Smallpox and its Eradication

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The authors alone are responsible for the views expressed in this publication.

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Contents

		Page
Foreword, *by Dr Halfdan Mahler*		vii
Preface		ix
Acknowledgements		xiii
Chapter 1.	The clinical features of smallpox	1
Chapter 2.	Variola virus and other orthopoxviruses	69
Chapter 3.	The pathogenesis, pathology and immunology of smallpox and vaccinia	121
Chapter 4.	The epidemiology of smallpox	169
Chapter 5.	The history of smallpox and its spread around the world	209
Chapter 6.	Early efforts at control: variolation, vaccination, and isolation and quarantine	245
Chapter 7.	Developments in vaccination and control between 1900 and 1966	277
Chapter 8.	The incidence and control of smallpox between 1900 and 1958	315
Chapter 9.	Development of the global smallpox eradication programme, 1958–1966	365
Chapter 10.	The Intensified Smallpox Eradication Programme, 1967–1980	421
Chapter 11.	Smallpox vaccine and vaccination in the Intensified Smallpox Eradication Programme	539
Chapter 12.	South America	593
Chapter 13.	Indonesia	627
Chapter 14.	Afghanistan and Pakistan	659
Chapter 15.	India and the Himalayan area	711
Chapter 16.	Bangladesh	807
Chapter 17.	Western and central Africa	849
Chapter 18.	Zaire and Sudan	911
Chapter 19.	Eastern Africa: Kenya, Uganda, United Republic of Tanzania, Rwanda and Burundi	945
Chapter 20.	Southern Africa	969
Chapter 21.	Ethiopia, Yemen and Democratic Yemen	997
Chapter 22.	Somalia and Djibouti	1037

Chapter 23. Smallpox in non-endemic countries 1069

Chapter 24. The certification of eradication: concepts, strategy and tactics 1103

Chapter 25. Certification by international commissions: 1973–1977 1149

Chapter 26. Certification of 29 countries of Africa and Asia: 1978–1979 1195

Chapter 27. The completion of global certification: the Horn of Africa and China 1227

Chapter 28. Post-eradication operations: implementation of the recommendations of the Global Commission 1263

Chapter 29. Human monkeypox and other poxvirus infections of man 1287

Chapter 30. Potential sources for a return of smallpox 1321

Chapter 31. Lessons and benefits 1345

References 1371

Index of names 1411

Subject index 1421

Contents

		Page
Foreword, *by Dr Halfdan Mahler*		vii
Preface		ix
Acknowledgements		xiii
Chapter 1.	The clinical features of smallpox	1
Chapter 2.	Variola virus and other orthopoxviruses	69
Chapter 3.	The pathogenesis, pathology and immunology of smallpox and vaccinia	121
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Chapter 6.	Early efforts at control: variolation, vaccination, and isolation and quarantine	245
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Chapter 8.	The incidence and control of smallpox between 1900 and 1958	315
Chapter 9.	Development of the global smallpox eradication programme, 1958–1966	365
Chapter 10.	The Intensified Smallpox Eradication Programme, 1967–1980	421
Chapter 11.	Smallpox vaccine and vaccination in the Intensified Smallpox Eradication Programme	539
Chapter 12.	South America	593
Chapter 13.	Indonesia	627
Chapter 14.	Afghanistan and Pakistan	659
Chapter 15.	India and the Himalayan area	711
Chapter 16.	Bangladesh	807
Chapter 17.	Western and central Africa	849
Chapter 18.	Zaire and Sudan	911
Chapter 19.	Eastern Africa: Kenya, Uganda, United Republic of Tanzania, Rwanda and Burundi	945
Chapter 20.	Southern Africa	969
Chapter 21.	Ethiopia, Yemen and Democratic Yemen	997
Chapter 22.	Somalia and Djibouti	1037

Chapter 23. Smallpox in non-endemic countries 1069

Chapter 24. The certification of eradication: concepts, strategy and tactics 1103

Chapter 25. Certification by international commissions: 1973–1977 1149

Chapter 26. Certification of 29 countries of Africa and Asia: 1978–1979 1195

Chapter 27. The completion of global certification: the Horn of Africa and China 1227

Chapter 28. Post-eradication operations: implementation of the recommendations of the Global Commission 1263

Chapter 29. Human monkeypox and other poxvirus infections of man 1287

Chapter 30. Potential sources for a return of smallpox 1321

Chapter 31. Lessons and benefits 1345

References 1371

Index of names 1411

Subject index 1421

Foreword

For more than three thousand years, smallpox was a major scourge of mankind, spreading across the world as new centres of population became established and grew in size. Because of its high fatality rate, it was universally feared; in the towns and cities of Asia and Europe where records were kept, it caused on average 10% of all deaths each year. As early as the tenth century, Chinese and Indian sages had discovered a method that provided some protection against this terrible scourge, albeit one which often resulted in serious illness and some loss of life. This was the inoculation of smallpox virus from scabs—variolation—a practice that was taken up in a number of countries but seldom widely applied. Then in 1796 came one of the seminal discoveries of medicine—the demonstration by experiment that a harmless virus obtained from cows could protect man against smallpox. Edward Jenner, an English country doctor, had discovered vaccination—a practice which was rapidly disseminated throughout the world. It resulted in a marked decrease in the toll of smallpox in the industrialized countries, but the disease continued almost unabated in Africa, Asia and Latin America.

