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**ELIMINATION AND ERADICATION OF DISEASES,  
WITH SPECIAL REFERENCE TO MEASLES AND TUBERCULOSIS**

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## EXECUTIVE SUMMARY

Control of communicable diseases, which implies reducing their occurrence, has always been a major public health priority. Elimination or eradication of a disease, in general, depends on identifying the various interactive factors related to its occurrence, in addition to the available effective intervention techniques.

Elimination means the disappearance of transmission of an infection from an area (small or large) within a country, a region or a continent such that it ultimately becomes free of the infection, or the reduction of case transmission to a predetermined very low level at which the disease is no longer a public health problem. Eradication, defined as the extinction of the pathogen that causes the infectious disease in question or as the achievement of a status whereby no further cases of a disease occur anywhere and continued control measures are unnecessary, implies, for infectious diseases, that transmission of the causative agent has ceased irreversibly as a result of its extermination and that the infection has disappeared from all countries of the world.

Following the success in smallpox eradication and the considerable achievements of the Expanded Programme of Immunization against six diseases of childhood (poliomyelitis, measles, neonatal tetanus, diphtheria, pertussis and tuberculosis), elimination and eradication became again the objective for many diseases, including poliomyelitis, dracunculiasis, leprosy, measles and neonatal tetanus, and recently tuberculosis.

Elimination of tuberculosis could be achieved through proper adoption of control strategies that focus on case finding based on microscopy and culture techniques, treatment of all cases using DOTS, screening for infected individuals who are at increased risk of developing the disease, use of preventive chemotherapy in persons identified as being at risk of developing the disease; and vaccination of neonates with BCG.

Measles elimination/eradication is possible through strengthening of immunization services, including high routine immunization coverage together with mass immunization campaigns, and strengthening of measles surveillance, including development of standard case definitions, a standard format for measles cases investigation, and national and subnational measles diagnostic laboratories with properly trained personnel and suitable equipment and reagents. Also, immediate reporting from all health facilities together with laboratory confirmation of reported cases would be required.

It is recommended that a task force is convened to identify diseases which are feasible for elimination or eradication from the Region and to study the cost-effectiveness of programmes aimed at achieving these targets. Measles elimination strategies should be implemented immediately in countries which have interrupted transmission of poliomyelitis. Other countries should adopt measles control acceleration strategies in preparation for further elimination.

Member States with low incidence of tuberculosis should adopt a target of tuberculosis elimination by the year 2010. The strategy DOTS All Over should be implemented in all countries with intermediate to high incidence as a prerequisite phase for initiation of the elimination process.

## 1. INTRODUCTION

Infectious diseases continue to be the world's leading cause of morbidity and mortality, accounting for at least one in every three deaths globally. The toll of morbidity is also significantly high.

Control of communicable diseases, which implies reducing their occurrence, has always been a major public health priority. In the past, control measures were based on incomplete knowledge of the epidemiology of the disease to be controlled and were directed at perceived factors of disease causation. As knowledge of the epidemiology of diseases improved, and with the development of scientifically sound intervention techniques, it has been possible to direct specific control measures at factors related to the occurrence of particular diseases. With recent developments in disease control technologies, new and more optimistic targets for the reduction in the occurrence of a disease have been put forward, and the concept of eradication, which implies that the disease will no longer occur in a population, has been widely adopted.

Attempts to stamp out infectious diseases began almost a century ago. In 1896, rabies was declared eradicated from the United Kingdom. In the first decade of this century yellow fever was eradicated from Cuba. In 1917, a decision was made to eradicate bovine tuberculosis from the United States of America. However, modern ideas on eradication began with the work of Soper and his colleagues in South America in the 1930s. These efforts were mainly directed against the mosquito *Anopheles gambiae* which was newly introduced in Brazil and had resulted in a devastating epidemic of malaria. A programme to eradicate every single specimen of this vector started in 1939, and by 1941 the task had been completed. In the early 1940s, Upper Egypt was caught in the grip of a similar epidemic to that of Brazil, also caused by *A. gambiae*. Dr Soper and his team were also successful in eradicating the species from Upper Egypt.

These successes made the eradication concept more popular: WHO proclaimed the global goals of malaria eradication and then smallpox eradication. The latter was successfully achieved in 1980.

With the eradication of smallpox and the considerable achievements of the Expanded Programme on Immunization against six diseases of childhood (diphtheria, measles, pertussis, poliomyelitis, tetanus and tuberculosis), elimination or eradication again became the objective for many diseases, including poliomyelitis, dracunculiasis, measles, neonatal tetanus and recently tuberculosis.

