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ABSTRACT

CAN VIRAL INFECTIONS BE ERADICATED?

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The success of the smallpox eradication campaign has regenerated widespread interest in the once discredited concept of disease eradication. Many candidate diseases have been proposed for eradication of which poliomyelitis and measles are the leading contenders. Responses of health officials to these proposals have ranged from antipathy to enthusiastic endorsement. Those expressing antipathy believe, in principle, that eradication campaigns will compromise and distort delivery systems for other health services. Enthusiasts argue that even if eradication goals are unrealistic and fail, much progress will be made in the overall development of health services. Regrettably, arguments on both sides are more often grounded in ideology than in reason.

The practical difficulties in eradicating a disease must not be underestimated. For many reason, smallpox was, by far, the simplest of the potentially eradicable diseases. Surveillance was comparatively simple because of the characteristic smallpox rash; subclinical infections were unimportant epidemiologically; the disease spread slowly; and a heat stable vaccine provided durable immunity to almost all who were vaccinated even once. Nevertheless, the goal was scarcely attained. Significant problems

included deficiencies in national leadership, unstable governments, civil war, problems in obtaining contributions to the program and a general propensity both by donors and national contributors to conclude or modify health programs every four or five years.

A second eradication campaign, one for poliomyelitis, has now been in progress in the Americas since 1985 with apparent success at hand. What has been learned? First, smallpox and polio have sufficiently different characteristics that very different tactics are required and to this end, both field and bench research have been requisite. Continuing evolutionary changes in the nature of the program have been necessary. Second, the campaign has attracted resources which would not otherwise have become available. It has served to augment the delivery of other vaccines and services as well as providing the beginning of a national surveillance structure. Third, the challenges to the achievement of global polio control, let alone eradication, are now seen more clearly. They point to the urgent need for a wide-ranging, coherent program of research addressing problems of the vaccine, of diagnostic reagents, of the epidemiology of the disease and of operational methodology. However, until recently, interest in all of these issues has been negligible.

The polio eradication program, like that for smallpox, has been extremely helpful in dramatizing the fact, once again, that the goal of a health program is more than attaining, for example, mere levels of vaccine coverage. Its aim is to reduce the burden of disease. This requires measurements of disease and health and,

to date, health services are ill-equipped either to do so or to use intelligently the data they obtain. Secondly, it points up the need for better, more practical methods for disease prevention.

Polio may indeed be successfully eradicated and possibly other diseases as well but little progress can or will be made without substantially more practical research efforts to better understand the diseases and methods for dealing with them. Given the level of present efforts, there is limited cause for optimism.

CAN VIRAL INFECTIONS BE ERADICATED?

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Just a decade ago, the World Health Assembly, in a specially convened plenary session, declared that smallpox had been eradicated. It recommended that all countries throughout the world stop their vaccination programs -- and within two years, essentially all had done so. Our oldest vaccine, one which had been in use for nearly 200 years, was relegated to history.

For myself and others whose specialty and life had been smallpox, the detection and containment of that last case marked an abrupt ending to a major phase of our professional careers. Few of you can imagine the emotions associated with the Assembly's declaration. For years, we had been at the forefront of public health in coping with a major problem - international experts in smallpox, at the center of excitement in achieving what many once believed impossible. Suddenly, the disease vanished. It was akin perhaps to the armistice at the end of the World War - immensely gratifying but suddenly rendering obsolete one's professional credentials. I've wondered how many old generals became deans for want of better employment!

It is difficult today to imagine how few, only 25 years ago, believed that the eradication of smallpox or any other human disease was a feasible or practicable objective. Skepticism and disbelief in the concept itself were widespread and these included

Both politicians and knowledgeable scientists. One of the most widely read and influential of the scientists in the 1950's and 1960's was Rene' Dubos - the Lewis Thomas of that era. In 1965, he published his very readable book, Man Adapting.[1] This appeared just as the World Health Assembly was deciding to embark on its 10-year Smallpox Eradication campaign to set the stage. I quote from his chapter dealing with eradication:

"At first sight, the decision to eradicate certain microbial diseases appears to constitute but one more step forward in the development of the control policies initiated by the great sanitarians of the 19th century.... In reality, however, eradication involves a new biological philosophy. It implies the [complete elimination] of etiological agents, once and for all...

