Theory and practice of disease elimination and eradication

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Introduction

After the World has successfully eradicated smallpox in 1980, many other communicable and non-communicable diseases are put under scrutiny for their eligibility for eradication or elimination. The terms: control, elimination and eradication of disease(s) are extensively and loosely used by many for the past decades. A lot of confusion is raised not only from the misunderstanding by these terms, but also due to inappropriate adoption of existing public health strategies. This paper highlights the theory and practice of disease elimination and eradication, especially meant for those young medical and public health professionals.

More than sixty years ago, global elimination and eradication campaigns were carried out against a few infectious diseases of global importance such as smallpox, yellow fever, and malaria. Later, it was expanded to cover other diseases, mainly vaccine-preventable diseases such as poliomyelitis, measles and neonatal tetanus. With the advancements in the field of pharmaceutical sciences, elimination of a few other infectious diseases like lymphatic filariasis, trachoma, and leprosy were added. Several attempts have been made among public health communities around the world to clarify these terms - control, elimination and eradication of diseases for decades[1]. In 1998, the accepted definitions for these terms were proposed, as follows[2]:

- **Control** of a disease means the *reduction of incidence, prevalence, morbidity or mortality* of the disease to a locally acceptable level as a result of deliberate efforts; and, continued intervention measures are required to maintain the reduction;
- **Elimination** of a disease or infection means the *reduction to 'zero' incidence* of the specified disease or infection caused by a specific agent, in *a defined geographical area* as a result of deliberate efforts; and, continued measures to prevent re-establishment of transmission are required; and,
- **Eradication** of a disease means a *permanent reduction worldwide to 'zero' incidence* of the disease or an infection caused by a specified agent as a result of deliberate efforts, such that control measures are ***no longer*** needed.

With the rapid advancement of science and technology and parallel development and improvements of health systems, there is now a possibility of eliminating or eradicating some communicable as well as non-communicable diseases. The above definitions on control or elimination of a disease have emphasized that after reduction of incidence or prevalence to an acceptable level, there is a need to continue the intervention measures

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to maintain or sustain the reduction or to prevent re-emergence or re-establishment of transmission. This is major source of confusion among public health specialists and policy makers who after certain targets for the control or elimination of a disease was achieved, tend to neglect or complete the intervention activities, with corresponding decrease in financial and human resources[3].

On top of the above confusion that has been caused by the unwitting use of these terms on the control, elimination and eradication of a disease or diseases, additional terms such as 'nation-wide, region-wide or world-wide ***campaigns***' and 'national, regional and global ***control programmes***' have further confused the situation. A '***campaign***' for control of disease(s) is a resource-limited action for the control of specific disease(s) with short-term objective(s). A disease '***control programme***' constitutes a long-term vision for reducing the incidence or prevalence of the disease in the mass population, and it sets the vision, mission and strategies with finite resources and having potential for expansion. Many national ***disease control programmes*** started at an early initial stage with the ***campaigns*** or had built-in intermittent campaigns in order to reduce the disease prevalence and incidence more effectively and efficiently.

Eradicability of a disease

In theory, all diseases could be **eradicated** if appropriate interventions for the prevention and reduction of morbidity and mortality are available. However, in practice, to be able to eradicate a disease or an infection, it will depend upon the following THREE main criteria: (a) biological and technical feasibility, (b) economic considerations, and (c) social and political support.

(a) Biological and technical feasibility: Biological features of the disease agent and its relationship with the respective host and environment is inherently distinct, and in addition other technical factors such as availability of an appropriate intervention, make a disease for potential eradication more or less likely or not. The present day categorization of a disease as currently not eligible for elimination or eradication may change completely tomorrow when new discoveries are made with regards to the epidemiology, immunology, pharmaco-genomics, and the application of these advance technology and knowledge in dealing with this disease.

The following four main technical factors are considered to be of primary importance for eligibility of a disease for eradication.