The World Health Organization was established in 1948 and from its inception successive World Health Assemblies urged Member States to take all measures to control smallpox. In 1953 the first Director-General, Dr Brock Chisholm, made an unsuccessful attempt to persuade the World Health Assembly to undertake a global smallpox eradication programme. Five years later a Soviet delegate to the Assembly, Dr Viktor Zhdanov, persuaded the Organization to accept responsibility for a global eradication programme. But only minimal funds were provided, and although by 1967 the disease was eliminated from some thirty countries in Asia, Africa and South America, the hard core of the problem—the Indian subcontinent and most countries in sub-Saharan Africa—was largely unaffected.

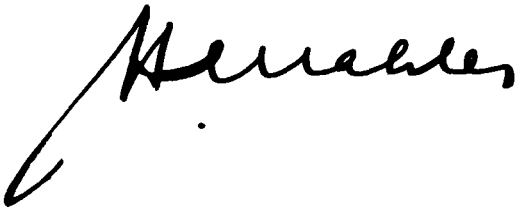
In 1966 the World Health Assembly decided that this situation was intolerable, and established an Intensified Smallpox Eradication Programme, with an annual allocation of $2.4 million from the WHO regular budget and the declared goal of global eradication within 10 years. Thanks to the efforts of numberless national health staff in the endemic countries, the enthusiastic devotion of international workers, and the masterly coordination of the effort by the WHO Smallpox Eradication unit, the goal of global eradication was achieved in just over ten years.

Simultaneously, a sustained effort was made to demonstrate to the public and the international health community that eradication had indeed been achieved, by a carefully orchestrated certification programme planned and coordinated by the World Health Organization. The result was that on 8 May 1980 the Thirty-third World Health Assembly adopted a resolution declaring that smallpox had been eradicated globally. In another resolution it endorsed 19 recommendations covering all aspects of the post-smallpox-eradication era, including the cessation of vaccination of the public and of international travellers. Despite intensive surveillance, no case of endemic smallpox has been detected anywhere in the world since the last case in Somalia in October 1977.

The Thirty-third World Health Assembly recommended that this unique accomplishment should be properly recorded; this book is the result. Written by five men who were intimately associated with various aspects of the eradication and certification programmes, and subject to detailed review by many of their colleagues

in the eradication campaign, it provides a comprehensive description of a formerly cosmopolitan and lethal disease that man has now eradicated, forever, and of the programme in some eighty countries in Africa, Asia and South America that led to this achievement. The major part of the book recounts the saga of eradication in the ancient strongholds of the disease—Africa, the Indian subcontinent and other parts of Asia. Also included are descriptions of other poxvirus infections of man, and a detailed description of a new, generalized orthopoxvirus disease of man, human monkeypox, discovered during the smallpox eradication programme. The book concludes with an overview of the lessons learnt during the programme—lessons that have already been applied by the World Health Organization to a variety of other programmes designed to lighten the burden of human illness, from the Expanded Programme on Immunization to the new efforts on AIDS.

The World Health Organization, and I, as its Director-General, are proud of this signal achievement in preventive medicine, and proud of the book in which it is described, with its wealth of detail and colour plates, figures, maps and graphs, that records for posterity just what this extinct disease was like and describes in graphic terms the problems and successes of the Intensified Smallpox Eradication Programme.



H. Mahler, M.D.
Director-General

Preface

The world's last naturally occurring case of smallpox developed illness in Somalia late in October 1977; the last case, which was associated with a laboratory infection, occurred in England in September 1978. Following an extensive programme to verify the absence of the disease, the Thirty-third World Health Assembly in May 1980 adopted a resolution accepting the report of the Global Commission for the Certification of Smallpox Eradication, and affirming its belief that this once-universal disease had been eradicated world-wide. In the resolution, the Health Assembly requested "the Director-General to ensure the production, within a reasonable period of time, of appropriate publications describing smallpox and its eradication, in order to preserve the unique historical experience of eradication and thereby contribute to the development of other health programmes". This book, published by the World Health Organization, responds to this request. The authors, all of whom were personally involved in the programme's execution, are, however, entirely responsible for the opinions expressed.

