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M.A. Klingberg, Ness-Ziona/Tel-Aviv

Eradication of Infectious Diseases

A Critical Study

P. Yekutieli, Ramat-Aviv/Tel-Aviv



S. Karger · Basel · München · Paris · London · New York · Sydney

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Eradication of Infectious Diseases

Contributions to Epidemiology and Biostatistics

Vol. 2

Series Editor

M.A. Klingberg, Ness-Ziona/Tel-Aviv



S. Karger · Basel · München · Paris · London · New York · Sydney

To the memory of my two great teachers

Professor *Gideon Mer* (1894–1961)

Professor *George Macdonald* (1903–1967)

Editor's Preface

The great advances in biomedical technology and international communication during the second half of this century provided the background for launching ambitious regional and global campaigns for the eradication of various communicable diseases. However, problems and setbacks of the 1950s and 1960s gave rise to much controversy regarding the merits of the eradication approach.

In this monograph, the second volume in the series *Contributions to Epidemiology and Biostatistics*, the author presents a more balanced stand which has been reached mainly by application of the epidemiological approach and by consideration of the many socio-economic and administrative factors which can influence the outcome of an eradication programme. The first part of the monograph examines these basic issues and provides precise epidemiological and operational criteria for deciding on control or eradication in given situations. In the second part, the author reviews the successes and setbacks of recent and current eradication campaigns against malaria, smallpox, yellow fever and yaws in light of these criteria. In the closing chapter he outlines present approaches in the control of infectious diseases and considers the feasibility of further eradication programmes.

Professor *Yekutieli* has wide international experience in the control and eradication of infectious diseases. He has served as Chief Epidemiologist of the Division of Malaria Eradication and as Chief of the Unit of Global Epidemiological Surveillance at WHO Headquarters in Geneva. He is currently a member of the Department of Preventive and Social Medicine at Tel-Aviv University.

Marcus A. Klingberg

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Introduction

During the decade prior to 1970, three comprehensive texts on the eradication of infectious diseases were published. Two are in the form of books devoted to this topic (1, 2), and the third text comprises important sections of *Dubos'* volume entitled *Man Adapting* (3). These authors, no less than other writers during the same period, reached widely divergent conclusions as to the feasibility or advisability of eradication programmes, based on equally profound examinations of the evolution of infectious diseases against a wide background of biological and ecological concepts and historical facts.

The present monograph does not aspire to add yet another exhaustive treatise on the foundations and history of the control and eradication of infectious diseases. To obtain an insight into this important body of knowledge, the reader is well advised to consult the scholarly texts mentioned above. On the other hand, since their publication, much has happened, and perhaps even more has been learned in the *practice* of eradication of disease. The revision and reformulation of strategy in the global malaria eradication programme (1969–1970) and the start and successful conclusion of the global smallpox eradication campaign (1967–1979) are two outstanding examples of these developments.

It is the purpose of this monograph to review these recent developments and to show how the experience gained in various campaigns in different countries and continents has led to a better understanding of the complex factors involved in their progress and outcome. This understanding was aided by the application of the modern epidemiological approach, distinguished by its recognition of the multiplicity of interacting factors – including socio-economic components – in the causation and dynamics of diseases (infectious and others) in individuals and populations. Sober epidemiological analysis of these factors allows us currently to establish sound criteria for the decision whether to opt for control or eradication in a given situation, rather than formulating a rigid position for or against eradication, based on biological or administrative doctrine – a tendency that permeates much of the literature of the past decade.

It is intended to develop in this monograph the ‘balanced viewpoint’, documenting it by observations made in the large regional or global campaigns.

We trust that such an analytical approach will prove more interesting and more useful than a descriptive account of recent campaigns and/or a comprehensive review of the recent literature.

I The Controversy: Control or Eradication?

We cannot refrain altogether from examining the roots of this controversy, if only because the extreme views for and against eradication have exerted and are still exerting a — to my mind — highly detrimental influence on public health practice. Over-enthusiastic and optimistic conceptions have led governments and international health agencies into costly eradication ventures in situations where a more critical and cautious approach might have foreseen the formidable obstacles that eventually thwarted their success; in other instances, fears engendered by gloomy theories on the utopian nature of the concept of eradication have prevented or delayed perfectly feasible actions for eradication.