(i) effective intervention for interrupting the transmission cycle of infected and infective cases for a prolonged period of time in a large geographical area;

(ii) availability of practical clinical and laboratory diagnostic tools with sufficient sensitivity and specificity to detect the presence and progress of infection or disease state;

(iii) developing herd immunity in the community by natural or artificial means; and,

(iv) presence or absence of human reservoirs and secondary hosts - including vectors.

The effectiveness of technical intervention or diagnostic tools has both biological and operational dimensions. Provision of adequate water supply, personal hygiene, and general sanitation have made a disease like trachoma possible for elimination in one geographical area but not in another. Diseases caused by agent(s) that has human as a definitive host like smallpox and poliomyelitis may have been possible for eradication, while diseases with secondary hosts like malaria, yellow fever and lymphatic filariasis, could be possible for elimination in a certain geographical area, but not for total eradication. Eradication of *dracunculiasis* has showed that if effective intervention tools are made available, an independent reservoir is not an absolute barrier for the eradication of infection.

(b) Economic considerations: Since health resources both in terms of human and financial are limited in nature, economic considerations become an absolute necessity when deciding whether a disease or an infection is eligible for elimination, eradication or control. Alternative costs and benefits, the number of infected/disease cases averted in economic terms are to be analysed in addition to the direct effects like reduction in morbidity and mortality as a result of elimination or eradication efforts. In addition, the indirect effects such as positive and negative consequences on the entire health systems and the socio-economic environment would have to be taken into consideration.

(c) Societal and political support: The success of elimination, eradication or control of any disease would largely depend upon the societal beliefs as well as the political and financial commitment and support given towards this goal from the beginning up to the very end. Therefore, a consensus must be reached among the experts (scientific community), decision makers, planners and financiers and the beneficiaries with regards to the justification to eliminate and eradicate a candidate disease. The accumulation of knowledge and past experience of success in eradicating or eliminating a disease in a large geographical area(s), the neighbouring countries, regions or elsewhere in other parts of the world, could generate incentives for the adoption of elimination or eradication initiatives along with attracting international support.

During the post-World War II period, countries in Asia and Europe were rampant with war-torn miseries, and at the same time, many communicable diseases were found to be widespread causing high morbidity and mortality. As a result, many countries launched the national disease control programmes and campaigns, one after another, with ultimate aim for the control, elimination and eradication. As the bio-medical science advanced and with the application of new technology, newer and improved vaccines, better medicines (chemotherapeutic agents), coupled with improved transportation and logistics including cold-change systems, health strategies were developed during immediate post-World War II period, and this has helped the eradication and elimination of diseases globally to a great extent.

Disease eradication/elimination in 20th century

Smallpox

Even more than 150 years after the invention of vaccine and vaccination, smallpox was still rampant in many parts of Asia, Africa and Latin America in 1950s. The reasons for this were mainly due to impurities and variability in the potency of smallpox vaccine and poor vaccination technique. It was also supplemented by low vaccination coverage and lack of political commitment by the colonial administrators to deal with this terrible disease. On top of these constraints, there was also a limitation of human resources, and finally lack of confidence in vaccination programme by the local populace.

In late 1950s, with the assurance of a continued supply of efficient and effective freeze-dried heat-stable smallpox vaccine, international development agencies like WHO, UNICEF and UNDP, advocated the worldwide control of smallpox by stepping up mass vaccination activities. International support was provided to all endemic countries in the world to organize national ***smallpox eradication programmes***. The programme had utilized the basic health staff and institutions to achieve an effective vaccination coverage, backed by *legislation*.

Only in a few countries where the basic health infrastructure was weak, vertical smallpox eradication programmes supplemented with campaigns were established. In some countries, specific vaccination teams were used. Major strategies for high vaccination coverage varied according to each country's health infrastructure and the disease endemic status.