Past experience made it imperative that before undertaking any disease eradication/elimination project all epidemiological and public health aspects of that disease problem should be studied and critically appraised. Questions about the past, current and future situation and importance of the disease problem, the availability of technically sound intervention strategies and the feasibility of implementation of these strategies in well defined communities should be answered prior to any commitment to eradication/elimination. It should always be kept in mind that although setting targets is extremely useful for mobilizing resources and enhancing the credibility of the health sector, failure in achieving these targets can have grave repercussions.

## 2. DEFINITION OF TERMS

Clear definition of the essential terms used in this context is necessary before going any further. The implications of these definitions should also be stressed.

### 2.1 Control

As applied to many communicable and some noncommunicable diseases, control means *ongoing operations* or programmes aimed at *reducing* the incidence and/or prevalence of such diseases.

Control may be looked upon as a process with different levels of reduction in frequency, reduction to a point where a disease ceases to become a major public health problem or reduction to a point of great rarity and extermination. In this sense elimination and eradication are the highest levels of control.

### 2.2 Elimination

Elimination has been used to describe two different epidemiological situations:

- a) *Elimination of infection*. This refers to disappearance of transmission of an infection from an area (small or large) within a country, region or continent, which ultimately becomes free of the infection, e.g. disappearance of poliomyelitis from the Americas. Infection can be reintroduced as long as it is present in other parts of the world.
- b) *Elimination of disease*. This means that the occurrence of cases has decreased to zero while infection may still occur. The term is also used to denote reduction of case transmission to a predetermined very low level at which the disease is no longer a public health problem, e.g. elimination of neonatal tetanus, leprosy, tuberculosis.

### 2.3 Eradication

The definition of eradication given by Cockburn in 1961 during a meeting of the American Public Health Association has received wide acceptance in public health circles. He defined eradication as the extinction of the pathogen that causes the infectious disease in question. So long as a single member of that species survives then eradication has not been accomplished. This definition implies action on a worldwide scale.

WHO defines eradication of a disease as the achievement of a status *whereby no further cases of a disease occur anywhere, and continued control measures are unnecessary*. It implies, for infectious diseases, that transmission of the causative agent has ceased irreversibly through its extermination and the infection has disappeared from all countries of the world.

In the past, particularly in the 1930s and 1940s, the concept of regional eradication was used. However it implies a basically unstable situation because at any time the infection may be reintroduced. It is now accepted everywhere that the term "eradication" should only be used when it refers to global eradication.

The essential difference between eradication and elimination and control is that once eradication is achieved, the infection has gone for ever and control measures may be dropped completely. If control measures have to be continued to prevent a return of infection then the state is one of control and not eradication.

It is clear from these definitions that elimination is a step towards eradication but falls short of it. The shortfall is either in the fact of the geographic coverage being less than global, or in the level of disease reduction being less than complete absence.

### **3. BASIC PRINCIPLES**

Elimination or eradication of a disease depends, in general, on identifying the various interactive factors related to its occurrence. The degree of comprehensiveness with which these factors are identified and are susceptible to modification through intervention strategies will determine the ability to implement control and hence elimination or eradication measures. This means that for elimination or eradication (at any level) of any disease, the epidemiological features of that disease should be known in addition to the availability of effective intervention techniques.

Infectious diseases occur as the end result of the interaction of three major factors—the agent, the mode of transmission and the host. The relationship between these three factors is known as the chain of infection. The environment is an integral part of this relationship in that it affects individually or collectively all three factors. Each factor (link) is composed of elements that must be defined as completely as possible in order to determine the most appropriate direction for the application of specific and potentially effective control measures. These should be directed at the most susceptible factor or factors in the chain—the points at which such action would be most likely to control the subsequent occurrence of the disease.

The more we know about the specific characteristics of the agent (such as pathogenicity, invasiveness, infective dose, antigenic variation, reservoir and source), such as by the mode of its transmission (by contact, by common vehicle, airborne or vector-borne) and the host defence mechanism (nonspecific or specific), the more will be our capability of identifying the weak points in the chain as a whole.

When the first link, the agent, is deemed to be the most susceptible, then control measures against that agent may be directed at the reservoir or source of the agent in an attempt to eradicate or reduce the quantity of the agent available for dissemination. In this case, control measures include isolation of the reservoir, treatment of the reservoir and elimination of the source if feasible. The main difficulties in dealing with this link lie in the fact that the reservoir might be inapparent and difficult to detect or it might be unreachable (for example, wild animals).

When the control measures are to be directed at the second link, transmission, then the goal will be to interrupt transmission of the agent from the source to the susceptible host. Control measures here include disinfection and decontamination techniques, personal hygiene and vector control measures.

When the best means of control is determined to be related to the third link in the chain of infection (that is, the host) attention should be directed to improving the defence mechanisms of the host. Control measures here are mainly immunization and chemoprophylaxis. Vaccination is one of the most important control measures when a potent, safe and easily administered vaccine is available.

