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EDITORIAL

Eradication and elimination: facing the challenges, tempering expectations

David H. Molyneux*

Department of Parasitology, Liverpool School of Tropical Medicine, Pembroke Place, Liverpoool, UK

*Corresponding author: E-mail: David.Molyneux@lstmed.ac.uk

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The words eradication, elimination and control have been regularly defined in attempts to avoid inappropriate use of terminology while addressing the realities and challenges of public health programmes.[1,2]

Whitty[3] has recently outlined the dangers of raising expectations in the face of political, financial, biological and logistical efforts of eradication or elimination programmes, emphasising these risks in search of a holy grail. Bockarie et al.[4] noted five categories that defined the elimination or endgame challenges—biological, sociogeographic, logistic, strategic and technical—providing examples from current programmes. These have created significant strategic and resource impediments to progress in implementation, requiring changes in approach often with significant financial implications.

A variety of strategies are used to reduce incidence and prevalence of infectious diseases: vaccination (smallpox, polio, measles), chemotherapy (onchocerciasis, lymphatic filariasis, schistosomiasis), vector control, (onchocerciasis, malaria, schistosomiasis) and provision of improved clean water and sanitation (trachoma, guinea worm, soil transmitted helminths, schistosomiasis). Such strategies are more effective when combined, for example, chemotherapy, vector control and behaviour change, thereby achieving proportionately greater and more rapid impact on transmission.

Eradication as a concept is specifically defined as a reduction to zero global incidence of a specific pathogen, not a disease, which results from such an infection. This represents a crucial distinction—the words disease and infection are often used interchangeably but incorrectly. Even WHO reporting recently on the yaws programme in India entitled their publication 'Eradication of yaws in India.' Thus, even WHO are unable to consistently use correct terminology. Another example is the call for the eradication of malaria. However, eradication is defined as the removal from the planet of a specific infection; raising the question, which of the five human species of *Plasmodium* is to be targeted? This is yet to be specified.

If an organism, such as the smallpox virus, is maintained in the laboratory then the infection is considered eradicated but it is not extinct. In the case of smallpox, the virus was maintained in the USA and the Soviet Union (Russia). A global certification process is required for those organisms targeted for eradication and a Declaration of Global Eradication is required from WHO.

For Dracunculiasis (guinea worm disease), an independent body, the International Commission for the Certification of Dracunculiasis Eradication, was established to oversee the process to conform with WHO's legal obligations through World Health Assembly resolutions. Members are appointed by the Director General of WHO to assess the validity of the evidence that transmission of *Dracunculus medinensis* has been achieved in previously endemic countries. Countries with no evidence of infection are required to submit a statement that transmission does not take place.[5] Countries that have been certified following scrutiny of the evidence presented require a visit to validate the information provided to WHO by an independent certification team. If certified, countries are required to maintain vigilance that they remain transmission free through continued surveillance and maintenance of a rumour register. Any rumour should be investigated within 24 hours of being reported and the national reward system to do this should be continued. The responsibility for 'proving a negative' is a significant one if the target is global eradication or country or regional elimination. Evidence must be robust with regular assessments and surveillance for at least 3 years after the interventions have stopped.

The smallpox programme in its final stages introduced a global reward of US$1000 to report any suspected case. Such a system will need to be established for guinea worm when all countries have been certified free of transmission. To date, some 194 countries and territories have been certified free of transmission. There remain four Guinea worm endemic countries: Chad, Ethiopia, Mali and South Sudan. The challenges of the endgame and the costs of driving transmission to zero country incidence are exemplified[3,4] in high unit costs per case detected, in remote settings where

health systems are weak, where surveillance and communication a challenge, and where civil unrest and conflict prevail. The recent experience of the polio eradication programme in Pakistan testifies to the security challenges.

UN access to endemic areas may not be permitted for security reasons potentially preventing certification to validate the situation on the ground. Proving a negative to the satisfaction of an independent body will be a challenge despite the remarkable gains made in the guinea worm programme to date, with the two most endemic countries, Ghana and Nigeria, recently certified as free of transmission.[6] The question of the use of the term 'eradication' following the findings of dogs infected with *D. medinensis* in Chad,[7] and the possibility that the infection can be transmitted without the human host involvement, poses significant problems in confirming global eradication. In addition, post-intervention surveillance periods are necessary prior to any final assessment by an independent body to verify absence of transmission. The assessments required to provide sufficient evidence that transmission has been arrested are potentially expensive when needed at scale and in all previously endemic countries.