Within a decade of launching the smallpox eradication programmes, several countries were able to report the occurrence of last case of smallpox. International Commission had certified that Myanmar had no more indigenous case, and no internal transmission of smallpox occur since 1969[4]. Only a few countries in Asia (mainly India, Indonesia, Nepal and Bangladesh) and some countries in Africa reported sporadic outbreaks of smallpox up till early 1970. In addition to mass vaccination campaigns, intensive efforts to detect new cases and contact tracing were done along with isolation of cases and contacts. Mass media campaigns were carried out to identify hidden cases with rewards for reporting cases. Effective interventions like active surveillance and containment measures (mass vaccination of all people in the immediate surrounding area of index case) were carried out, and these countries successfully contained the transmission of smallpox within a relatively short period. The last naturally-acquired human smallpox case in the world was reported in Somalia, Africa, in October 1977. By May 1980, the world had declared as free from natural transmission of smallpox[5].

To date, although no more human case has been reported due to natural infection by smallpox virus (*zero case transmission*), there were 2 human smallpox cases occurring as a result of a laboratory accident in UK in 1978, and a few vaccine-induced cases in USA as recently as in 2010[6]. Due to the outbreaks of such incidence, a global consensus could

not yet been reached on the timing for destruction of all existing wild smallpox variola virus stocks. The occurrence of pandemic avian influenza in recent years that caused a huge panic in the world and created a lot of negative and severe economic consequences, has also aggravated this situation. An international arrangement for the emergency stock piling of millions of doses of the first and second generation smallpox vaccines stored in a safe and secure place was made, in 2011, for use in case there would be a global smallpox outbreak, if and when it occurred, anywhere in the world[7]. The eradication of smallpox, however, is considered to be the most successful public health intervention that is achieved globally in the 20th century.

Yellow fever

Yellow fever (YF) is one of the earliest tropical diseases which had been aimed for eradication since 1915, utilizing vaccination coupled with vector control and personal protection. There is currently no effective and specific treatment for YF and vaccination is the single most effective mean to prevent and control it, and even for its eradication. By the end of 1950, the disease was controlled and virtually wiped out in Latin America and in certain parts of Africa. However, due to inadequate health infrastructure and ineffective coverage with YF vaccination, the disease is still endemic presently in 34 African countries. In recent years, sporadic outbreaks of YF occurred almost every year with an estimated number of 180,000 cases[8].

With the presence of vector, *Aedes aegypti*, which is available for transmitting many tropical diseases like dengue haemorrhagic fever, chikungunya, etc., Myanmar and many other Asian countries are liable for YF infection. Luckily, YF is still not prevalent in Myanmar with the ongoing circulation of wild YF virus in endemic countries in Africa, along with low coverage of vaccination and the existence of vector mosquito around the world, there is a real threat for international spread. Millions of lives could easily be lost unless there is a high level of vigilance, presence of an effective surveillance system, and a high level of immunization coverage with YF vaccine maintained in endemic countries.

Yaws

Yaws is an age-old tropical disease for which the global eradication effort was initiated in Africa, Asia, the Pacific and Latin America Regions immediately after the World War II. From 1952 to 1964, WHO and UNICEF had jointly launched the "***Global campaign for eradication of yaws***" through mass treatment with long-acting penicillin. The number of yaws cases worldwide had come down from 20 million in 1952 to 2.5 million by 1970.

Yaws was almost eradicated in many countries by 1970, but scattered foci of infection still persisted in some parts of Latin America, the Pacific and South and South-East Asia[9]. Extensive case finding measures, the use of newer antibiotics and follow-up of cases treated, and along with treatment of contacts, are important strategies for the eradication of yaws in 21st century.

Poliomyelitis

Poliomyelitis (polio) is an infectious disease that only affect humans, and an effective vaccine which produce life-long immunity is available. Myanmar introduced the national expanded programme of immunization (EPI) in 1977, and polio vaccination has been introduced as part of routine immunization of infants since 1986. Due to the low level of coverage obtained with routine polio vaccination in many countries in Asia and Africa (including Myanmar), additional campaigns for national immunization days (NID) or sub-national level immunization days (SNIDs) were organized.