Preparation of the book began in 1980 and was completed in 1987. It was a truly collaborative effort, and each of the authors reviewed and commented on all chapters at various stages of their preparation. Dr Fenner was responsible for the overall organization of the book, the reference lists and the indexes, and wrote Chapters 1–6, 8, 29 and 30. Dr Henderson wrote Chapters 9, 10, 12–22 and 31, assisted by Dr Ježek, who assembled and drafted basic material from the WHO Smallpox Archives and elsewhere. Dr Arita prepared the drafts of Chapters 7, 11 and 23–28 for further editing by Dr Fenner.

The four authors just named wish to pay special tribute to their co-author, Dr Ivan D. Ladnyi, whose tragic death in March 1987 prevented him from contributing, to the later stages of the preparation of this book, the full wealth of his knowledge and experience of the Intensified Smallpox Eradication Programme. His experience was especially valuable as he had both participated actively in the field work in Africa and provided staunch support and leadership in his later position as Assistant Director-General of the World Health Organization.

In addition to review of each chapter by each of the authors, 78 other persons, who were experts in an appropriate scientific field or who had personal knowledge of a particular eradication or certification programme, commented on various chapters when they were in draft form. Their names and affiliations are listed in the Acknowledgements.

The Intensified Smallpox Eradication Programme, the description of which is the main focus of this book, involved many people, in many parts of the world. Its successful prosecution depended on a variety of different activities, ranging from field work to administration through laboratory studies and fund-raising. We decided that the book would be most instructive if it incorporated the whole of this spectrum, and this we have endeavoured to reflect. For completeness, we have also provided a full account of the clinical and epidemiological features of the disease, the history of smallpox and of vaccination, and a description of the immunological and virological aspects of smallpox and of vaccination.

The structure of the book is defined by the chapter headings, but it may be useful to elaborate on the rationale of the nature and order of the topics covered. First, we

thought that a well-illustrated description of this now-extinct disease should be provided, so that readers would understand the nature of what was one of man's most serious diseases (Chapter 1). Then, since smallpox was caused by one virus and was eradicated through use of a vaccine which was prepared from another, related virus, there are chapters on the virology, pathology, pathogenesis and immunology of orthopoxvirus infections in general and smallpox in particular (Chapters 2 and 3). The other basic science crucial to smallpox eradication was epidemiology (Chapter 4), since eradication could not have been achieved without adequate understanding of how the disease was transmitted or if an animal reservoir had been present.

Following these four technical chapters, smallpox and its control are set in their historical perspectives in Chapters 5–8. The long and fascinating history of smallpox is summarized in Chapter 5, which deals with the history of smallpox from ancient times until the end of the 19th century, and in Chapter 8, which is concerned with its extent and incidence between 1900 and 1958, when global eradication was first proposed in the World Health Assembly. Likewise of interest is the history of the methods used to mitigate the severity of smallpox (variolation) and to prevent the disease (vaccination), which antedate other methods for successful intervention in infectious diseases. Thus Chapter 6 describes the early use of variolation and the introduction of vaccination, from the time of its discovery by Edward Jenner until the end of the 19th century. The fourth historical chapter (Chapter 7) traces developments in smallpox vaccine and vaccination up to 1958.

The succeeding 15 chapters describe various aspects of the global eradication campaign. Chapter 9 explores the development and application of the concept of eradication, the events which led to the resolution in the World Health Assembly in 1959 that global smallpox eradication be undertaken, the progress that was made in this effort between 1959 and 1966, and finally the circumstances which culminated, in 1966, in a decision to begin an intensified programme. Chapter 10 summarizes major events and developments in the Intensified Smallpox Eradication Programme throughout its course, from 1967 to 1980, and provides a perspective for subsequent chapters, which deal with operations in different parts of the world. It concludes with a series of maps of the world, graphs, and accompanying text, which encapsulate the history of this period. The provision of adequate amounts of a potent and stable vaccine and the development of better methods of vaccination were of such central importance to the Intensified Smallpox Eradication Programme that Chapter 11 is devoted in its entirety to these topics.

Chapters 12–22 describe the actual operations of the Intensified Smallpox Eradication Programme in different parts of the world on a geographical basis, corresponding, in large part, to the temporal sequence in which they were begun or strengthened. Because of travel between the endemic countries and their neighbours, as well as between them and more distant industrialized countries (from which endemic smallpox had been eliminated by 1950) there were many importations, some with serious consequences. Chapter 23 is devoted to this subject and to infections which occurred in laboratories.

The programme involved not only the eradication of smallpox, but also an array of activities designed to provide the world community with the necessary level of assurance that smallpox had indeed been eradicated. Without this, national health services would not have agreed to discontinue the vaccination of their own populations, nor would they have accepted the proposal that international travellers should be admitted without a valid vaccination certificate. Chapters 24–27 review the methods employed to certify that smallpox eradication had been accomplished, as well as observations made during the certification process.

