



Elimination and eradication of diseases

What can be learned from previous eradication and elimination programmes?

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Introduction

Elimination and eradication have been an important subject of public health research, projects and initiatives for more than a century. Although eradication of malaria, yaws and yellow fever in early years failed, the results of these campaigns contributed greatly to a better understanding of the social, biological, political and economic factors concerning disease control. Previous programmes led to a list of determinants of success or failure for upcoming disease eradication and elimination programmes. At the moment, smallpox has been eradicated and programmes to eradicate poliomyelitis and dracunculiasis (guinea worm disease) are be-

ing developed. Five diseases are proposed for eradication by the International Task Force for Disease Eradication and several other diseases have already been eliminated from parts of the world or are currently being targeted for regional or sub-regional elimination.

Eradication

In theory, if the right tools were available, all infectious diseases would be eradicable. However, there are several biological features of infectious diseases and technical factors that strongly limit their potential eradication.

Three criteria are considered to be essential for eradication:

1. An effective intervention must be available to interrupt transmission of the disease.
2. Practical diagnostic tools with sufficient sensitivity and specificity must be available to detect levels of infection that can lead to transmission.
3. Humans must be the only host of the agent. Animal reservoirs significantly complicate the eradication process.

Considering the biological criteria is only one step in the decision to embark upon an elimination or eradication programme. Health resources are limited, so an evaluation of the costs and benefits of eradication is required. It is crucial to create societal and



Ghana



23 008 000
inhabitants



\$ 1 240
income per year



♂ 56yrs ♀ 58yrs
life expectancy



6.2%
of GDP for health



0.2
doctors/1000 people



political commitment to the eradication of the disease. Therefore, besides economic considerations, social and political circumstances should be taken into account. Finally, the intervention should be technically feasible and an eradication strategy should be identified.

Lessons from the past

The eradication campaigns of yaws and malaria failed at the same time. Both campaigns began around 1955 and were terminated around 1970. It was the introduction of a new technology that triggered the launch of both programmes. For the treatment of yaws, this was a single-dose injection of long-acting penicillin and for malaria it involved the availability of large quantities of the inexpensive insecticide DDT. Surprisingly, neither campaign was based on pilot programmes to demonstrate the feasibility of eradication, given the tools and resources available. If they had, probably none of the programmes would have been started.

Elimination versus eradication

Eradication entails the permanent reduction of the worldwide prevalence of a disease to zero. Smallpox is the only example of an eradicated disease. In this case, intervention measures are no longer needed.

Eradication is sometimes confused with **elimination**, which is defined as the reduction of prevalence of a disease *in a defined area* to zero or the reduction of global prevalence to a negligible amount. Poliomyelitis and measles are examples of eliminated infections. To prevent re-establishment of transmission, continued measures are required.

Smallpox

Smallpox was one of the most devastating diseases known to humanity. Before an effective treatment was developed, the disease killed as many as 30% of those infected. Between 65 and 80% of the survivors were marked with deep pitted scars (pockmarks), most prominent on the face. An important discovery was made by Edward Jenner in 1798, who demonstrated that inoculation with cowpox could protect against smallpox. The eradication programme that followed was very successful and smallpox was pushed back to the horn of Africa and then to a single last natural case in Somalia, 1977.

SUCCESSFULLY ERADICATED



The strategy of the yaws eradication programme was based on the screening of patients with clinical disease and treatment with penicillin. Besides having failed to validate the strategy in pilot studies, the programme had two evident deficiencies. First, there was no surveillance, so it has never become clear what was actually happening. Secondly, there was no research programme, which might have demonstrated the futility of this programme far earlier.

Of these two programmes, the attempt to eradicate malaria was the most important

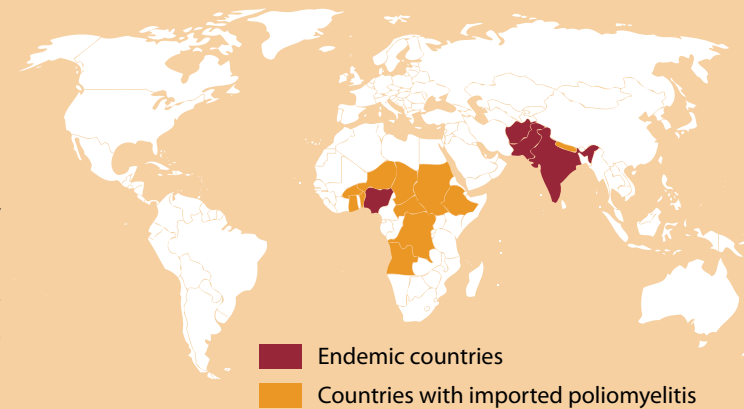
and expensive. During its 15 years of existence, it accounted for more than one-third of the World Health Organization's total expenditures and dominated the international health agenda worldwide. Three main points that contributed to the failure of the malaria programme can be recognized. First, the malaria service functioned as an independent, autonomous entity with its own personnel and its own pay scales. The community was not involved in the programme. Second, the programme was conceived and executed as a military operation to be conducted in an identical way whatever the battlefield. All programmes were obliged to adhere rigidly to a highly detailed manual, without adapting to local circumstances. Finally, research was considered unnecessary and was rigorously erased from the original programme.