Campaigns for NIDs and SNIDs have been added since 1996 in Myanmar to enhance the polio vaccine coverage. Within a few years of intensive campaigns, Myanmar has the last case of indigenous polio being reported in the year 2000. In 2014 March 27, SEAR declared regional certification of polio eradication (PE). The sporadic outbreaks were observed in the later years that was mainly due to importation of cases from neighbouring countries or being infected by circulating vaccine-derived polio viruses. Major global concern for polio eradication at present is the presence of wild polio virus circulating in two Asian countries, namely Afghanistan and Pakistan.

In 1994, the WHO Region of the Americas was certified polio-free, followed by the WHO Western Pacific Region in 2000 and the WHO European Region in June 2002. On 27 March 2014, the WHO South-East Asia Region was certified polio-free, meaning that transmission of wild polio virus has been interrupted in this bloc of 11 countries stretching from Indonesia to India. Once polio is eradicated, the world can celebrate the delivery of a major global public good that will benefit all people equally, no matter where they live[10].

Malaria

Although malaria is a tropical disease where life cycle of the parasite(s) includes mosquitoes as a secondary host, many countries in the tropics with support from donor countries had attempted in 1950s to launch national malaria control programmes with the ultimate aim to eradicate it. When these countries launched the ***national malaria control programmes***, there was a lot of anticipation that the disease could be eradicated through early case finding (active and passive methods and mass surveys) and the use of appropriate drugs for case management as well as the use of residual insecticide (DDT) indoor-spraying to control mosquitoes effectively.

While there may have been some reduction in the number of malaria case fatality rates, the annual number of malaria cases (both incidence and prevalence) remained stable for many decades in Asia after the initial launches of the programmes in 1950s. In many countries, sporadic epidemic outbreaks occurred with children and women being affected the most. In addition, drug-resistant malaria became a persisting issue till today. Malaria is a disease for which several global initiatives with billions of dollars have been invested till date for its prevention and control, including development of medicines,

vaccines, insecticides and other measures. It is still endemic in many developing countries, with the development and spread of drug-resistant malaria that has become a serious issue.

WHO in 2015 launched a "15 years Global Strategy" with the aim to accelerate the efforts towards ***elimination and attainment of malaria-free status***. There are some successes as several countries reported malaria-free status by 2016[11]. Myanmar has adopted the national strategic plan for intensifying malaria control and accelerating progress towards Malaria elimination, 2016-2020, with an ultimate aim of Myanmar being free from Malaria by 2030. It was expected to reduce reported incidence of malaria to less than 1 case per 1,000 population in all States/Regions by 2020, and to interrupt transmission of falciparum malaria in at least 5 States/Regions by 2020 (Bago, Magway, Yangon, Mon, Mandalay)[12].

Disease elimination in 21st century

Tuberculosis

Tuberculosis (TB) is an age-old disease, formed as one of the top 10 causes of death and the leading cause from a single infectious agent. Over 10 million people globally fall sick due to TB, with an estimated 1.6 million deaths in 2017. Drug-resistant TB continues to be a public health crisis, and best estimate worldwide in 2017 was around 600,000 people. Of these, 82% had multi-drug-resistant TB (MDR-TB)[13]. Main interventions to prevent new infection is immunization of children with BCG (Bacille Calmette-Guerin) vaccine and appropriate treatment with multi-drug therapy.

WHO Member States in 2014 had adopted the global strategy for End TB (ending TB epidemic) by 2030. Countries with high burden of TB requires to narrow the treatment gaps with increased efforts for active case finding and improving service coverage. Myanmar, one of the 30 globally high-burden countries, had adopted the national strategic plan for tuberculosis control, 2016-2020. This plan aimed for ending TB epidemic in Myanmar with fewer than 10 cases per 100,000 population by 2035[14].