For the control of many diseases all three links in the chain of infection should be attacked if measures are available. In some diseases, however, control measures may be focused on one specific link.

Several questions should be answered before initiating a specific disease elimination or eradication programme. The main ones are as follows.

- What is the public health importance of the disease problem? This is usually determined by several indicators, including morbidity and mortality figures, administrative and public-relations pressures, and regional and international action.
- What is the available knowledge about the epidemiological features of the disease? This is determined usually by the available knowledge about the different elements of the interacting factors in the chain of infection and about the distribution of the disease in the community.
- What are the available intervention techniques? These are determined by the scientifically sound measures that can modify the factors related to the occurrence of the disease.
- What is the feasibility of implementation of the available intervention techniques? This is determined by the safety, acceptability and the cost of the measures, the availability of both human and material resources to apply the measures and the efficiency of the health system for implementing the measures.
- What is the set target for control of the disease problem? This is determined by the level of control aimed at reduction, elimination (in either of its definitions) or eradication.

#### **4. POSSIBILITY AND FEASIBILITY OF ELIMINATING OR ERADICATING A SPECIFIC DISEASE**

##### **4.1 Technical aspects**

###### *4.1.1 Transmission and distribution*

Clear understanding of all the elements comprising the links in the chain of infection of a disease to be eliminated or eradicated and of the environmental factors that affect these links, as well as the distribution of the disease in particular populations, e.g. high-risk groups, high-risk areas and time changes in occurrence, is essential.

Theoretically, certain epidemiological features of a disease might make it more amenable to elimination or eradication. For instance the prospect of achieving eradication is most practicable for diseases in which the human host is the only reservoir for the agent, as was the case for smallpox and is for poliomyelitis and measles. The prospect increases when all infection in the reservoir is clinically apparent. In these instances the reservoir is both

detectable and reachable. This is also true for the source of infection, as is the case for tuberculosis, where the source of infection is almost always the smear-positive sputum of cases of pulmonary tuberculosis.

Another element which might determine the prospect for eradication is the scope of antigenic variation of the agent since it affects the development and persistence of natural and artificial immunity. A good example of this is the influenza virus, which undergoes antigenic drifts and shifts making it difficult to plan for its eradication.

The mode of transmission of infection affects also the prospect of eradication. In some diseases there is only one route, in others the agent is transmitted by several routes, some of which might still be obscure. It is obvious that the more routes there are (especially when some are still obscure), the more difficult the disease will be to control.

The level and duration of immunity developing after natural infection or artificial immunization determine for some diseases the likelihood of achieving elimination or eradication. If the immunity ensuing after natural infection or immunization is strong and persists for life then that disease is more prone to eradication. A good example of this is the strong immunity seen after infection with poliomyelitis and measles.

#### 4.1.2 *Control measures*

Scientifically sound and practically implementable effective control measures must be available. A disease can be eliminated or eradicated if one or all of the following tasks are accomplished.

- a) Elimination of the agent from its reservoir. This would entail in practice the existence of a highly effective treatment regimen (with a cure rate higher than 95%), such as in the case of tuberculosis. In order for this measure to be of real value, it is essential to detect and reach every individual in the reservoir. Another possible effective intervention would be to eliminate the reservoir itself when it is nonhuman, as is the case with rabies.
- b) Complete interruption of transmission. This is possible when there is one route of transmission for the disease that can be modified in such a way that transmission stops for the period needed to achieve eradication. A good example of this is a disease such as yellow fever, which is transmitted biologically only, by a vector, and this vector can be eliminated for a specific period of time.
- c) The establishment of a strong immunity barrier in the host. This is possible if there is a vaccine against the disease which is immunogenically potent at all ages, leads to long-lasting immunity and is safe and easily administered. Good examples of such vaccines are those against poliomyelitis and measles.



## **4.2 Other factors**

### *4.2.1 Political stability and commitment*

Eradication programmes are usually long-term and require international cooperation. Political instability, upheavals and internal strife make eradication programmes less likely to succeed. Examples are the problems facing dracunculiasis eradication in southern Sudan and the setbacks in poliomyelitis eradication in northern Iraq. Without strong political commitment, the elimination or eradication initiative cannot be launched and will never succeed. This commitment should be translated into sustained administrative and material support for the strategic plan of elimination or eradication and should facilitate implementation in all its phases. With this commitment, experience has shown that even in war-troubled areas much can be done, as with poliomyelitis eradication efforts in South America and in negotiating periods of tranquillity in order to implement national immunization days in Afghanistan as part of poliomyelitis eradication efforts.