"In all cases, the problems posed by biological and epidemiological peculiarities of each type of infection are still further complicated by financial, administrative and political uncertainties. Even if genuine eradication of a pathogen or vector on a worldwide scale were theoretically and practically possible, the enormous effort required for reaching the goal would probably make the attempt unwise....

"Social considerations, in fact, make it 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. Certain unpleasant but universal human traits will put impassable stumbling blocks on the road to eradication. For example, it is easy to write laws for

compulsory vaccination against smallpox, but in most parts of the world, people would much rather buy the vaccination certificate than take the vaccine....

"Public health administrators, like social planners, have to compromise with the limitations of human nature. For this reason, and many others, eradication programs will eventually become a curiosity item on library shelves, just as have all social utopias."

Dubos had cause to write as he did. The global malaria eradication campaign was then in its tenth year. Enormous sums of money had been allocated but progress in Asia and Latin America was far behind schedule and with no prospects for success. Costs were far greater than had been anticipated.

In 1959, WHO had also reluctantly launched a smallpox eradication effort,[2] but seven years later, there was little progress to report.[3] Senior staff at WHO openly opposed the program, in part because of the belief that the eradication of smallpox could only be achieved through universal vaccination. They knew this was impossible as indeed there were and are isolated peoples who seldom, if ever, come into contact with health staff. In 1965, WHO spent $63 million for malaria eradication and $200,000 for smallpox.

Belief in the concept of eradication was at a low ebb in 1966 when it was proposed that smallpox eradication be given one last chance through provision of additional funds.

In planning, WHO foresaw a need for international support

amounting to $7 million annually.[4] Voluntary contributions were expected to cover most of this. How much should be provided for in the WHO budget was heatedly debated but eventually $2.4 million was decided upon - overall, about $50,000 for each country where a program was required. Many countries were not enthusiastic and the lack of international support, thereafter, bore this out.

During the first seven years of the intensified program, the combined contributions of all countries and agencies amounted to less than $1,000,000 per year.[5] Indeed, throughout its course, smallpox eradication was a precariously funded, uphill battle whose achievement was anything but certain less than a year before the last case occurred.

It is important that we understand why there was such skepticism and so little support, for it has a bearing on the lessons which the campaign offers for future health initiatives, including eradication of other diseases. The reasons, as I will describe, rest primarily in the past history of eradication programs which most now have forgotten, programs which embraced strategies which dominated our entire international health agenda until little more than a decade ago.

As I shall describe, such programs were grounded more in emotion than practical considerations; and in principle they rejected the need both for ongoing research and effective surveillance of disease occurrence.

The first planned programs of eradication were conducted by our veterinary colleagues beginning in the late 1800's. They all

dealt, however, with recently imported vectors or organisms which were geographically localized and had not become enzootic. Most involved slaughter of animal herds found to be infected -- not a technique of much value in dealing with human disease, I'm afraid.

From their experiences, the belief grew that there might be a number of microorganisms or vectors which clung so tenuously to an ecological niche that simple measures could be found to upset the balance of nature. By the turn of the century, planned programs for disease eradication were a familiar concept to many in veterinary medicine but they were unknown in human medicine.

Surprisingly, the first human disease to be considered for eradication was hookworm - in 1907. This was soon followed by one for yellow fever. From what we now know of their biology, neither was a reasonable candidate. When the programs began, however, a visionary belief coupled with excessive optimism, albeit inadequate scientific knowledge, caused them to be selected. The magnitude of the effort was extraordinary even by contemporary standards and the patterns of program operation, especially for yellow fever, largely defined public health priorities for the next 50 years. Both were the products of the Rockefeller Foundation.