The discoveries in the second half of the 19th century of microbiological agents of diseases and the mechanisms of their transmission soon led to the employment of effective methods of control of many infectious diseases. This in turn brought about the complete elimination of some infections from large geographical areas towards the end of the 19th and the beginning of the 20th century, such as yellow fever, smallpox, typhus and cholera in the American continent north of Mexico and of the latter three diseases from the British Isles and other parts of Europe. This slow process of elimination was due to overall socio-environmental changes as well as to the use of specific control measures. The word 'eradication' was not used to describe this process. This term was first used in connection with the swift regional elimination of certain diseases of domestic animals — e.g. Texas cattle fever (piroplasmosis) and pleuropneumonia in cattle — and the extermination of insect pests, whether those damaging agricultural crops or those transmitting animal or human diseases (2, 4). The pre-eminence gained by the veterinarians over the physicians in short-term eradication of infectious diseases is largely due to their possessing one very effective weapon, the wholesale destruction of infected animal herds, a measure obviously denied to the human health worker.

Although the aim of eradication — rather than mere reduction, or 'control' — of infectious diseases was occasionally mentioned before then, it was only

after 1945 that there was a strong general movement promoting this approach, eventually formalized in the concept of time-limited eradication campaigns, as opposed to indefinitely continued control measures.

This new approach was chiefly stimulated by the vast and swift development of biomedical science that took place between 1935 and 1950. *Theobald Smith's* famous book *Parasitism and Disease* was published in 1934 (5) (*Smith* used the term 'parasite' to embrace all microbial agents of disease). From his chapter on 'Utilization of Discoveries in Parasitism' it becomes clear that at the time there were in use only three specific drugs against microbial agents: arsphenamine in syphilis, quinine in malaria and tryparsamide in sleeping sickness, all of them considered today poorly effective and now largely abandoned. Shortly afterwards began the immense development of anti-infective drugs, starting with the sulfonamides and continuing with penicillin and other antibiotics in the 1940s. As to vaccines, there were, in 1934, only two substances for *active* immunization sufficiently effective to be considered acceptable today: cowpox vaccine against smallpox and Ramon's anatoxin against diphtheria (still in the experimental stage in 1934). Only a few years later came the breakthrough towards highly effective vaccines with the introduction of the 17D strain yellow fever virus vaccine (6).

It is against this background that we must comprehend the enthusiasm, perhaps over-enthusiasm, of public health workers who suddenly, in the late 1940s and early 1950s, found themselves in the possession of a formidable array of powerful weapons: highly specific anti-infective drugs, highly effective vaccines, and last but not least, the new miracle synthetic insecticides (DDT and HCH in the beginning) for use against insect vectors of diseases. If it had been possible already before these developments to control effectively a number of infectious diseases, certainly, so it was argued, it must now be feasible to attain swift and complete eradication of many diseases within a brief period, through well-planned, intensive, large-scale campaigns.

Thus large-scale regional and global campaigns against yellow fever, malaria and yaws were set in motion at the end of the 1940s and the beginning of the 1950s. All these campaigns brought about reduction of illness to a degree and on a scale never witnessed before, but not in all of them and not everywhere was the proclaimed aim of eradication reached, and in practically none, within the planned span of time.

From their very beginning, and exacerbated by the inevitable ups and downs occurring during their course, critical voices were heard questioning the feasibility of eradication in general or its economic and administrative advisability in particular instances. We shall now examine the arguments in this controversy under three main headings: (A) conceptual confusion in the definition of 'eradication'; (B) the scientific-biological argument, and (C) the administrative, health-planning argument.

Conceptual Confusion in the Definition of 'Eradication'

Part of the controversy regarding the question 'control or eradication?' stems from the lack of a common, uniform concept of the meaning of the term 'eradication'; thus often those who hold differing opinions are speaking of different things and are at cross-purposes. This can be illustrated by looking at various definitions by different authors.