### *4.2.2 International support*

Global eradication programmes with their high cost and intense labour will not be successful if they do not have international support. The task of ensuring this support has best been done through WHO. There is a clear example of the success of international collaboration in smallpox eradication, particularly at the stage when some countries had only a lukewarm interest in the project, as happened in Somalia. The ongoing international support for poliomyelitis eradication is another example and there will hopefully be other examples soon in measles and tuberculosis elimination.

International support is particularly important for confronting difficulties in areas where the disease in question is of no public health importance locally. It becomes difficult to persuade decision-makers to allocate sufficient funds and make the efforts required for something that causes few local difficulties while they are facing many other problems competing for resources. There is an example in poliomyelitis eradication where, in some countries, the problem is not great enough to create an impetus to organize expensive measures that would, in some cases, be largely for the benefit of neighbouring countries.

Moreover, it is to be noted with satisfaction that some countries are supporting eradication efforts even though the disease is no longer of public health importance in their own countries. For example, the United States of America funded smallpox eradication worldwide and at present strongly supports global poliomyelitis eradication efforts although the disease has been extinct in the Americas for nearly five years. The support of the Islamic Republic of Iran for the poliomyelitis national immunization days in Afghanistan in providing the vaccine required is another example.

### *4.2.3 Availability of resources*

Both human and nonhuman resources are needed. Any strategic plan for elimination or eradication cannot be implemented without a cadre of health care professionals who are well equipped with the knowledge and skills needed for instituting the necessary activities. This could be ensured by a well structured training programme and in some cases, where

the personnel needed are too few for the task, by providing such technical support through international cooperation.

Implementation of the strategic plan will also require funds and other material resources. The cost of any elimination or eradication programme is higher per unit-time than the cost of an ordinary disease control programme. However, it is cheaper in the long run since such programmes are limited in time while ordinary control programmes continue as long as the disease problem continues. When the total national budget is inadequate, as it is in many developing countries, it is essential to seek the support needed, both material and financial, from partners. For example, in Sudan and Yemen, vaccine for national immunization days was secured from both the Centers for Disease Control and Prevention, Atlanta, USA, and Rotary International. However, whatever external support is provided there are crucial services that can be performed only by nationals themselves. They are vital in finishing the job of eradication in the final stages when external support recedes, as was the case with Pakistan and dracunculiasis eradication. The role of national authorities in efforts such as surveillance is vital and goes beyond any external support. They must pick up any reintroduction if a disease is not yet globally eradicated.

#### 4.2.4 *Efficiency of the health system*

An efficient health system built on the primary health care approach and with a high activity-coverage of the community will facilitate the implementation of the strategic plan for elimination or eradication and ensure its success. Areas characterized by low primary health care coverage and high endemicity of the disease will initially require temporary vertical programmes until the level of transmission has decreased to a predetermined level.

#### 4.2.5 *Coordination between various health care providers*

Coordination is essential to ensure complete harmony in the implementation of the strategic plan for elimination or eradication by all health care providers, including the private sector and nongovernmental organizations.

#### 4.2.6 *Community support*

It has been noted through many experiences in implementing health programmes in general, and intensive time-bound ones in particular (such as eradication programmes), that the support of the community is vital. This might be won through a well organized advocacy and health education plan.

## **5. TUBERCULOSIS ELIMINATION**

### **5.1 Justification**

The drive for the elimination of tuberculosis, which began in the USA and was picked up by scientific groups in Europe and other parts of the world, takes into consideration several public health facts which can be summarized as follows.

- Tuberculosis has lived long enough with humans, marking their history with misery and death.

- After an apparent decline in the incidence of tuberculosis, mostly noticed in the middle of this century, the disease is re-emerging globally, to the extent that in 1995 more people died of tuberculosis than in any other year in history.
- Even in developed countries and some developing countries with low incidence of tuberculosis, the rate of decline of incidence in the past 5 or 10 years has almost halted and is becoming stationary.

There are a number of factors behind the re-emergence of this disease and the halt in its decline:

- complacency in some countries, where the perception prevails that the disease is no longer a problem, and negligence in other countries, which has led to a deterioration of tuberculosis control programmes;
- the pandemic of HIV infection, which has a lethal partnership with tuberculosis;
- the emergence of multidrug-resistant tuberculosis as a result of poor patient management and incomplete treatment;
- the vast socioeconomic changes occurring in the world leading to large population movements over wide geographical areas, unorganized urbanization, increasing poverty and changes in lifestyle and behaviour.

There are also important epidemiological factors related to the possibility of elimination.

