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Disease Eradication and Control

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Introduction

The growing knowledge of disease causality and epidemiology, as well as new and improved preventive measures, have fostered ever more effective methods for disease control. Vaccination, vector control, chlorination of water, pasteurization of milk, micronutrient supplementation, improved sanitation, as well as antimicrobial and antiparasitic agents are all important prevention modalities, few of which were widely or effectively applied prior to this century. In aggregate, they account for most of the remarkable improvements which have occurred in infant and child survival rates.

The dramatic successes of disease control programs led scientists to pose the question as to whether certain diseases might not be eradicated entirely. Thus, beginning in 1909 with an ill-fated effort to eradicate hookworm in the United States and other countries, a series of different organisms have been targeted at different times for eradication. A yellow fever campaign, begun in 1915, was followed by a western hemisphere-wide effort to eradicate the urban vector of

yellow fever, Aedes aegypti; a yaws eradication campaign began in the late 1940s; and a global malaria eradication effort in 1956. By the early 1970s, all had had to be abandoned as it became apparent that the epidemiological understanding of the behavior of the agent was incomplete or the preventive interventions proved impracticable. During the 1960s and early 1970s, the concept of eradication itself began to be challenged as was the credibility of what was perceived to be an unrealistically optimistic public health community.

During the decade 1967-1977, however, a global smallpox eradication campaign was successfully executed under World Health Organization leadership, the last case in the field occurring in October 1977. The World Health Assembly, in 1980, officially declared eradication to have been achieved and at that time, vaccination ceased. No subsequent cases have occurred.

Given the stimulus of the victory over smallpox, two other global programs have been launched. One is intended to eradicate dracunculiasis (Guinea worm) by 1995, and the second, to eradicate poliomyelitis by the year 2000. In both campaigns, the progress is highly encouraging. By the end of 1995, the incidence of dracunculiasis had been reduced from an estimated 3.5 million cases (1986) to 130 000 cases. At that time, less than 9000 villages

remained infected in 15 countries of tropical Africa, Yemen and one state of India. Poliomyelitis was declared to have been eradicated throughout the Western Hemisphere in 1991. Many other countries are free or virtually free of the disease, including those in Europe, east Asia and North Africa, and programs are progressing well in most other countries. The principal endemic countries include India, Pakistan, Bangladesh, Afghanistan and Nepal in Asia, as well as the tropical sub-Saharan countries of Africa.

Contrasting costs and benefits of disease eradication and control

While in progress, disease eradication campaigns are invariably more costly and demanding than control programs. Such campaigns require that effective efforts extend throughout all areas of all countries which are infected or at risk of infection; more sophisticated surveillance systems are required to assure early detection, diagnosis and control or treatment of cases; more elaborate quality assurance measures are needed to ensure that all targeted areas and populations are satisfactorily dealt with; and, often, more costly control measures are needed.

The added costs of an eradication program can be recouped many times over if the effort is successful and conventional control measures can be materially reduced or stopped. For example, the total costs for smallpox eradication were $300 million ($100 million in international assistance and $200 million in national expenditures) over the 13-year period 1967-1979 or less than $25 million per year. When the program began in 1967, the estimated annual cost of smallpox to the world was more than $1350 million. That cost is now nil.

Obtaining the added resources needed for an eradication campaign presents special problems. Not surprisingly, the most infected countries have been those which are the poorest and least able to bear the burden of the additional funds required for an eradication effort. Thus, a successful program requires that the wealthier countries must commit to the support of efforts of those unable to bear the costs and the poorer countries must agree to give the program requisite political and moral support if resources are made available. Logic would suggest that the disease-free wealthier countries would readily support eradication campaigns against such as smallpox and poliomyelitis as the most effective means for protection their own populations. Experience demonstrated, however, that most countries contributed only reluctantly or not at all.

Thus, it is difficult to be optimistic abut the prospects for other eradication programs given today's climate of shrinking international assistance budgets, and the fact that needed resources for the two existing eradication initiatives are barely sufficient.

Criteria for assessing candidate diseases for eradication

Five principal determinants are proposed as minimum criteria to be met before an eradication program is launched. All three of the most recent eradication programs (smallpox, poliomyelitis, dracunculiasis) fulfilled these criteria before being launched.

1. *There is no natural reservoir for the organism other than man.*

infections are not candidates for eradication because the responsible organism infects naturally both man and other mammalian species or may survive naturally in the environment. Thus, knowledge of an organism's ecology is crucial and not to be ignored. This was aptly illustrated by the failed yellow fever eradication effort which forged ahead

for nearly two decades before discovering that there was a jungle reservoir of the virus which precluded eradication.