Measles

An initiative was launched in mid-1980s known as universal child immunization (UCI) with the goal to maintain around 70% vaccination coverage among infants and young children in many developing countries. Within a decade, the case fatality rates, morbidity and mortality of vaccine-preventable diseases came down to a level where some diseases like poliomyelitis, diphtheria, tetanus, pertussis, etc., are no longer posing a public health problem. The ***ultimate elimination of measles*** in the American continent in late 1990s had prompted the launch of the Global Measles Initiative in 2001, aiming to accelerate and sustain a high coverage for routine immunization measures (at least a single dose of measles vaccine) to more than 90% of infants in every district in high burden countries in Africa and Asia. Supplementary mass immunization campaigns were

conducted periodically targeting all children between the ages of 9 months and 14 years. Follow-up campaigns were held every 2-4 years targeting children between 9 months and 5 years of age. Increased emphasis was placed on laboratory-backed surveillance of new measles cases and monitoring vaccination coverage.

From 2000 to 2017, the estimated vaccine coverage increased globally from 72% to 85% respectively, and the estimated annual number of deaths from measles decreased by 80% from 545,174 to 109,638 cases globally[15]. Since 2007, Myanmar had launched Measles Control campaigns by intensifying vaccination coverage for children between 9 months and 5 years. By 2015, Rubella control was added by changing the measles vaccine with measles and rubella combined vaccine. Myanmar aimed at measles elimination by 2020. In many countries especially in the least-developed ones, it is unlikely to achieve ***measles elimination*** in the very near future unless the high coverage of second dose of measles vaccination (> 94%) is achieved.

Tetanus

A high coverage of tetanus toxoid (TT) immunization to all women of childbearing age and a high coverage of DPT (diphtheria, whooping cough and tetanus) vaccine for infants and under 5 are the simplest and most cost-effective way to reduce tetanus infection in women during child birth and also deaths due to neonatal tetanus (NNT).

In 1989, the global community called for the ***elimination of neonatal tetanus*** (reducing to the level of incidence of one NNT case per 1,000 live-births in all districts in countries) by the year 2005. The existing high incidence of the NNT is the result of inadequate coverage of TT/DPT vaccinations, coupled with poor access to proper ante-natal care, and clean and safe child delivery conducted by trained personnel.

Myanmar had claimed that the elimination of maternal and neonatal tetanus was achieved by May 2010[16]. By the end of 2010, around 10 countries in the world were known to be tetanus endemic. If future generations are to live without the threat of a catastrophic resurgence of this disease, routine immunization coverage with tetanus toxoid vaccine must be achieved and sustained at a level that is over 80% of women of childbearing age in all the districts in the country, and, all infants must be vaccinated with a full course of DPT, and, at least 80% of births be taking place under hygienic conditions with skilled birth attendance.

Hepatitis

Viral Hepatitis is caused by at least 5 different viruses, Hepatitis A, B, C, D and E, with the symptom that may be similar, but the infection routes and the outcomes may be quite different. Globally, it is responsible for 1.4 million deaths a year, and majority of them are due to chronic liver disease and primary liver cancer. An estimated 257 million people are living with chronic liver disease due to Hepatitis B virus (HBV), and over 71 million

people with Hepatitis C virus (HCV). Mass vaccination against HBV was introduced as part of the routine EPI vaccination in some Asian countries in the early 1990s. The vaccination coverage was accelerated in many countries with support from the GAVI Alliance in the later years. By the end of 2007, a total of 171 countries in Asia, Africa and Latin America were using both plasma-derived and recombinant HBV vaccines as part of their routine immunization programmes.

Myanmar has introduced HBV immunization as part of routine EPI programme for children in late 1990s. Vaccination coverage has been intensified with the introduction of pentavalent vaccine in 2013 as part of GAVI Alliance support. Ministry of Health and Sports, Myanmar, has launched national plan for hepatitis control for 2016-2021, with an aim of eliminating HBV infection and reducing burden of HCV infection by 2030[17]. If the Hep B vaccine supply can be ensured and the programme is properly managed ***HBV infection can be eliminated*** within the next one or two decades.