- Tuberculosis is a curable and preventable disease. Making use of available drugs, almost all patients with tuberculosis can be cured if properly treated. Preventive therapy with available drugs has proved to be very efficacious in preventing disease in infected individuals.
- Tuberculosis is not very infectious. It spreads essentially from one infected person to another. It is important to keep in mind that the smear-positive pulmonary case is by far the most important source of infection and it is quite possible to detect such a source by relatively simple means and render it noninfectious relatively quickly through chemotherapy. Thus, it is possible to reduce the problem of tuberculosis if control measures are applied.
- It has been demonstrated that the 10% annual rate of decline achieved in some countries following the extensive application of effective treatment programmes can be further increased to 20% by using the tools that are currently available.
- Tuberculosis control activities enjoy what is referred to as the “ratchet” effect, which means that any reduction in the level of the problem, under normal circumstances, can be sustained for sometime even if those activities cease or are interrupted (this is in striking contrast to a disease like malaria).
- Research is thriving in the field of tuberculosis with the aim of finding more effective tools for combating the disease and more efficient means for implementing available ones.

A comprehensive appraisal of these facts leads us to conclude that:

- The tuberculosis problem, if not contained properly and immediately, will race out of control.
- It is possible with available means and with the prospect of immediate use of new technologies to initiate a programme of tuberculosis elimination.

## 5.2 Operational definitions

The following definitions apply in all WHO documents on tuberculosis:

- *Low-incidence countries*: countries with an incidence of sputum smear-positive tuberculosis of 10 or fewer per 100 000 population or those with an incidence of all forms of active tuberculosis below 20 per 100 000 population.
- *High-risk groups*: groups with an incidence of sputum smear-positive tuberculosis of 50 or more per 100 000 population or with an incidence of 100 tuberculosis cases (all forms) per 100 000.
- *Elimination phase*: a phase reached when the incidence of sputum smear-positive cases is 1 per 100 000 population or fewer.
- *Elimination of tuberculosis*: reduction of incidence of tuberculosis (number of new cases) to a rate of 1 per 1 000 000 population or fewer.
- *Preventive therapy*: treatment of latent infection with *Mycobacterium tuberculosis* to prevent progression to active disease.

## 5.3 Intervention strategies

Theoretically speaking, tuberculosis can be eliminated if the following tasks are accomplished:

- detection and cure of all patients with active disease
- prevention of progression of infection to active disease in those already infected
- prevention of infection in those who are not infected.

The currently available prevention and control strategies to accomplish these tasks are:

- case-finding, which is based particularly on microscopy and culture techniques for the identification of mycobacteria
- treatment of all cases using short-course chemotherapy under direct observation
- screening for those individuals infected with *M. tuberculosis* that are at increased risk of developing the disease
- use of preventive chemotherapy in persons identified as being at risk of developing the disease
- vaccination of neonates with BCG.

Global experience shows that the above mentioned strategies have not yet been fully utilized in a well planned thrust against tuberculosis in any one community. As tuberculosis

elimination will depend on a more effective use of the existing intervention strategies, it is essential to outline the main aspects of these strategies.

a) *Case-finding*

Since cases of active tuberculosis are practically the only source of infection in the community, it is understandable that every active case should be detected as early as possible. Furthermore, among cases the main source of infection to others is the pulmonary sputum smear-positive case, and therefore every effort should be made to identify such cases through microscopy of sputum of suspect patients presenting with symptoms suggestive of the disease, such as cough for three weeks or more. This is by far the most reliable diagnostic method. Tuberculosis is difficult to diagnose with certainty by X-ray alone, and culture may be of help in reaching definite diagnosis in milder cases which are negative on microscopy.

Passive case-finding will remain the principle means of detecting tuberculosis cases and therefore the health care provider's index of suspicion for the disease should be high enough. Active case-finding should be used in low-incidence countries but it should be limited to population segments with high incidence of tuberculosis (an incidence which is greatly in excess of that in the general population).

b) *Treatment of cases*

The aims of treatment of tuberculosis cases are to cure patients, prevent death from active tuberculosis or its late effects, prevent relapse and development of resistant bacilli in infectious patients, and end or greatly reduce transmission of tuberculosis to others. This can be achieved to a great extent by short-course chemotherapy using proper combinations of available drugs. Recently WHO published guidelines on the treatment of tuberculosis for national programmes. In these guidelines standardized treatment regimens were recommended to accomplish the aims mentioned above. With short-course chemotherapy regimens it is possible to achieve cure rates as high as 95% or more in short periods of time, not exceeding six months in most instances, but for these regimens to be effective patients should take the prescribed drugs with sufficient regularity and duration. Non-compliance of patients with prescribed therapy can lead to the emergence of drug resistance, continuing transmission of infection, treatment failure and death. In order to overcome this problem, directly observed therapy (DOT) has been recommended by WHO. There is every indication that this is the most important intervention strategy available now for control of tuberculosis. There are several alternatives to ensure the proper implementation of DOT and the most appropriate for a particular community or a particular group in a community should be sought out.

