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Disease Eradication: Lessons from the Great Campaigns

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The historical record is clear that no single medical intervention comes close to being so important to the present health of mankind as does disease control through vaccination. The ultimate expression of disease control is eradication and, over the past 90 years, enthusiastic eradicators have mounted one great campaign after another. One might expect vaccines to have played a major role in the great eradication campaigns but, until smallpox eradication, they did not and none proved to be successful.

Many have forgotten that there have been, so far, seven major international eradication programs launched during the 20th century. They played important roles in defining international health agendas but until the campaign against smallpox, all had proved disappointing, leaving little as a legacy¹ despite the expenditure of enormous energy and funds. **SLIDE** The first, a global campaign against hookworm, mounted by the Rockefeller Sanitary Commission in 1909, eventually extended across 52 countries on 6 continents and to 29 island groups². It relied primarily on the treatment of patients and the provision of sanitary facilities. It was scientifically unrealistic and eventually had to be abandoned.

It was followed by more than 50 years of eradication campaigns which relied primarily on vector control measures. First, there was a program designed to eradicate yellow fever and when that failed, to eradicate the principal mosquito vector that transmitted yellow fever. The programs proved to be extraordinarily difficult to

implement; they were extremely costly; and eventually they had to be abandoned.

SLIDE The most extensive program of all was that for malaria which, over 15 years, commanded more than two thousand million dollars -- at least 3 times that amount in today's dollars; more than 500 times what it cost to eradicate smallpox. It failed. One further program was mounted, that for yaws,³ which relied on patient treatment with penicillin and that too failed.

Not until smallpox eradication was there an eradication campaign based on the use of a vaccine rather than on vector control or drug treatment. This is puzzling because vaccines represent the optimal intervention for disease control. Programs that require treatment necessitate that individual patients be seen when they are ill and drugs administered. Logistically, this is a serious barrier and, especially so where health services are sparse. Moreover, even for a single treatment, drugs are almost invariably more expensive than vaccines. Thus, past eradication programs based on drug treatment -- those for hookworm and yaws -- fared badly. Likewise, disease campaigns based on vector control, such as yellow fever and malaria, had to be abandoned altogether because of costs, insecticide resistance and the practical problems of implementation.

Of the two vaccine-based programs, smallpox was declared eradicated in 1980; **SLIDE** polio was banished from the Americas some nine years ago⁴ and similar successes for polio have now been registered in Europe and Eastern Asia as well as in northern and southern Africa⁵. In a world where every few months it seems, one group or another loudly proclaims its intent to eradicate one disease or another, let us look at specific determinants of eradication -- at least as I would identify them:

SLIDE Disease sufficiently important to warrant the effort

- SLIDE** No natural reservoir for the organism other than man
- SLIDE** Patient ceases to harbor organism on recovery
- SLIDE** Intervention is effective, affordable and logistically practical
- SLIDE** Interruption of transmission demonstrated to be practical

Recently, the idea of measles eradication has been advocated. And, indeed, it has been possible to interrupt transmission in many countries of the Americas⁵ as well as in the United Kingdom. Unfortunately, measles vaccine cannot be administered until a child is 9 to 12 months of age because of the interference of maternal antibody. Because of this and the extreme contagiousness of measles, coverage of 95% or more becomes essential if transmission is to be interrupted. Thus, its eradication presents essentially insuperable problems in Africa if nowhere else. is most unlikely with the present vaccine. And, note, that outside of the Americas and a few countries in Europe, none have succeeded in interrupting measles virus transmission. However, were a suitable vaccine available, eradication could be considered but to be noted is the fact that the vaccine in use has not been improved in nearly 30 years.

Strategy

The successful eradication programs have embraced a two-part strategy – a population-wide vaccination campaign and a disease surveillance program¹. Principles for the application of each of these strategies evolved during the course of the smallpox and polio campaigns. Let me offer my thoughts as to the key factors and why they present special problems.

SLIDE The first and most obvious is the need for sustained political commitment and, given the pace at which politicians come and go, that is no easy task to obtain.

SLIDE Program leadership is far more vital than most imagine. One good leader can transform a program involving thousands. Yes, programs involve teamwork but without a good captain of the team, accomplishments will be modest. The unfortunate truth is that when a successful leader does emerge and succeed, he is very quickly swept away to some other position. **SLIDE** A sound, feasible plan. Perfectly obvious. But, in fact, I would judge that at least half of the international initiatives for which I have been asked to consult were based on someone's wishful thinking, often someone who has never worked in the field --and a belief that if everything were perfect, miracles could be accomplished. The world viewed from behind the desk looks very different from the world viewed from the field. And, rarely do plans ever proceed as one who has never lived in the field would like to believe..