2. *The infected patient, on recovery, ceases to harbor the organism and desirably is immune to later reinfection*

does not continue to shed virus and is effectively immune for life against repeat infection due to variola or the specific polio type. Natural infection thus has played an important role, with vaccination, in diminishing both the numbers excreting virus and the susceptible pool of potential recipients. Likewise, the dracunculiasis patient ceases to harbor the organism on recovery. Although he is not immune to subsequent infection, transmission requires special contact with water.

For those diseases in which the organism continues to be present in the body either in its naturally infectious form or a latent one (eg., hepatitis B, tuberculosis, varicella), there is little hope for eradication. An eradication program would require an effort extending over a generation or more--hardly a feasible proposition given the difficulties in

sustaining international commitments to any programs for more than 10 to 20 years at most.

3. *The preventive intervention is affordable and logistically practicable to apply.*

Affordability is critical given the fact that disease candidates for eradication afflict all or most of the poorest countries, where obtaining resources for vaccines which cost as little as US$1 per dose have so far proved to be difficult to impossible.

The feasibility of application reflects the realities of the limited transportation, health and communications infrastructure in so much of the developing world. Smallpox vaccine exemplifies an ideal preventive agent--a highly heat-stable product, readily administered, which confers long-term protection to each recipient with a single dose. Oral polio vaccine, requiring three to five or more doses, clearly presents greater problems and long-term treatment regimens such as are needed in treating tuberculosis all but preclude the possibility of eradication where such is the only feasible strategy.

Dracunculiasis eradication has a very different strategy in endeavoring, first, to provide safe water wherever possible, but as its principal prevention modality, relying on health education, the provision of cloth filters for water, and the detection and treatment of afflicted patients. The fact that the disease is confined to a comparatively small number of rural villages and is not, in fact, especially transmissible makes this approach feasible.

4. *The disease is sufficiently important to*

considered smallpox to be a priority and virtually all were engaged in control efforts when global eradication began. Not all countries, however, were able to assign adequate additional funds to transform a control effort into one of eradication, but all cooperated when necessary international assistance was provided. In contrast, neither poliomyelitis nor dracunculiasis had been accorded such a high level of priority by most countries, and it is questionable in either case whether an eradication initiative would have had sufficient support if other considerations did not pertain. Specifically, polio eradication built on the polio control efforts and structure of the more broadly based Expanded Program on

Immunization; dracunculiasis eradication built on the broader global initiative to provide adequate, clean water supplies to peoples throughout the world.

One disease which commands special attention at this time because of its universal character and severity world-wide is measles. Indeed, several African countries, prior to smallpox eradication, were more interested in measles control than smallpox eradication. With an effective vaccine available and with the disease having no natural reservoir other than man and not carrier state, eradication is at least theoretically possible. While there are other diseases such as mumps and rubella which have no hon-human hosts and for which affordable vaccines are available, none are sufficiently serious compared to others to warrant consideration for eradication.

5. *Interruption of transmission has been demonstrated to be possible in developed countries and in some developing ones.*

costly investment whose benefits will not be realized unless eradication is achieved, permitting preventive control measures to be sharply curtailed or abolished. Accordingly, it

is only prudent to demonstrate on a national or regional scale that the interruption of disease transmission is feasible before embarking on a larger or global effort. Successful programs over limited areas, preceded each of the smallpox, polio and dracunculiasis eradication campaigns.

Today, the feasibility of measles eradication is being tested in greatly intensified control programs throughout the Western Hemisphere. Measles poses a special challenge because of the ease and rapidity of its spread and the fact that vaccination of children younger than nine to twelve months may be ineffective because of the interference of maternal antibody. Measles transmission now appears to have been interrupted for a several-year period in the island Caribbean countries and some smaller countries of Latin America. However, surveillance measures are not yet sufficiently mature in these or any other countries to yet assess the prospects for a larger eradication campaign.

Conclusion

Eradication campaigns imply a substantial added commitment of resources beyond those needed for control programs and should, therefore, be undertaken only when there is a clear scientific basis for doing so, a political commitment by both the afflicted countries and those expected to provide the resources, and a practical demonstration of feasibility. Global eradication programs are now in progress for poliomyelitis and dracunculiasis, following on from the successfully completed smallpox program and pilot programs are now testing the practicability of measles eradication. Other candidate diseases may emerge as improved and less costly prevention measures become available but there are no imminent candidates today.

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