With Foundation support, eradication campaigns began throughout the southern United States in 1909. Why hookworm? In its more severe forms, it caused anemia and lassitude and, this, it was thought, was the underlying cause for what was perceived to be a less vigorous and productive population. Some, in fact, called hookworm infection the disease of laziness. In the belief that the

eradication of hookworm would effect a fundamental economic transformation of a region, an eradication program was launched. The strategy called for mobile teams to identify infected persons by stool examination and to treat them. At the same time, other teams worked to construct sanitary privies. It was anticipated that this would interrupt the cycle of transmission between infection in man and persistence of the worm in the soil. During the first five years of the program, $1.0 million was expended, a very large sum in those days. Over succeeding years, cooperative programs were extended to 52 countries on 6 continents and to 29 island groups. It was an unprecedented global effort.

The program strategy had been based on faith, without confirmation by a pilot project that the measures employed actually would be effective in practice. Progress was measured in terms of numbers of treatments and numbers of privies constructed. Neither surveillance for infections nor research were deemed important. Not until more than ten years had passed were studies conducted anywhere to determine whether transmission <u>was</u> actually being interrupted. When they were finally conducted, they showed that infection rates were <u>not</u> diminished, although those infected had fewer worms, on average, and fewer symptoms.[6] Clearly, eradication was out of the question and soon thereafter, the program began to be phased out.

In 1915, the Rockefeller Foundation embarked on yet a second global eradication program - against yellow fever. Here, the scientific foundation was better laid although understanding of the

epidemiology of the disease was still deficient, as later became apparent. Prospects for yellow fever eradication originated in the dramatic interruption of yellow fever transmission in Cuba in 1901. Only the year before, Walter Reed demonstrated conclusively that the disease was caused by a virus and transmitted by the Aedes aegypti mosquito after an extrinsic incubation period of 9-16 days.[7] The mosquito was shown to breed almost exclusively in and around houses. Immediately William Gorgas began a massive control program.[8] Patients were isolated in screened quarters; breeding sites were eliminated by the removal of bottles and cans and kerosene was applied to water surfaces. The program was a military-style operation in which teams of three inspectors were each assigned responsibility for 1,000 homes to be inspected at the rate of 30 houses per day. Only eight months later, Havana and indeed Cuba became free of yellow fever for the first time in memory. Gorgas wrote, "I look forward to a time when yellow fever will have entirely disappeared .... I believe that when the yellow fever parasite has become extinct, it can no more return than the dodo."[9]

Gorgas concluded that yellow fever transmission could be sustained only in population centers of 50,000 or more and that by intensive, short-term campaigns to reduce, not eliminate Aedes aegypti populations, yellow fever could be eradicated.[10]

In 1915, the Rockefeller Foundation announced its intention to provide assistance wherever infection with yellow fever was endemic with the objective of global eradication.

Eradication in the Americas was foreseen within five years; a timetable for Africa awaited further study. The campaign began in 1918 with Gorgas himself as its Director.

Using the same meticulously planned, quasi-military approach as had been used in Cuba, rapid progress was made - at least as measured by known outbreaks of yellow fever in urban areas. By the late 1920's, almost a year elapsed during which no cases were known to occur in the Americas. In March 1928, however, the first cases of yellow fever in 20 years occurred in Rio de Janeiro and epidemics swept across the country. Doubts about the feasibility of yellow fever eradication began to be expressed and, with a failing anti-hookworm campaign, the Rockefeller Foundation came under severe criticism for its support of disease eradication programs.[11]

What had gone wrong? The Foundation turned to one of its promising young staff members, Fred Soper. He was subsequently to prove to be one of public health's most skillful administrators and an effective and articulate advocate of disease eradication as public policy. Through his efforts, he dictated an international public health agenda which extended over the next 30 years.

