
The principles of disease elimination and eradication

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The Dahlem Workshop discussed the hierarchy of possible public health interventions in dealing with infectious diseases, which were defined as control, elimination of disease, elimination of infections, eradication, and extinction. The indicators of eradicability were the availability of effective interventions and practical diagnostic tools and the essential need for humans in the life-cycle of the agent. Since health resources are limited, decisions have to be made as to whether their use for an elimination or eradication programme is preferable to their use elsewhere. The costs and benefits of global eradication programmes concern direct effects on morbidity and mortality and consequent effects on the health care system. The success of any disease eradication initiative depends strongly on the level of societal and political commitment, with a key role for the World Health Assembly. Eradication and ongoing programmes constitute potentially complementary approaches to public health. Elimination and eradication are the ultimate goals of public health, evolving naturally from disease control. The basic question is whether these goals are to be achieved in the present or some future generation.

Introduction

Elimination and eradication of human disease have been the subject of numerous conferences, symposia, workshops, planning sessions, and public health initiatives for more than a century. Although the malaria, yellow fever, and yaws eradication programmes of earlier years were unsuccessful, they contributed greatly to a better understanding of the biological, social, political, and economic complexities of achieving the ultimate goal in disease control. Smallpox has now been eradicated and programmes are currently under way to eradicate poliomyelitis and guinea-worm disease.

In 1993, the International Task Force for Disease Eradication evaluated over 80 potential infectious disease candidates and concluded that six were eradicable (1). In 1997, the World Health Assembly passed a resolution calling for the "elimination of lymphatic filariasis as a public health problem". Also in early 1997, WHO listed leprosy, onchocerciasis, and Chagas disease as being candidates for elimination "as public health problems within ten years".

With this background, the Dahlem Workshop on the Eradication of Infectious Diseases was held in March 1997 (2). The Workshop was unique in that it focused on the science of eradication, with the understanding that the present Atlanta Conference would address specific candidate diseases for elimination or eradication in the context of global health strategies. The Workshop addressed four questions: 1) How is eradication to be defined and what are the biological criteria? 2) What are the criteria for estimating the cost and benefits of disease eradication? 3) What are the societal and political criteria for eradication? and 4) When and how should eradication programmes be implemented?

Definitions

Eradication has been defined in various ways — as extinction of the disease pathogen (3), as elimination of the occurrence of a given disease, even in the absence of all preventive measures (4), as control of an infection to the point at which transmission ceased within a specified area (5), and as reduction of the worldwide incidence of a disease to zero as a result of deliberate efforts, obviating the necessity for further control measures (1). The hierarchy of potential public health efforts in dealing with infectious diseases was discussed at the Dahlem Workshop. Differences in these efforts made a distinction between the disease caused by the infection and the infection itself, the level of reduction achieved for either of these, the requirement for continuation of

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control efforts, and, finally, the geographical area covered by the intervention efforts and their outcomes. Although definitions outlined below were developed for infectious diseases, those for control and elimination apply to noninfectious diseases as well

- *Control*: The reduction of disease incidence, prevalence, morbidity or mortality to a locally acceptable level as a result of deliberate efforts; continued intervention measures are required to maintain the reduction. Example: diarrhoeal diseases.
- *Elimination of disease*: Reduction to zero of the incidence of a specified disease in a defined geographical area as a result of deliberate efforts; continued intervention measures are required. Example: neonatal tetanus.
- *Elimination of infections*: Reduction to zero of the incidence of infection caused by a specific agent in a defined geographical area as a result of deliberate efforts; continued measures to prevent re-establishment of transmission are required. Example: measles, poliomyelitis.
- *Eradication*: Permanent reduction to zero of the worldwide incidence of infection caused by a specific agent as a result of deliberate efforts; intervention measures are no longer needed. Example: smallpox.
- *Extinction*: The specific infectious agent no longer exists in nature or in the laboratory. Example: none.

Principal indicators of eradicability

In theory if the right tools were available, all infectious diseases would be eradicable. In reality there are distinct biological features of the organisms and technical factors of dealing with them that make their potential eradicability more or less likely. Today's categorization of a disease as not eradicable can change completely tomorrow, either because research efforts are successful in developing new and effective intervention tools or because those presumed obstructions to eradicability that seemed important in theory prove capable of being overcome in practice. Three indicators were considered to be of primary importance: an effective intervention is available to interrupt transmission of the agent; practical diagnostic tools with sufficient sensitivity and specificity are available to detect levels of infection that can lead to transmission; and humans are essen-

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tial for the life-cycle of the agent, which has no other vertebrate reservoir and does not amplify in the environment.

The effectiveness of an intervention tool has both biological and operational dimensions. Elimination validates the effectiveness of an intervention tool, but it does not necessarily make the agent a candidate for eradication. Highly developed levels of sanitation and health systems development may make elimination possible in one geographical area but not in another.

Diagnostic tools also have both biological and operational dimensions. The tools must be sufficiently sensitive and specific to detect infection that can lead to transmission, and also sufficiently simple to be applied globally by laboratories with a wide range of capabilities and resources. Eradication is a much more feasible target of deliberate intervention when humans form an essential component of the agent's life-cycle. An independent reservoir is not an absolute barrier to eradication if it can be targeted with effective intervention tools.

