found. The fact that during the past 10 years, every focus of smallpox in non-endemic areas has been able to be traced to known endemic regions is the most persuasive evidence that indeed none does exist.

This will then leave variola virus confined to research laboratories. During the past ~~two~~ years, WHO has undertaken a special program to identify and register all of these laboratories. All governments have been queried; all laboratories registered as being able to carry out variola virus isolating have been contacted as well as all laboratories which since 1950 have reported in the literature that they have done

research with variola virus. ^{Today} ~~So far, 18~~ laboratories are registered as retaining stocks of variola virus; more than 60 have destroyed their stocks. By the end of the year, it is anticipated that no more than 10 laboratories will retain this virus under high security precautions.

What has this all cost? We have endeavored to tabulate all international assistance of every form. Through 1979, when we believe that final certification of eradication will take place, ^{about \$1.2} ~~some~~ \$96 million will have been spent - approximately \$8 million per year. The developing countries themselves will have spent perhaps twice this amount but few will have spent much more than what they were spending in smallpox control programmes. It is a small sum when contrasted to the \$150 million expended each year in the United States alone to prevent smallpox importations and substantially less than the annual budget of this University.

Is this then the end or the beginning?

Many of the same individuals who were scathing of the program only 10 years ago now insist that it was a sort of fluke, an aberration in the health system - that no disease can be dealt with in the same manner, that such prodigious sums of money cannot be mobilized for other health problems, and so on. In brief, a plea to return to business as usual.

But can it ever be the same again?

- In many of the developing countries - where Health Ministers have traditionally been held in low esteem - there is a perceptible new sense of confidence in their own ability to do a job and a respect within their government that given even modest support, a well-conceived plan, an involvement of the community, and an element of management that the impossible is well within reach.

- More than 700 international staff from 52 countries served WHO in this campaign - and, in the process, acquired expertise, a point of view and a sense of the possible. Most were under

40, far younger than the average WHO consultant. Many were not physicians. Several are now already serving in directorate general positions in their own governments; one is Assistant Director General of WHO; one is heading WHO's new immunization program; and Bill Foege, whom many of you know, is the new Director of CDC in Atlanta.

And, perhaps, even within the developed world, there is an increased perception that in this one world, better health per se is important and important to all countries.

It is my hope, and I know the hope of the thousands with whom I have worked in this program that we have helped to do more than eradicate smallpox - that this achievement, unique though it may be, represents but a very small beginning in a very much greater and more complex effort.