Soper diagnosed the problem as being primarily one of failures in administration. Accordingly, Brazil's program was radically restructured. All personnel in the country working on yellow fever were brought under a single National Service which Soper himself directed. Extensive, detailed manuals were prepared and rigid discipline was imposed to insure that all premises in urban areas

were meticulously searched and vector control measures applied.

In 1930, fully 12 years after the eradication program began, efforts were finally made to establish a disease surveillance program. It quickly became apparent that there were a number of rural jungle areas in which yellow fever was endemic and that this was not a new phenomenon.[13]

Eradication was, therefore, impossible. The failure to establish a surveillance system to detect cases and thereby to measure progress is wholly inexplicable - especially in view of the same deficit having been a serious omission in the hookworm campaign. But this is a deficit which has, up to the present, continued to characterize most of our efforts to control human disease.

Meanwhile, Soper's highly disciplined, all but autonomous Army was recording extraordinary successes. In some areas, they not only reduced Aedes aegypti breeding to low levels, they succeeded in eliminating the vector itself. Soper proposed a bold new initiative, the eradication of the mosquito species itself - yet one more eradication initiative undertaken with limited deliberation and limited thought as to the practicality of so doing.[14] The Brazilian government did not immediately agree and the Rockefeller Foundation objected although it continued to provide reluctant support. Soper pressed on.

A few years later, the African mosquito malaria vector Anopheles Gambiae was found in Brazil - a newly imported infestation. Soper's vector control army snuffed it out.[15] These

were notable achievements from which Soper drew a number of far-reaching conclusions.[16] Most important was his belief that the eradication of selected vector species was entirely feasible, as was the eradication of certain infectious disease agents. Success, as he saw it, lay in vigorous and effective action rather than refined measurement of the problem. For example, he had no malariologists on his staff and saw no need for them. The major constraints on disease eradication, as he saw it, lay primarily in the lack of vision of health administrators rather than in the lack of appropriate technology. With a meticulously executed field program, directed by dedicated staff, the inconceivable could become possible.

Following the war, Soper, still the enthusiastic eradicationist, became director of what is now called the Pan American Health Organization (PAHO), and the stage was set for the next great adventure in eradication - a program to eliminate malaria.

DDT had become available in the 1940's and proved dramatically effective in stopping malaria transmission - at least at first. PAHO, with Soper's leadership, began a regional malaria eradication campaign. Substantial bilateral resources were made available but far from enough. Greater support was needed and the opportunity was presented to obtain that support when early evidence of DDT resistant mosquitos was uncovered.

Soper and the eradicationists argued for a massive international effort to be undertaken as an emergency measure to

eradicate malaria before the problem of resistance became widespread.[17] This visionary goal was doubted by a number of scientists[18] [19] but uncritically welcomed by politicians and international agencies. They supported it as no other international health program before or since. Over a decade, 1955-1965, WHO malaria staff posts increased to more than 600. One estimate indicates that $1.4 billion was expended during a 10-year period.[20]

The organization and strategy of the program echoed that of the great Aedes aegypti programs of the 1920's and 1930's. A separate and autonomous malaria eradication service, entirely independent of the health authority, was called for, which would have no other duties than those concerned with malaria.[21] Higher pay scales than those in the health service were provided in order to attract the best staff. The numbers involved were enormous. In some countries they outnumbered the total of all health personnel. This was the case, for example, in Ethiopia as recently as 1975. Not surprisingly, the health staff resented the program.

Highly detailed, standardized manuals of procedures were developed which described in minute particulars the duties of every person on the staff. The strategy focused on the application of DDT to the walls of dwellings. Traditional methods of mosquito control were largely abandoned - as was research. The problem was perceived in Soper's terms to be primarily one of meticulous administration and application of known measures.