Hospitalization for isolation purposes is usually unnecessary, since most patients with pulmonary tuberculosis quickly cease to be infectious once they are diagnosed and placed on an effective treatment regimen. However quarantine measures, including temporary institutionalization, should be used in those instances when infectious patients refuse to comply with directly observed therapy. Legal action might be needed in such instances.

c) *Screening for individuals at increased risk of tuberculosis and identification of high risk groups*

There are several factors that increase the risk of progression of infection with *M. tuberculosis* to active disease. The relative risk and prevalence of these factors in a community should be determined in order to define the screening and preventive intervention strategies applicable in that community. However the following risk factors might generally be considered because of their importance.

- *HIV infection.* This is the strongest identified factor for increasing the risk of progression to disease among those infected with tubercle bacilli. All persons infected with HIV should be screened for infection with *M. tuberculosis*.
- *Recent infection.* The risk of developing the disease is highest in the years immediately following infection. Contact investigation among newly discovered cases should receive high priority second only to treatment of new cases.
- *Fibrotic lesions.* Whenever a chest radiograph taken for any reason shows fibrotic lesions in an infected individual the risk of tuberculosis is high.

Other factors include the existence of a medical condition such as silicosis, diabetes mellitus, gastrectomy, low weight or one requiring immunosuppressive therapy.

Screening for infection in high-risk groups having an incidence of tuberculosis that is greatly in excess of that in the general population and the use of preventive therapy in those detected might be necessary for the elimination process. These groups usually include minorities, immigrants, displaced populations and other entrants from high-incidence countries.

Screening is done by using the tuberculin test, the results of which should be interpreted properly, especially in communities where BCG vaccination is widely used (a test resulting in a diameter of induration above 10 to 15 mm is considered positive). In some situations, for example among applicants for emigration or work, the use of radiographic screening in addition to tuberculin skin-testing has proven to be of value.

d) *Preventive chemotherapy*

Preventive chemotherapy means treatment of persons with latent infection with *M. tuberculosis* to prevent progression to active disease. Isoniazid (INH) preventive therapy has been found to reduce the risk of tuberculosis by more than 90% among persons who complete a full course of treatment. This strategy has proved to be very efficacious when used properly. It should be more widely used, but not indiscriminately, and thus it is necessary to clearly define groups at particularly high risk of developing tuberculosis in whom preventive chemotherapy would provide individual and public health benefit. There are certainly some obstacles for the widespread use of INH preventive chemotherapy such as the toxicity of the drug for some individuals, the inconvenience of long-term therapy and lack of motivation for an apparently healthy person to accept medication. However these

obstacles have to be managed well because preventive therapy must play a major role in tuberculosis control if the goal of elimination is to be achieved in low incidence countries.

e) *BCG vaccination*

Although the role of BCG vaccine in preventing infection with *M. tuberculosis* is doubtful, it plays an important role in preventing serious, but rarely contagious forms of tuberculosis in children. It seems that BCG vaccination protects against uncontrolled replication and dissemination of *M. tuberculosis* from the primary foci to other parts of the lung and body. WHO still recommends BCG vaccination for neonates in countries with high incidence of tuberculosis, usually within the Expanded Programme on Immunization. However, the overall epidemiological impact of BCG (on transmission in particular) is negligible. Its role in low-incidence countries should be evaluated more within the context of the whole elimination plan. In most countries where BCG is not universally used it is still recommended for children who belong to high-risk groups within these countries.

#### 5.4 Monitoring indicators

The following are the main indicators to monitor the activities and impacts of the elimination plan:

- incidence of active tuberculosis per 100 000 population
- proportion of new pulmonary smear-positive cases of all newly notified tuberculosis cases
- incidence of tuberculosis meningitis in children
- mortality rate from tuberculosis
- sputum smear conversion rate among new smear-positive patients at the end of two or three months of treatment
- cure rate among new smear-positive pulmonary cases
- number of persons screened annually and percentage of them who are positive
- number of persons on preventive therapy and percentage of them completing treatment
- proportion of contacts traced and treated
- BCG coverage rates among children under the age of 1 year in high-risk groups
- completeness and timeliness of surveillance processes.