Elimination is defined in a geographical context where transmission has been verified as having been arrested in a defined geographic location. Previously, eradication has been inappropriately used to define this situation. Most recent examples of achievements in verification of the absence of transmission are *Onchocerca volvulus* in Colombia and Ecuador,[8] while Mexico and Guatemala are documenting similar achievements through dossiers submitted to the Pan American Health Organization (PAHO). The remaining endemic countries in this region, Brazil and Ecuador, if regional elimination is to be declared, have to ensure that the remote Yanomami communities on the border areas are accessible for regular ivermectin treatment, preferably more than once a year, or are treated with the macrofilaricide, doxycyline. The Yanomami endemic area illustrates the challenge of reaching remote communities where access is limited, where communities are migratory and health services sparse or non-existent.

The African Programme for Onchocerciasis Control (APOC) changed its objective from control to elimination after it was demonstrated that transmission could be reduced if sustained high coverage of annual ivermectin treatment could be achieved over a period of 15–17 years in Senegal and Mali[9] and in Kaduna State, Nigeria.[10] However, the aspiration to eliminate transmission of *O. volvulus* throughout all endemic areas of Africa requires extension of programmes into areas not previously treated. The change from a highly successful control programme to one of elimination emphasises the increased costs of going the last mile in a greatly expanded programme. Will the costs of expansion of long-term treatment and of verifying that transmission has been arrested in some of the more remote and inaccessible parts of Africa over the long-term be sustainable? Proving to the satisfaction of an independent body that there is zero transmission over all the endemic areas of Africa has long-term financial, coordination and human resource implications.

Lymphatic filariasis has been verified as eliminated in China and South Korea some 15 years ago. In China this followed several decades of interventions of chemotherapy and vector control. The current programme for the elimination of lymphatic filariasis as a public health problem has also achieved significant gains, providing evidence that transmission has been arrested in several countries thereby ensuring that no clinical cases will emerge following the cessation of mass drug administration. Again the challenge of obtaining the requisite evidence at scale globally will be a financial and logistic challenge based on the need to verify in 70+ endemic countries that transmission, the key parameter of success, has been arrested even if the public health problem has been alleviated.

The use of the term 'as a public health problem' has been addressed[3] in the case of the leprosy elimination programme. Success in the use of multi-drug therapy to reduce the public health problem in many countries has resulted in the perception that there remains a limited problem despite the large number of cases that remain in highly populous countries such as India. The definition of a public health problem is a subjective view and the parameters for such a definition dependent on expert opinion. While the desire to eliminate local transmission in perpetuity can be achieved in certain isolated geographic settings, the balance between true elimination and elimination of a public health problem will continue to be debated. The availability of interventions and, often, donated drugs to impact on the health of the poor should not be a reason for avoiding responsibility to provide resources to implement activities that will have a significant public health impact despite the fact the ultimate goal of total transmission control is difficult to achieve.

The term eradication has been used to describe success in several isolated, often island, settings. More correctly, elimination should be the term applied. Examples of attempts at elimination of cystic hydatid disease to reduce human incidence of *Echinococcus granulosus* from Iceland in the 1800s, Cyprus, Tasmania, the Falkland Islands and New Zealand provide an insight into the application of a range of measures to prevent transmission. Dogs were prevented from access to sheep offal and purged to remove tapeworms, destruction of cyst-infected sheep carcasses instituted and extensive health education campaigns.[11] All these island programmes were carried out over a period of decades, with New Zealand and Tasmania declaring provisionally they were free of hydatid disease in 2002. The elimination of the transmission of *O. volvulus* on the island of Bioko, following vector control of the Bioko form of *Simulium yahense,* has also been achieved.[12] However, given that in Bioko *S. yahense* was a unique cytoform, it can be claimed that not only was elimination of transmission achieved but also extinction of a unique vector form.

The debate around issues of eradication and elimination will continue. However, although the challenges are well-defined, the spectrum of these challenges, given they will play out over the long duration of programmes, will need continuous responses by the many stakeholders who have invested in them. The complexities of eradication and elimination and the public health policy issues generated require a deep understanding of the many dimensions that confront decision makers. As programmes evolve and complexities increase,[13] the dynamic of changing biological, ecological and political scenarios over long periods of time demand an inbuilt flexibility and capacity to respond. The necessary response to these inevitable challenges requires vision, finance and commitment by the stakeholders of these programmes. Removing the last filarial worm or gametocyte in remote and insecure settings, and verifying to the scientific community that the evidence is sufficiently robust to declare eradication or elimination has been achieved, seems optimistic given the constraints identified and the biological capacity of our targets to challenge us. The objectives of eradication or elimination are laudable but prove costly. We should recognise that solving a public

health problem is indeed a significant benefit, which has been achieved in many settings, and that the search for the holy grail may take longer than expected.

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