Through the early 1960's, reasonable progress could be

documented. By 1966, however, it had become apparent that the program was lagging seriously and that the very costly measures of the so-called "attack phase" would have to be extended over many additional years.[22] By 1973, seven years later, the demise of the malaria eradication program had been officially acknowledged. Jeffrey, one of its senior statesmen, ruefully pointed out that "The science of malaria control, developed slowly and painfully from the beginning of the century to a relatively high level of sophistication, was almost overnight converted to the rather simplistic technology of malaria eradication."[23]

Of what relevance is this now ancient history to today's challenges for disease eradication or to smallpox eradication itself? These events, in fact, have a great deal to do with both of the above.

Bear in mind that during a 50-year period in the Americas, the dominant international programs were those for vector control to combat yellow fever and malaria. In most of Asia as well as in WHO, malaria programs dominated health agendas and budgets for well over two decades - throughout the formative years of their public health programs. They operated outside of the health service structure; their demands on funds, both international and national, were insatiable; and they were deeply resented. Those engaged were well-meaning and preoccupied with what was truly a major health problem but, in consequence, other community-based health programs received little attention. National immunization programs were all but non-existent, sanitation schemes received little attention and

the development of basic preventive services was postponed until "the malaria eradication program could be integrated into the basic health services."

Given this background, it is not surprising that the collapse of malaria eradication had profound repercussions. The credibility of public health expertise was called into question. Illustrative of attitudes in the late 1960's was that of UNICEF, once a major supporter of malaria eradication which withdrew its support and refused to contribute to smallpox eradication.[24] Most bilateral agencies responded similarly. The antipathy was so great that many health services rejected, out of hand, all other categorical programs, however structured. Family planning and smallpox eradication were both recipients of this backlash as were later immunization programs and those for oral rehydration therapy. Categorical programs of whatever stripe were suspect and so, until recently, we labored in the gray twilight of policies designed to promote integrated primary health programs, few of which had any stated goals. Meaningless interminable debates raged on all sides about 'vertical' and 'horizontal' programs.

The success of the smallpox eradication program served to provide an effective counterbalance to the more extreme and reactionary views. It provided a constructive impetus to many countries to again undertake targeted community-wide prevention initiatives.

Operating within and as part of the health services structure, smallpox eradication represented an important shift in strategy -

instead of autonomous armies of vector-control technicians meticulously following manuals it relied on flexible, area-specific community-based prevention strategies now being echoed in the expanded program of immunization, of oral rehydration therapy, of Vitamin A supplementation and others.

The foundation of the smallpox strategy was built on a specific goal - zero cases of smallpox. It was an outcome objective which required surveillance. In undertaking surveillance much was learned about the epidemiology of the disease and how and where programs worked and how and where they didn't. It demonstrated that a national surveillance system could be established even in the least developed countries.

Notably, the program bore little resemblance to the many mindless programs which, even today, only count the numbers vaccinated or procedures performed, which estimate coverage rates and recipients of services but <u>wholly ignore</u> whether or not disease incidence is actually diminishing.

Success in smallpox eradication served to restore a measure of credibility to public health and demonstrated that a program with defined objectives could attract substantially greater and needed resources for health programs as a whole. Wisely used, such funds demonstrably could serve to strengthen the fabric of a national health service. Not surprisingly, there is now a reawakened interest in disease eradication[25] [26] [27] - other efforts which could galvanize attention and mobilize funds and efforts.

Given the past history, however, I'm sure you can appreciate

my own conservatism and concern that any new eradication effort be soundly based - with reasonable prospects for success and that it incorporate both surveillance and research.

Can other viral infections be eradicated? To my colleagues, I have proved to be depressingly cautious. But then I lived the saga of smallpox eradication and know only too well how difficult it was and by what a narrow margin success was obtained. At one time, in fact, I proposed that we eradicate the word 'eradicate' and get on with the business of disease control.

Candidate virus diseases for eradication are those for which there is no animal reservoir, for which we have an effective vaccine and which represent significant public health problems. Such diseases as rabies, yellow fever, influenza, the hemorrhagic fever and the viral encephalitides all have significant animal reservoirs. Many other viral diseases, such as mumps and rubella, for which vaccines are available, are not now problems of significant global importance. Probably the only two viable candidates, as I see it, are measles and poliomyelitis.