Onchocerciasis

With the success of eliminating onchocerciasis (commonly known as river blindness), a parasitic infection due to **filarial worm** *Onchocerca volvulus* **transmitted by repeated bites of infected black flies**, in some regions in Africa, by means of effective community-based mass drug administration and vector control during the period 1970s to 2000, a campaign to ***eradicate this disease*** was launched in 2015[18]. An estimated 21 million people are infected in 2017, and of these, around 15 million had skin lesions and 1 million had vision loss.

Lymphatic filariasis

Lymphatic filariasis (LF) is a vector-born neglected tropical disease, targeted for ***elimination*** as a public health problem by 2020. It was launched as a global programme in 1997, mainly implemented in endemic countries of Asia, the Pacific and Africa, where the disease is highly prevalent. Main strategy is to have a high coverage of mass drug administration in multiple cycles, at least for five consecutive years to stop transmission of LF. Since 2000, cumulative total of 7 billion treatments have been delivered to around 900 million people at least once in nearly 40 endemic countries around the world[19]. Ministry of Health, Myanmar, has launched in 2000, the National Plan to Eliminate Lymphatic Filariasis (NPELF); the strategy is aimed at elimination of lymphatic filariasis in 2020 (i.e. < 1/1000 population) through Mass Drug Administration (MDA), using 2 drugs: Albendazole and Diethylcarbamazine[20]. A total of 65 endemic districts have been covered with the campaign by mass drug administration and management of cases.

Trachoma

Blinding trachoma is endemic in many of the poorest and most remote areas of 51 countries in Africa, Asia, Central and South America, Australia and the Middle East.

Worldwide, an estimated 2.2 million people are visually impaired as a result of trachoma, of which 1.2 million becomes blind. An estimated 232 million people living in trachoma-endemic districts are at risk. More than 21 million have active trachoma and about 7.3 million require surgery for *trachomatous trichiasis*. Africa is the worst affected continent: 18 million cases of active trachoma (85% of all cases globally) and 3.2 million cases of *trichiasis* (44% of all cases globally) are thought to exist in 29 of the 47 countries in WHO's African Region. Ethiopia and South Sudan have the highest prevalence of active trachoma: in some areas of these countries, active disease is present in more than 50% of children aged 1-9 years and *trichiasis* affects more than 10% of adults. The risk of blinding trachoma is greater in women than in men. Beyond the disability, distress, isolation and stigma that it causes, the economic burden of trachoma on affected individuals and communities is enormous, costing between US$ 2.9-5 billion annually, increasing to US$ 8 billion when *trichiasis* is included. At about US$ 40 per surgery, preventing this economic disaster is very affordable.

In 1996, WHO launched the Alliance for the ***Global Elimination of Trachoma*** by the year 2020 (GET 2020), as a global partnership which supported country implementation of the SAFE strategy and the strengthening of national capacity through epidemiological assessment, monitoring, surveillance, project evaluation and resource mobilization[21]. Main goal is to eliminate trachoma as a public health problem by the year 2020, i.e., a reduction in the prevalence of *trichiasis* "unknown to the health system" to less than 1 case per 1,000 total population ("known" cases are those in whom *trichiasis* has recurred after surgery, those who refuse surgery, or those yet to undergo surgery whose surgical date is set); and a reduction in the prevalence of the active trachoma sign "TF" in children aged 1-9 years to less than 5%[22]. Myanmar achieved this elimination target by 1978 and it has sustained this achievement[23].

Micronutrient deficiency disorders

Attempts have been made to eliminate a few micronutrient deficiency disorders (such as deficiency of iodine, iron, folic acid, and vitamin A) in many countries. Developed countries have almost wiped out such deficiency diseases by improving nutrition, proper supplementation of diet mainly through public subsidization and food support, legislative measures in support of public health interventions (iodination of salt) and individual case management. In Asia, efforts have been made to eliminate iodine deficiency disorders by ensuring universal salt iodination through proper legislation and health education. However, full participation of the salt industry with regards to appropriate storage, distribution and sale of iodized salt is still not satisfactory. In Myanmar, the goiter prevalence has been brought down to less than 5% of population in endemic districts since 2003[24].