Cockburn's Definition

The most exact — and exacting — is *Cockburn's* (1, 7): 'Eradication is the extinction of the pathogen that causes the infectious disease in question; so long as a single member of the species survives, then eradication has not been accomplished... *Regional* eradication implies a basically unstable situation.'

Nobody could quarrel with the scientific clarity and precision of this statement. But it would indeed be impractical to plan the 'eradication', *sensu stricto*, of almost any infectious disease, using this definition. (Strangely enough, *Cockburn* must be counted amongst the pro-eradicationists by his overall approach and conclusions.) What is missing in this definition is a consideration of practical aims of eradication from a public health point of view.

The Andrews-Langmuir Formulation

The following definitions of 'control' and 'eradication' were formulated by *Andrews and Langmuir* (8): 'Control is the *purposeful* reduction of specific disease prevalence to relatively low levels of occurrence... eradication ditto, but to the point of continued *absence of transmission* within a *specified area*.'

This definition of eradication contains a statement of aims in practical terms, in contrast to the absolute terms of *Cockburn's* statement.

The Russian Concept

The statements of various Russian authors and their reviewers (9–12) could roughly be summarized as follows: 'The aim of eradication of an infectious disease is its reduction to a level at which it ceases to constitute an important public health problem.' The levels required are, in the USSR, specifically fixed for each infectious disease. These levels are so low that probably very little transmission is still taking place at that stage; yet the Russian authors state clearly that preventive measures have to be continued. This, in our view, signifies 'control' rather than 'eradication'.

Eclectic-Differential Approaches

Payne (13, 14) proposes a more flexible and differentiated approach to control and eradication of infectious diseases. He distinguishes between three steps or grades: control, 'elimination' and eradication. 'Elimination' is conceived

as a reduction of the disease prevalence to a lower degree than is aimed at in ordinary control, but without attempting complete eradication. As to eradication, he has certain doubts in principle as to its feasibility or (economic) advisability and prefers, at that time (1962–1963) to reverse judgement; he states however, that for certain carefully selected diseases, eradication may be the method of choice.

Spînu and Biberi-Moroianu (15) largely adopt *Payne's* concepts and describe the national 'anti-epidemic' planning in Rumania after 1960, in which 'control' was decided upon for one group of diseases, 'elimination' for another (taken as 'elimination of the disease, not the pathogen') and 'eradication' (complete interruption of transmission) for a third. (This is a paper worth reading in full — though published in a Rumanian journal it is written in English. By the time of its publication — 1969 — the various targets had either been reached or nearly so; incidence-prevalence rates fixed for specific diseases and the degree of control attained are spelled out.)

The definitions quoted reveal marked conceptual differences with regard to the aims of eradication (whether expressly stated or implied), ranging from a reduction in disease incidence-prevalence below 'public health importance' to worldwide complete extinction of the pathogen. Were it only a question of semantics, there would be little point in protracted argument whether a certain programme should be called 'control' or 'eradication' (or 'elimination'), as long as the programme sets out clearly what its objectives are.

But the difference between control (including 'elimination') and eradication is not merely a matter of degree; it is an essential difference from the point of view of public health action. This was been clearly expressed by *Cockburn* (1, p. 134) in the following sentences: 'There is an essential difference between the concepts of eradication and control. Once eradication is achieved the infection is gone forever, and the *costly burden of recurring control measures may be dropped*. If procedures have to be continued to prevent return of the infection, then the state is one of control and not eradication.'

The aspect which has attracted epidemiologists and health administrators to the idea of eradication is not the academic satisfaction of proving its possibility, but its practical, socio-economic advantage over control, i.e. freedom from the effect of a disease for the price of a time-limited 'capital investment' in an eradication campaign as against the ever-recurring costs of control measures. The latter can easily be shown to be considerably more expensive (even if calculated for a limited period of say 20–30 years) than the capital investment of eradication.

The practical application of this concept depends on the feasibility of regional eradication — continued absence of transmission in a specified area, the possibility of strict limitation of time of the campaigns, and the manageability of the many economic and practical problems inherent in such a type of