Measles certainly fulfills the criteria of significance and absence of animal reservoir - and there is an effective vaccine available. As experience as shown, however, it is readily transmitted by aerosol so that a single infectious person can transmit infection to dozens of others even on brief exposure. Not surprisingly, most children in crowded third world settings have acquired infection by two to three years of age. Even in less crowded, more prosperous settings, it has so far proved impossible

to interrupt transmission. In 1978 the United States embarked on such a goal with the aim of stopping transmission by 1982. Surveillance programs were strengthened and containment vaccination was undertaken whenever a case was detected. It quickly became apparent, however, that the disease moved more rapidly then did the epidemiologists, and when Anderson and May subjected the data to mathematical modelling, they concluded that 95% of susceptibles would have to be protected if success were to be achieved. Given the fact that the vaccine itself is not better than 95% efficacious, this implies the need for vaccination of <u>all</u> susceptibles, a patently impossible task. A more effective vaccine which could be administered at or soon after birth <u>might</u> serve to altar the strategic balance, but I am not optimistic.

The second candidate, poliomyelitis, originally did not appear to me to be any more attractive. True, it is a disease of significance; there is no animal reservoir; and a vaccine is available. However, repeated studies in third world countries reveal vaccine efficacy ratios of only 60 to 80% after three doses compared to efficacy ratios of more than 95% in such as Finland and other temperate climates. In part, this can be explained by interfering enteroviruses, and perhaps nutritional problems and perhaps other factors. A second problem is the vaccine's high thermolability, which requires that it be refrigerated almost to the moment of administration.

My conservatism was shaken by events in Brazil where national vaccination days were being organized twice each year with the

objective of vaccinating all children under five years of age. Polio incidence plummeted and remained at low levels [**SLIDE 1**]. Reporting was acknowledged to be deficient but it was clear that the reporting system which previously had reported hundreds of cases per week was now reporting very few. Most of the cases during the 1970's had been reported from tropical areas of the Northeast, areas where repeated studies had shown that even after three doses of vaccine, seroconversion rates seldom exceeded 60 to 80%. The National Vaccination Days were clearly having a surprising impact even in the tropical Northeast. Similar experiences were documented in other Latin countries. An eradication program throughout the Western Hemisphere with a target date of December 1990 was recommended and subsequently approved by the Directing Council of PAHO.

The program embraced two new components which inexplicably had been lacking in the decade-old global immunization program - surveillance and research. A reporting network was created calling for weekly reports from all hospitals, rehabilitation centers and clinics apt to see cases of paralysis. Today, there are more than 7,000 reporting sites. Each center was to report all cases of acute onset flaccid paralysis among children less than 15 years of age. Trained surveillance officers were expected to visit each case within 48 hours and if a specific diagnosis other than poliomyelitis could not be made, it was labeled as 'possible poliomyelitis' and specimens were obtained. Reporting of 'acute flaccid paralysis' rather than polio was decided upon, recognizing

that in the past, some pediatricians, confronted with flaccid paralysis in a vaccinated child diagnosed the illness as Guillaine-Barre disease even though this was reputed to be extremely rare in children.

The surveillance system quickly divulged two important findings. The first was that most cases were type III polio, customarily much less common than type I polio, and that many patients had been vaccinated. Studies of serological responses to the OPV formulation showed a satisfactory serological response among less than 40% but, if the type III titer were doubled a response was obtained which was comparable to monovalent type III vaccine. The vaccine formulation for the Americas was promptly changed and type III cases quickly dropped. The second discovery was that cases of acute flaccid paralysis, even in areas where no polio virus could be found, were far more common than we had believed. Rates of one to two cases per 100,000 children were usual. Most cases appeared to be Guillaine-Barre disease, but to be more certain of the diagnoses, qualified neurologists had to be incorporated into the surveillance teams. And such is now the practice in all countries.