## 6. MEASLES ELIMINATION AND ERADICATION

### 6.1 Background

Before immunization against measles became available, measles was endemic globally, with epidemic peaks every 2–3 years and the disease was common among very young children. The introduction of the measles vaccine resulted in a decrease in the overall incidence of the disease; however, it was not until high immunization coverage rates were reached and sustained that other epidemiological features started to be affected. At this later stage it was observed that the decrease in incidence was also accompanied by lengthened interepidemic periods (4–8 years, depending on coverage in each birth cohort), shifting of the incidence to higher age groups, an increased proportion of cases who had been vaccinated and a decrease in the case fatality rate. These changes were the result of the slow

accumulation of susceptible people in a population with a high immunization coverage. Accumulation of susceptible people is a function of both the coverage rate, which is always less than 100%, and the vaccine efficacy, which is not perfect.

A global consultation on measles in May 1996 concluded that measles could eventually be eradicated with the proper application of a measles elimination strategy. However, as the world is in the middle of global efforts to eradicate poliomyelitis it must be stressed that the immediate priority of global immunization efforts should be the eradication of poliomyelitis. The eventual success of poliomyelitis eradication will be essential for ensuring the political and donor support needed to coordinate measles elimination efforts. In an increasing number of countries that have already eradicated poliomyelitis, a measles elimination strategy is being implemented.

## 6.2 Definitions

- *Measles elimination*: the disappearance of transmission of infection with measles virus with the country, region or continent ultimately becoming free of the disease.
- *Measles eradication*: global elimination, with the disappearance of the disease and extermination of its causative agent worldwide.

## 6.3 Intervention strategies

The overall strategy aims to rapidly reduce the number of measles-susceptible individuals in a population through a mass immunization campaign and then to maintain the number of susceptibles below the "epidemic threshold" through high one-dose routine immunization coverage and follow-up campaigns. The strategy also includes strengthening of surveillance and of laboratory diagnosis of cases.

This strategy has been used extensively to interrupt measles transmission in the WHO Region of the Americas, as well as certain countries of the European, South-east Asian and Western Pacific Regions with great success. The main elements of the strategy are to strengthen routine immunization services and conduct supplementary immunization activities, and to strengthen measles surveillance and laboratory confirmation of cases.

### a) *Strengthening routine immunization services and conducting supplementary immunization activities*

High routine measles immunization coverage of at least 90% should be achieved and maintained among children under the age of 1 year in all sites and groups. Such high routine immunization coverage with a single dose of measles vaccine among all population subgroups remains the basis for any measles control programme. Measles-susceptible individuals will continue to accumulate, however, resulting in regular outbreaks. The addition of a second dose of measles vaccine to the routine immunization schedule in some developing countries has generally had only a limited impact on the epidemiology of the disease. Outbreaks have continued to occur because second dose coverage is virtually always lower than first dose coverage and the second dose seldom reaches children who were missed in the first dose.



Close monitoring of immunization coverage among children by geographical area (district) and population subgroups is required to determine areas where coverage is substantially below that targeted. In addition the age and vaccination status of measles cases should be carefully scrutinized to determine whether it is consistent with reported immunization coverage. Pockets of low coverage may put the general population at risk.

Identified low coverage areas or populations should be investigated to determine the reasons, and proper responses should be made to address the problems. Such responses might include the following.

- In areas with no access to immunization services, immunization sites should be provided and local people should be informed about vaccination and mobilized to get vaccinated. This may need the support of the community and community leaders as well as nongovernmental organizations, for both mobilization of financial resources to expand the services and of mothers to use the services.
- In other areas where low coverage exists among children with access to vaccination services, one or more of the following is required:
  - strengthening of outreach activities
  - improvement of the coordination and cooperation between different governmental and nongovernmental sectors to support immunization activities
  - reduction of missed opportunities through training and supervision of health workers
  - strengthening of health education and provision of social mobilization messages to the community by all available means.
- Immunization coverage among high-risk areas or groups should be improved. These groups may include all or any of the following.
  - Children living in poor urban slum areas. Mass campaigns should be conducted in these areas, followed by house-to-house immunization activities in any poorly covered sections. The target age of children to be included in the campaign should be determined based on the local situation, and poorly covered sections should be determined based on monitoring of campaign activities.
  - Displaced children including those living in armed conflict zones and those migrating. A mass immunization campaign is required. Usually children aged 9 months to 5 years are included in the campaign; however, based on the local conditions, older children (up to the age of 15 years) may be included. The age may be lowered to 6 months provided that all those who will be vaccinated below the age of 9 months are traced and receive another dose as soon as they are 9 months of age.
  - Children living in hard-to-reach remote areas. These children are at risk of illness when seeding of the virus from crowded urban areas occurs. The immunization of these children can be difficult and costly as mobilization of vaccinators is required.
- Continuous monitoring of the measles occurrence trend should be conducted with the aim of anticipating outbreaks or epidemics. If such a situation is expected based on disease occurrence trend analysis, then a subnational or national immunization campaign

will be required. Proper analysis, anticipation and implementation of the campaign will most properly abort the outbreak or epidemic. In this respect, to ensure the success of these efforts all the attention should be directed to identification and immunization of the susceptible population. Also, the reasons for the mass campaign should be made clear to the community, media and health professionals so that they can be involved in promoting and supporting the campaign activities.