SLIDE Surveillance. The eradication programs were to demonstrate again and again the efficacy of disease surveillance both for monitoring progress in the program and for providing epidemiological data that served to alter program strategy. However logical it would seem to use disease incidence as the ultimate measure of progress in a control program, few do so even today. They rely instead on process indicators such as numbers of vaccinations performed. Such, in fact, was the history of smallpox control prior to the launching of the global program in 1967. Surveillance for cases of smallpox transformed the eradication campaign. Surveillance for cases of acute flaccid paralysis (which included poliomyelitis) was a hallmark of the polio eradication program in the Americas⁴. In little more than five years, polio eradication was achieved in the Americas. In contrast, surveillance in the global polio eradication program was generally ignored over most of its first five years of existence and, without it, the program stumbled

badly. Today the program is in its twelfth year: surveillance is far from what it should be and eradication sooner than five years hence will require a miraculous effort.

SLIDE Quality control. In developing countries, it became clear in the eradication campaigns that when the active participation of community leaders and the community itself was sought; when vaccine was provided at a convenient time and place; and when it was apparent that the program enjoyed widespread popular support, vaccination levels of 90% and higher were readily achieved. This needed to be checked, however, on a regular basis by special assessment teams. With quality control in place, one knew where the problems were and where to place special emphasis. With special campaigns, it was far easier to assure that the vaccine was properly refrigerated up to the time of administration; wastage was far less; and vaccination technique could be more closely monitored. Eventually, many of the vaccination campaigns we mounted were to mature as annual or semi-annual national immunization days in many countries around the world.

Research

Finally, but not least, has been the importance of research to a successful eradication effort, a subject that regrettably often is given short shrift in public health programs. Attitudes toward research in eradication efforts were most explicitly stated at the time of launching of the malaria eradication effort in 1955. Program directors said in so many words, "we have the tools (DDT); we know what needs to be done; it is simply a matter of going out and doing it⁶. The challenge was defined as being, in essence, an administrative problem, not a scientific one. Some 10 to 15 years after the eradication program had begun, as insecticide resistance was increasing, as prescribed techniques failed to work as anticipated, help was sought from malariologists but, as the leadership

wistfully noted, the program had done a far better job in eradicating malariologists than malaria. The needed resources were no longer extant.

The nihilistic view of the value of research has continued to predominate in public health circles. At the time of launch of smallpox eradication, senior WHO leadership took a similar view stating: "we have a good vaccine; we can assume that if we vaccinate everyone, the disease will vanish. In brief, it is purely an administrative task of operating an effective global vaccination program." The simplistic belief that one could ever vaccinate everyone in any community was surprisingly naïve. New born susceptibles are continually entering the population; immunity among those previously vaccinated is waning; and migrants and refugees, difficult to locate and difficult to vaccinate, are a commonplace occurrence in the modern world.

Only because of research efforts conducted during the course of the smallpox program was the achievement of eradication possible. To be noted, in particular, was the discovery and application of a more efficient vaccination device that used 75 % less vaccine. The discovery that the epidemiological pattern of spread of smallpox was very different than the textbooks described changed the pace and character of the surveillance effort. The demonstration that vaccine efficacy did not fade over 3 to 5 years but was 90% at 20 years shifted vaccination goals from vaccinating and revaccinating everyone to assuring that all had a vaccination scar. Had these and other findings not been made and incorporated into the program, smallpox would be with us today, of that I am confident.

Research, however, has been, at best, a largely ignored effort on the agenda of WHO's Expanded Program on Immunisation, the follow-on effort after smallpox eradication. Indeed, the polio program, in an extraordinary act of ignorance 8 years ago,

deliberately scrapped its limited but promising efforts to develop an improved vaccine on the grounds that a new vaccine would not be available by the projected target goal for eradication of 2000!. In consequence, we are today still labouring with the same oral polio vaccine that was licensed 35 years ago. It is a vaccine that is far from sufficiently antigenic for use in third world countries and so heat labile as to require refrigeration where ever it goes. However, it must be noted that none of the vaccines in common use today are fully satisfactory and yet, research on most has been effectively nil since the time of licensure. A blunt message to you all -- unless there is a substantially greater investment in research, the promise of effective disease control through vaccination will never be realised let alone eradication of anything.

In 1982, there was a Conference at the National Institutes of Health that addressed the question of what next do we eradicate. All manner of sensible and nonsensical suggestions were offered. I had been asked to be the keynote speaker. However, even the subject of the symposium had surprised me as I don't recall ever during the 16 years we worked on smallpox eradication did anyone ask that question. Why? Quite simply, we all realized how many favorable factors there were that facilitated the eradication of smallpox compared to any other disease. Moreover, we were all acutely mindful of the fact that the eradication program barely succeeded, frequently hanging in the balance between success or failure based on political and other events that were far beyond the reach of the program. At that meeting I offered the suggestion that we eradicate the word 'eradication'. It was a keynote speech that was not well received. Today, the nations of the world, through WHO, are committed to polio and Guinea worm eradication. Until both of these can be satisfactorily concluded, it would be reckless, in fact irresponsible, to propose embarking on yet another effort.

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