In 1980, when the Thirty-third World Health Assembly proclaimed the achievement of global eradication, it adopted 19 recommendations made by the Global Commission for the Certification of Smallpox Eradication, for activities to

be conducted in the post-eradication era—from 1980 until the publication of this book. Chapter 28 describes the implementation of these recommendations. This is followed by a chapter detailing the investigations which were undertaken to determine the nature and public health importance of human monkeypox, the smallpox-like disease that was discovered during the eradication campaign in Africa. Chapter 30 looks again at the virology and epidemiology of smallpox, to answer—with confidence—questions about its possible recurrence or return as a human disease. The book concludes with a chapter which attempts to fulfil the request of the World Health Assembly that the book should discuss "the principles and methods that are applicable to other programmes", and assesses the costs and benefits of the Intensified Smallpox Eradication Programme.

* *
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In preparing the book, the authors have availed themselves of the extensive published literature and have cited references wherever possible. For activities after 1960, they have relied most heavily on the special smallpox archives that were established in WHO Headquarters in 1980. All data in the eradication and certification chapters not ascribed to a particular source came from these archives. Personal recollections of the authors and others who have been consulted have been regularly corroborated through reference to archival material and consultation with other participants.

We have provided many detailed tables documenting matters such as disease incidence, numbers of vaccinations performed, results of assessments and costs of the programme, in recognition of the fact that few such data have been published and access to them in the WHO archives is difficult. In this sense, the book is, and is intended to be, in part archival in nature. For clarity of exposition, we have liberally supplemented these tables with maps and graphs. We have used illustrations freely, for several purposes. We have endeavoured to include a photograph, either alone or in a group, of many of the more senior persons involved in the eradication programme. We have used colour photographs to illustrate the clinical appearance and relevant virological features of smallpox and other poxvirus diseases, and colour and half-tone prints provide a flavour of the terrain and circumstances under which the campaigns were conducted in different parts of the world.

We hope that this book will enable readers to appreciate the nature and magnitude of the task of global eradication of a once-common human disease; a goal that could not have been achieved without the dedicated contributions of hundreds of international experts and tens of thousands of national health workers, working within a framework of international cooperation provided by the World Health Organization. This book bears testimony to their efforts and a remarkable adventure in public health in which we have been privileged to share.

F. Fenner, D. A. Henderson, I. Arita, Z. Ježek
Geneva, September 1987

Acknowledgements

In order to ensure that the contents of each chapter were as accurate as possible and provided a properly balanced view of the state of the science or the nature of the operations involved, every chapter was first read critically by all the authors. When these comments and criticisms had been evaluated and incorporated by the primary author concerned, each chapter was sent to a number of reviewers.

The reviewers were people who were judged by the authors to be knowledgeable in the field covered in a particular chapter, as a scientist, as an administrator, or as a person who had been directly involved in a particular facet of the eradication campaign. The responses of the reviewers, whose names and affiliations at the time are listed overleaf, proved most useful; the decision whether to incorporate such comments was made by the author concerned.

In addition to the reviewers, who were most generous with their time and talents, there were many others without whose efforts this book could never have become a reality. The authors wish to acknowledge several in particular. Mr John Wickett of the World Health Organization assumed responsibility for the laborious task of preparing financial analyses, reconciling morbidity data, and compiling and verifying basic data pertaining to vaccine receipts and shipments and many other items of information. He also acted as photo editor, assembling pictures from public and private sources throughout the world and preparing them for publication. To ensure uniformity of style, the diagrams and black-and-white maps were all prepared by one artist, Mr Kevin Cowan of the Australian National University. The maps in full colour were prepared by Miss Susan Hobbs in Geneva. The authors also express their gratitude to Mr Dominic Loveday and Mrs Stella Deck of the World Health Organization for their editorial work on all aspects of the book, and to Mr Loveday and Mr Keith Wynn of the World Health Organization who guided the book through to publication.

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Most of the colour and half-tone illustrations used come from the WHO Smallpox Archives; others were kindly provided by various field and laboratory workers. A few were obtained from other sources, as indicated in the acknowledgements on each plate.

Preparation of so large and complex a book as this was inevitably an expensive task. The authors are grateful to the World Health Organization for providing office facilities and access to the WHO Smallpox Archives for work done in Geneva; the two senior authors are appreciative of the financial assistance provided by the World Health Organization for clerical and technical assistance, and to the Australian National University and the Johns Hopkins University respectively for special office facilities. Finally, both the World Health Organization and the authors are grateful for the financial assistance provided specifically for the production of the book by the Finnish International Development Agency, the International Division, Ministry of Health and Welfare, Japan, and the Japan Shipbuilding Industry Foundation.

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