The malaria eradication programme failed. Lessons learnt from the programme, however, were very important in designing the smallpox eradication strategy. This programme

Poliomyelitis

Poliomyelitis (polio) is a highly infectious disease caused by a virus. It invades the nervous system and leads to irreversible paralysis in one in two hundred infections, usually in the legs. Polio mainly affects children under the age of three. Humans become infected by faecal-oral contamination. Eradication started in 1988, when the WHO voted to launch a global target to eradicate polio. At that moment, wild poliovirus was endemic in more than 125 countries on five continents, paralyzing more than 1 000 children every day. As a result of the Global Polio Eradication Initiative, by the end of 2006, only four countries remained endemic (Nigeria, India, Pakistan and Afghanistan) and less than 2 000 cases are reported globally each year.

ERADICATION
EXPECTED



Distribution of polio viruses in November 2008.
Data adapted from WHO.

had to be organized differently. It was not politically acceptable nor financially possible to let the programme function as an independent, autonomous entity. The programme necessarily had to run within existing health services. This proved advantageous! With proper direction and motivation, health personnel performed well. Besides that, research initiatives were encouraged at every level. In this way, the programme was under constant evaluation to enhance its effectiveness and efficiency. Without all these research initiatives, it is unlikely that eradication of smallpox would have succeeded.

Determinants of success or failure

Based on lessons from the past, the US Centres for Disease Control and prevention (CDC) formulated a list of factors that determine success or failure of an eradication programme.

The major issues are listed below.

- A good surveillance system and a sensitive response mechanism are essential to monitor progress, detect epidemics and programme deficiencies, and take remedial action.
- Research in advance is needed to provide the scientific basis upon which to make programme adjustments.
- Both political will and commitment are essential.
- Basic training and continuing education at all levels are crucial, and supervision

should be seen as a part of the educational process.

- Community participation and coordinated national and international action are required to avoid duplication of effort and to maximize impact.

In the future...

The International Task Force for Disease Eradication considers the following diseases as suitable for eradication: poliomyelitis, dracunculiasis, lymphatic filariasis, measles, mumps, rubella and taeniasis (also known as



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My experience with guinea worm eradication is that changing people's behaviour and attitude is very difficult. A woman, suspected from carrying guinea worm disease, in my village Taha went to get water despite telling her multiple times that it was absolutely prohibited to enter the water! But what else can be expected of a woman who can not see or feel a worm and who desperately needs water in her household?!



Guinea worm disease

Dracunculiasis or guinea worm disease is a disease caused by the parasitic worm *Dracunculus medinensis*. The parasite causes dreadful suffering and disability among the world's most deprived people. Currently there are no drugs available to cure or heal this infection. However, dracunculiasis is relatively easy to combat because of the exclusive relation with unsafe drinking water. Eradication efforts have been based on making drinking water supplies safer and on educating people on safe drinking water practices. These strategies proved successful: in 1986 the global incidence was approximately 3.5 million which has reduced to 9838 cases in 2007. Only five countries – Sudan, Ghana, Mali, Nigeria and Niger – are still endemic.

cysticercosis or pork tapeworm).

This task force also formulated a list of diseases of which some aspects could be eliminated, for example the vector-borne transmission of American trypanosomiasis (Chagas disease). Examples of diseases that are not eradicable at all are African trypanosomiasis, buruli ulcer, amebiasis and bartonellosis.

Conclusion

Eradication of yaws, malaria and yellow fever failed. Smallpox has been eradicated since 1980. Eradication of poliomyelitis and dracunculiasis is expected soon. According to the International Task Force for Disease Eradication, lymphatic filariasis, measles, mumps, rubella and taeniasis are candidates for eradication as well.

To assess if diseases are eradicable it is important to research the biological, economic, social and political characteristics. Before starting a new eradication or elimination programme, it is very important to analyze previous programmes. Lessons from the past can help us make eradication or elimination of diseases successful.

About the author

Marjolijn Paauwe is a fifth year medical student from Amsterdam. She is currently enrolled in a course on International Development Studies.

Further reading

- Morbidity and Mortality Report (MMWR), December 31, 1999 / Vol. 48 / Supplement, Centers of Disease Control and Prevention (CDC).
- International Task Force for Disease Eradication, The Carter Center, Disease candidates for eradication and elimination.

Yaws

Yaws is a chronic infection that mainly affects the skin, bone and cartilage. The disease is rarely fatal but can lead to chronic disfigurement and disability. A single lesion develops at the point of entry of the bacterium *Treponema pertenuis* and without treatment will lead to multiple lesions all over the body. Yaws is transmitted through direct skin contact with an infected person and can be treated with a single injection of the long-acting Benzathine penicillin. Despite the eradication programme between 1950 and 1970, the prevalence was estimated to be 2.5 million in 1990. Unfortunately, the prevalence today is not known because there is no official notification of the disease globally. There are unconfirmed reports that yaws is still present in some countries: new cases are reported and it looks as if the disease starts to come back.



**ERADICATION
FAILED**