- A nationwide nonselective initial mass immunization campaign should be conducted with the aim of rapid achievement of a high level of coverage in a wide target age group. This age group would depend on the local measles occurrence situation and availability of resources. Generally children between 9 months and 15 years of age are included. They should receive the measles vaccine regardless of their previous immunization status. The campaign should be designed and implemented properly so that very high coverage rates in all the sites and population groups is achieved; the campaign should be evaluated by district. This will rapidly reduce the number of susceptible individuals and so will interrupt the transmission or reduce it to minimal levels. The campaign can then be followed up by raising the age for the routine first dose from 9 to 12 months. However, as previously mentioned, a very high (above 90%) routine immunization coverage should be maintained.
- Periodic national follow-up mass immunization campaigns should be conducted every 3–7 years to reduce the accumulation of a susceptible population. These campaigns should be determined based on the level of immunization coverage, the expected vaccine efficacy, the number and size of the high-risk areas and the effectiveness of any response to them. The follow-up campaigns should include all the children above the age of 1 year who were born after the previous campaign (initial or follow-up) regardless of their immunization status.

b) *Strengthening measles surveillance and laboratory confirmation of cases*

Reporting of measles is usually incomplete in most countries. The disease is accepted by the public as a natural event and the great majority of mild cases do not appear at health facilities. Reported cases are usually only those admitted to hospitals, and cases seen in basic health facilities (health units and centres) are not reported. In addition, in countries where the private sector is active, many measles cases presenting for medical care at private facilities are not reported. Proper surveillance systems are required not only to monitor the achievement of the elimination or eradication goal, but also to indicate the progress towards the goal and to direct intervention activities (mainly supplementary immunization) towards the high-risk areas. Surveillance for cases should include the following basic elements.

- A national standard case definition is needed to ensure consistency in reporting and comparability of results. Based on experience in some Member countries, the WHO recommended standard case definition for suspected measles cases is: a diagnosis as measles by a medical officer (physician), or an individual with fever, maculopapular rash, and cough, conjunctivitis or coryza. These cases should be confirmed by laboratory serology.

- There should be a standard format for measles cases investigation which allows for collection of minimum required data about reported cases, including age, date of onset, immunization status and severity (outcome).
- National and subnational measles diagnostic laboratories with properly trained personnel and suitable equipment and reagents should be established.
- Measles cases should be immediately reported from all health facilities, including private sector facilities. Reported cases should be investigated immediately. Such case investigation should be re-emphasized when a major reduction in occurrence of the disease is observed. At this stage both epidemiological, clinical and laboratory investigation of each case is required.
- Virus isolation from a sample of the total cases discovered is required. This should be started in the early phases of disease control, and the isolated virus should be subjected to genotyping so that mapping of the virus genotypes prevalent in different geographical areas can be conducted. This is of great value in identifying a virus that has been imported to an area where elimination has been achieved. Such cases may be expected to occur for some time until global eradication of the disease is achieved.

#### **6.4 Indicators**

The performance indicators can be divided according to the two main strategies.

##### *1. Immunization performance indicators*

- Routine immunization coverage rate nationwide and by district or area
- Campaign coverage rate nationwide and by district or area.

##### *2. Surveillance performance indicators*

- Completeness of routine reporting from selected sites including zero reporting (percentage of reporting sites reporting as per the specified period)
- Timeliness of routine reporting (percentage of reporting sites reporting within the specified time period)
- Percentage of reported measles cases with age and immunization status
- Percentage of reported suspected measles cases investigated within 48 hours
- Percentage of reported suspected measles cases laboratory confirmed
- Percentage of laboratory results received within 10 days of sample collection.

## **7. RECOMMENDATIONS**

1. The feasibility of eliminating/eradicating diseases of regional priority and the cost-effectiveness of programmes aimed at achieving such targets should be studied.
2. Measles elimination strategies should be adopted and implemented by all countries, with the aim of achieving measles elimination by 2010.
3. Measles elimination activities should not, in any way, jeopardize poliomyelitis eradication.
4. Member States with low incidence of tuberculosis (i.e. less than 20 cases per 100 000 population) which have not yet adopted the target of tuberculosis elimination by the year 2010 should immediately do so.
5. All countries with intermediate to high incidence of tuberculosis (i.e. more than 20 cases per 100 000 population) should implement the strategy DOTS ALL OVER as a prerequisite for elimination.
6. Follow-up reports on the elimination of tuberculosis and measles should be presented regularly to the Regional Committee.