Leprosy

Leprosy has been known for centuries as a chronic dreadful illness that affects millions of people and their families causing great social, mental, and physical suffering. After extensive use of mass treatment with *dapsone* for six decades, the number of leprosy cases in many endemic countries dropped significantly. Some countries in Europe closed down the leprosy sanatoriums and hospitals as the number of patient went down. This situation provided the first real hope of curing leprosy in many endemic countries[25]. While millions of leprosy patients were identified and registered for treatment, many of them (ranging from 30-90%) were not able to receive proper treatment due to lack of accessibility to treatment and irregular supply of drugs. Because of irregular and intermittent treatment with a single drug *dapsone* for long period, secondary *dapsone* resistance had developed. Before long, primary *dapsone* resistant also appeared in many endemic countries[26].

With the development of multi-drug therapy (MDT) in 1982 which contains 3 drugs namely, *dapsone, clofizamine and rifampicin*, a shorter treatment duration of treatment and cure for leprosy became available. The MDT, having bactericidal properties (due to rifampicin), led to reduction of the transmission and finally the reduction of incidence of leprosy. As such, an ambitious global campaign to eliminate leprosy as a public health problem (reducing the registered prevalence below 1 case per 10,000 population) was launched in 1991 by the WHO and its global partners. Intensive case finding through mass surveys, providing free of charge MDT for all patients and promoting community awareness campaigns were launched, which significantly brought down the national and global prevalence within a decade. By 2001, 107 out of 122 endemic countries were able to achieve the global target of leprosy elimination (Note: Myanmar achieved the global elimination target by 2003).

The burden of leprosy continues to decline globally as a result of sustained efforts carried out by national leprosy control programmes along with continued support from both national and international partners. Globally, the number of new leprosy cases reduced from the highest peak of 775,000 cases in 2001 to 228,500 cases by year 2010[27]. In 2017, 192,700 cases were registered and 210,700 new cases were reported[28]. Elimination of leprosy as a public health problem in the 21st century could be considered as another successful global health initiative. Sustained strategies of early case detection and effective treatment with MDT, strengthening routine surveillance and strengthening referral services are still the cornerstones of leprosy control. If the current trend in disease reduction in terms of both prevalence and incidence is maintained, the goal for leprosy elimination could be achieved in the near future.

Lessons learnt

In addition to the high level societal and political commitment that needs to be given to eliminate or eradicate a disease, enormous financial investments are also

required. The success of any elimination or eradication programme is basically dependent on the availability of effective intervention tools to interrupt the transmission cycle of the disease that can be carried out in a cost-effective way, and that is acceptable to the community. All these requirement will in a way depend on the distinct biological features of the disease agent and its relationship with the host(s) and environment. Improving the immunity status of the hosts by means of vaccination was used for many diseases that is targeted for elimination or eradication, such as smallpox or poliomyelitis.

Another strategy is to detect infected individuals and infectious cases and their contacts through early case detection (clinical examinations and laboratory tests) and provide prompt treatment with effective drugs (usually using a combination of drugs). This strategy was used to eliminate leprosy as a public health problem in many endemic countries. Similar strategy has been used for many parasitic and helminthic infections such as Lymphatic filariasis (LF), onchocerciasis and soil-transmitted helminthic infections.

In order to maintain a high level of immunization coverage (more than 90% of the targeted population) or to deliver appropriate treatment ensuring effective medicines properly prescribed (i.e., a full cycle of treatment for TB takes at least 6 months to a year) and in some instances their contacts (prophylactic treatment for months), a strong and efficient basic health care infrastructure is necessary in order to deliver the necessary health services in a sustainable and effective way.

Disease elimination or eradication programmes are to be distinguished from ongoing routine disease control programmes resulting in benefits to be gained in terms of reduction in morbidity and mortality, in addition to the financial saving to be gained by eliminating or eradicating the specific disease forever. In actual practice, this effort requires parallel development of basic health care infrastructure that is responsible for the identification of infected and infective cases and to deliver appropriate treatment.