A laboratory network was established, now embracing ten laboratories. This was done through careful selection of the best of the Latin American laboratories already employing tissue cultures. A common manual was developed, training courses were held and all were provided with common equipment and reagents. Their task was maximally simplified to the extent that the

laboratories were expected only to identify and type polio viruses. Other pathogenic enteroviruses were ignored. Unknown panels of specimens are distributed every six months as a quality control check. Surveillance for wild polio virus now depends on isolation of polio virus from two stool specimens, desirably collected within 14 days of onset. **SLIDE 2** shows that specimens are now being obtained from 80% of cases and within 14 days.

Meanwhile, Olin Kew at CDC, with PAHO support, began to sequence wild polio viruses [**SLIDE 3**] and discovered that all strains within defined geographic areas and, indeed, over a period of many years were highly related and could be readily differentiated from strains prevalent in other areas. This was a startling discovery - and perhaps might have been anticipated - as it implied that the virus did not readily spread over extended areas. It seemed reasonable to conclude that if a substantial geographic area became free of polio, it was likely to remain so. With this information, it was possible to deploy resources more effectively.

The vaccination strategy came to consist of three parts [**SLIDE 4**]. The so-called 'mopping up' component may be subdivided into two. The first is prompt and intensive vaccination of <u>all</u> children under five years whenever a possible case is discovered. This is done on the assumption that cases are most likely to be found in areas of poorest coverage and that the populace is most receptive to vaccination when there is a suspect case in the area. A second component consists of a special house-by-house vaccination

in slum areas during the inter-seasonal low in incidence. This followed on the discovery that cases tended to be most prevalent in these areas and, reasoning from our smallpox studies, this would be the area which would sustain transmission between peaks in occurrence of disease.

So what has happened? **SLIDE 5** shows the expected rising incidence of reported cases of acute flaccid paralysis as surveillance improved but, at the same time, a declining incidence of confirmed cases. Isolates of wild polio virus for 1987 are shown in **SLIDE 6**; for 1988 in **SLIDE 7**; and for 1989 in **SLIDE 8**. During 1990, four isolates of wild polio virus have been obtained:

in Ecuador in March

in Peru in April

in Mexico in February and June.

The last known case experienced onset in Mexico on 8 June, four months ago. There may or may not be others, but hope runs high that the last case will occur before the end of the year.

The initiative of the polio eradication program has had salutary effects on other aspects of the health care system. A surveillance system is now in place and is increasingly being utilized to report cases of neonatal tetanus and measles. Other vaccines, in addition to polio, are being administered during the special vaccination days and are being actively promoted. In consequence, vaccination coverage has steadily risen and reported cases of diphtheria, tetanus, pertussis and measles have fallen to historic lows. Finally, the community-based programs necessary to

mount the special immunization days have recruited participation of a number of voluntary groups, one of the most important being the Rotarians. In consequence, new strategies are evolving for the provision of community-based services.

Should the principle of disease eradication be pursued? I believe so, but selectivity is required and such programs must be conducted with broader objectives in mind. What few realize is that many of us in the smallpox eradication program saw that program not as an end in itself, but a vehicle to develop a structure for immunization programs and for practical epidemiological training of surveillance-containment teams. Likewise, polio eradication can serve a most valuable function in establishing surveillance networks and in further developing community-based programs.

With a structure in place to deliver vaccines and to measure their efficacy in terms of disease incidence, there is a potential for expanding the number of vaccine antigens in use. A series of meetings over recent years have portrayed the fact that we have scarcely begun to explore the possibilities opened for us by recent advances in molecular biology, the discovery of the potential of sustained release preparations and the feasibility of use of carrier antigens.

My crystal ball says that in the next century we could be routinely protecting children, especially those in the developing world, against 20 to 25 different diseases from the time of birth. And perhaps we may be able to consider other targets for

eradication <u>but</u> bearing in mind that disease eradication must, in part, be a means to an end and <u>not</u> the end in itself.

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