Economic considerations

Meeting the biological criteria is only one step in the decision to embark upon an elimination or eradication programme. Health resources are limited and resources cross sectors. Therefore, decisions have to be made as to whether the use of resources for an elimination or eradication programme is preferable to their use in nonhealth projects, in alternative health interventions, in continued control of the condition, or even in the eradication of other eradicable conditions. All of these decisions necessitate an evaluation of the cost and benefit of eradication and the alternative use of resources. There is no easy answer.

Formal economic analytical techniques are not ideally suited to eradication programmes. It is not clear, for example, how to handle future benefits and cost, particularly long-term effects. Equally unclear is whether and how to discount future effects. Of the available techniques, the Workshop concluded that cost-effectiveness analysis appeared to be most useful when the outcome is expressed in health terms. This technique allows evaluation of disease eradication in comparisons with other health sector projects.

The costs and benefits of global eradication programmes can be grouped into two categories — direct effects and consequent effects. The direct effects of eradication are that no morbidity or mortality due to that disease will ever again occur. Control programmes can cease. The consequent effects are those

that impact positively and negatively on the entire health care system. Because of the close interrelationships between eradication programmes and other health programmes, the Workshop concluded that eradication goals and activities should be expressed in the context of overall health services. Explicit efforts should be taken to maximize the effectiveness of both eradication and comprehensive health programmes.

Social and political criteria

A set of social and political criteria was identified by Workshop participants. These and other related factors are summarized as follows:

- The success of a disease eradication initiative, like any public health programme, is largely dependent on the level of societal and political commitment to it from the beginning to the end. Considering the potentially enormous cost of failure, any proposal for eradication should be given intense scrutiny.
 - The disease under consideration for eradication must be of recognized public health importance, with broad international appeal, and be perceived as a worthy goal by all levels of society. There must be specific reasons for eradication. The demands for sustained support, high quality performance, and perseverance in an eradication programme increase the risks of failure, with a consequent significant loss of credibility, resources, and health workers' self-confidence.
 - A technically feasible intervention and eradication strategy must be identified, field-tested in a defined geographical area, and found effective. The accumulation of success in individual countries or within a region generates the momentum needed for international support.
 - Consensus on the priority and justification for the disease must be developed by technical experts, the decision-makers, and the scientific community.
 - Political commitment must be gained at the highest levels, following informed discussion at regional and local levels. A clear commitment of resources from international sources is essential from the start. A resolution by the World Health Assembly is a vital booster to the success of any eradication programme.
 - An advocacy plan must be prepared and ready for full implementation at global, regional, and national levels. Eradication requires an effective alliance with all potential collaborators and partners. Finally — a recurring theme — the eradication programme must address the issues of equity and be supportive of broader goals that have a positive impact on the health infrastructure to provide a legacy in addition to eradication of the disease.
- Disease eradication programmes are conceptually simple, focusing on one clear and unequivocal outcome. At the same time, however, their implementation is extraordinarily difficult because of the unique global and time-driven operational challenges. The limitations, potential risks, and points of caution for eradication programmes include higher short-term costs, increased risk of failure and the consequences of failure, an inescapable sense of urgency, and diversion of attention and resources from equally or more important health problems that are not eradicable, or even others that may be eradicable. Care must be taken that eradication efforts do not detract or undermine the development of the general health infrastructure. Other limitations are the high vulnerability of eradication programmes to interruption by war and other civil disturbances: the potential that programmes will not address national priorities in all countries, and that some countries will not follow the eradication strategy; the perception of programmes as "donor driven", placement of excessive, counterproductive pressures and demands upon health workers and others; and the requirement of special attention for countries with inadequate resources and/or weak health infrastructure (including hit-and-run strategies).
 - The favourable attributes and potential benefits of eradication programmes are a well-defined scope with a clear objective and endpoint, and the duration is limited. Successful eradication programmes produce sustainable improvement in health and provide a high benefit-cost ratio. Eradication programmes are attractive to potential funding sources because they establish high standards of performance for surveillance, logistics, and administrative support; develop well-trained and highly motivated health staff; assist in the development of health services infrastructure including, for example, mobilization of endemic communities; and provide equity in coverage for all affected areas, including urban, rural, and even remote rural areas. They also offer opportunities for other health benefits (e.g. for dracunculiasis eradication: health education and improved water supply), improved coordination among partners and countries, and dialogue across frontiers during war.

- Decisions on initiating a global disease eradication campaign should also take into consideration the ideal sequencing of potentially concurrent campaigns. Eradication programmes consume major human and financial resources. Careful consideration must be given to whether two or more eradication programmes are to be conducted simultaneously or sequentially, or if the target disease is confined to a limited geographical area.

Disease elimination and eradication programmes can be distinguished from ongoing health or disease control programmes by the urgency of the elimination and eradication programmes and the requirement for targeted surveillance, rapid response capability, high standards of performance, and a dedicated focal point at the national level. Eradication and ongoing programmes constitute potentially complementary approaches to public health. There are areas of potential overlap, conflict and synergy that must be recognized and addressed. In many cases the problem is not that eradication activities function too well but that primary health care activities do not function well enough. Efforts are needed to identify and characterize those factors responsible for improved functioning of eradication campaigns, and then apply them to primary health.

Conclusion

In summary, elimination and eradication programmes are laudable goals, but they carry with them an awesome responsibility. There is no room for failure. Careful and deliberate evaluation is a prerequisite before embarking on any programme. Elimination and eradication are the ultimate goals of public health. The only question is whether these goals are to be achieved in the present or some future generation.

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