In order to continuously carry out surveillance of the disease to monitor the trends in a timely manner, a well-trained and highly motivated health staff and an effective surveillance system need to be established. General public education and specific health education for patients and their families are necessary to mobilize the people in endemic communities. Equity in health care coverage for all people living in the affected areas is another important issue. Improvement in clinical diagnostic tools and laboratory facilities for implementation of elimination and eradication efforts also provides benefits and opportunities for other disease control programmes.

Basic research on the disease and its causative organism especially in the field of disease epidemiology, immunology, development of vaccine and medicines are needed to strengthen control measures and to evaluate effectiveness and efficiency of the elimination and eradication programmes. Research in the area of health economics is also required to help develop effective health programmes that are sustainable.

Impact on health systems

A health system comprises of organizations, institutions and resources devoted to produce health actions, related to any effort that leads to personal health care or public health services. The primary purpose of a health system is to promote, restore, maintain and improve the health of the population through prevention and control of infectious and non-infectious diseases. The health care system should not only improve health of the people to a level that is possible with the resources made available, but also ensure equity in the delivery of health care services.

As many developing countries in Asia and Africa came out of colonial rules around 1950s and 1960s, the development of their health systems usually is based on how their colonial rulers established the health systems and laid down the foundation. Most of the health infrastructures were rudimentary especially in rural areas. These rural health facilities had to deal with a high burden of almost all known major tropical diseases such as leprosy, malaria, sexually-transmitted diseases, plague, cholera and tuberculosis. Thus, the health care facilities had to be supplemented by special disease control programmes and campaigns that were organized as separate vertical entities. The infrastructure for these campaigns/programmes, and the strategies used by them were especially targeted towards the rural population where the coverage of basic health care services is weak. These campaigns/programmes over a period of time developed into parallel establishments to the basic health care services such as hospitals and community health centers/clinics both in the urban and rural areas.

The main experience from many disease control programmes/campaigns during the past five decades in the developing countries in Asia and Africa is that it is not about whether disease eradication or elimination was achieved through vertical or integrated programmes, but how these programmes are effectively managed with the resources made available to them within a relatively short period of time.

Despite widespread acceptance by health authorities regarding integration of health services (from vertical campaigns with basic health services) in the early 1950s, there were many practical and operational constraints that hindered the transformation of specialized campaigns into an integrated basic health services. On many occasions, especially when reviewing or planning disease elimination and eradication programmes, alternative systems were explored between an apparently selective approach to health development (vertical health system) and a systematic and integrated approach (comprehensive health system). Ultimately, it all depended on the socioeconomic conditions and the availability of basic health infrastructure that exits in an area that could be used to deliver the required services. Resource constraints on the part of the host programme, combined with external donor pressure usually forced the health programmes to use a selective approach in health development, as seen in the EPI programme, Reproductive Health programme and/or HIV/AIDS, TB and Malaria control programmes during the past century.

Conclusion

Disease causing agents, microbes, are dynamic and resilient: they spread locally, nationally, regionally, and internationally with ease, and when they find susceptible populations they re-emerge as public health problems. Disease elimination and eradication programmes differ from ongoing routine disease control programmes on the issue of urgency. Continued surveillance and sustained control activities are needed to maintain achievements in disease control. Reducing the high prevalence or incidence of the disease within a short period of time to such a level that the disease becomes no longer a public health problem, or eliminated or eradicated, requires a well-defined strategy, rapid response capabilities and an effective surveillance system.

In many instances, elimination and eradication activities on their own are functioning well, but once the activities of the elimination and eradication programmes are taken over by the basic health services, things do not function well anymore. Efforts are needed to identify factors to be improved in order that the basic health services are functioning well, so as to maintain the elimination and eradication status of the disease.

In summary, elimination and eradication of any disease is a noble goal. However, setting such a goal creates a tremendous responsibility on the part of the health services both in terms of human and financial resources. Once it is decided to embark on the goal of eliminating or eradicating a disease, it is important that the necessary resources to achieve the goal are ensured till the goal has been attained.

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