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Recommendations of the International Task Force for Disease Eradication

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Foreword

CDC is proud by means of this publication to make available in one place all the recommendations of the International Task Force for Disease Eradication. My immediate predecessor as Director of CDC, Dr. William Roper, CDC's Deputy Director Dr. Walter Dowdle, and many other CDC professional staff participated in the deliberations of the Task Force. In addition, this project illustrates the close collaboration between CDC and our colleagues at The Carter Center of Emory University.

This systematic review of diseases as possible candidates for eradication is an important follow-up to the successful eradication of smallpox in 1977, a campaign that ranks among the finest achievements of CDC, in conjunction with other organizations. The World Health Organization has now targeted two other diseases for eradication. Dracunculiasis (Guinea worm disease) is scheduled to be eradicated by the end of 1995 and poliomyelitis by the end of the year 2000. The substantial progress already evident toward achieving these two goals confirms the wisdom of the Charles A. Dana Foundation in making a grant in 1988 to establish the secretariat of this Task Force. In addition to endorsing the two targets of dracunculiasis and poliomyelitis eradication, the Task Force has helped to chart logical next steps for humankind's use of the powerful weapon of eradication. It has done this by identifying four other diseases as potential long-term targets for eradication—rubella, mumps, cysticercosis, and filariasis—and by establishing clear criteria that can be used in an ongoing process of evaluation of candidate diseases and conditions in the light of new discoveries.

As the world gains more confidence with successful disease eradication campaigns, I hope we shall have the courage and foresight to embrace other appropriate targets for eradication and work diligently to achieve them.

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Recommendations of the International Task Force for Disease Eradication

Summary

This report summarizes the conclusions of the International Task Force for Disease Eradication (ITFDE), a group of scientists who were convened by a secretariat at the Carter Center of Emory University six times during 1989–1992. The purpose of the ITFDE was to establish criteria and apply them systematically to evaluate the potential eradicability of other diseases in the aftermath of the Smallpox Eradication Program. The ITFDE defined eradication as "reduction of the worldwide incidence of a disease to zero as a result of deliberate efforts, obviating the necessity for further control measures."

The names of the members of the ITFDE, the criteria they developed and used, and summaries of the papers that were presented to the ITFDE by various experts are included in this report, as well as a brief history of the concept of disease eradication since the late 19th century. The ITFDE considered more than 90 diseases and reviewed 30 of these in depth, including one noninfectious disease. It concluded that six diseases—dracunculiasis, poliomyelitis, mumps, rubella, lymphatic filariasis, and cysticercosis—could probably be eradicated by using current technology. It also concluded that manifestations of seven other diseases could be "eliminated," and it noted critical research needs that, if realized, might permit other diseases to be eradicated eventually. The successful eradication of smallpox in 1977 and the ongoing campaigns to eradicate dracunculiasis by 1995 and poliomyelitis by 2000 should ensure that eradication of selected diseases will continue to be used as a powerful tool of international public health.

INTRODUCTION

This issue of *MMWR Recommendations and Reports* consolidates the deliberations of the International Task Force for Disease Eradication (ITFDE), which was convened six times from 1989 through 1992 to evaluate diseases as potential candidates for global eradication (*1–7*). CDC supports the findings in this report, which indicate a need for greater recognition of the potential to eradicate targeted diseases. Three reports, covering results of the first five meetings, were published previously in the *MMWR* (*1–3*), and reprinted in WHO's *Weekly Epidemiological Record* (*4–6*). A report of the sixth meeting was also published in the *Weekly Epidemiological Record* (*7*).

Eradication is defined as reduction of the worldwide incidence of a disease to zero as a result of deliberate efforts, obviating the necessity for further control measures. The criteria that the ITFDE developed and their conclusions after reviewing more than 90 diseases are presented in this report.

An important part of the work was to help identify key impediments to improved prevention and control of the diseases under discussion, even if the disease was not considered to have potential as a candidate for eradication. One such "noneradication

outcome" was the impetus that the members of the ITFDE gave to initiating a demonstration project to control intestinal parasites among schoolchildren in Ghana.

A SPECTRUM OF DISEASE CONTROL

Between the extremes of disease "control" (reduction in incidence and/or prevalence) and "eradication," several intermediate levels of impact on diseases may be described. The term "elimination" is sometimes used synonymously with "eradication," but it refers to a single country, continent, or other limited geographic area, rather than global eradication. True eradication usually entails eliminating the microorganism itself or removing it completely from nature, as in the case of smallpox virus, which now exists only in storage in two laboratories. It is also theoretically possible to "eliminate" a disease in humans while the microbe remains at large, as in the case of neonatal tetanus, for which the World Health Organization (WHO) in 1989 declared a goal of global elimination by 1995.

Although a disease itself may remain, a particularly undesirable clinical manifestation of it may be prevented entirely. Examples of this level of eradication are the use of chemotherapy with ivermectin to eliminate blindness resulting from onchocerciasis and of vitamin A to eliminate xerophthalmia. Eliminating transmission of a disease may also be considered, as in the case of yaws, the late noninfectious clinical manifestations remain of which but are not a danger to others. Finally, "elimination" can be defined as control of the manifestations of a disease so that the disease is no longer considered "a public health problem," as an arbitrarily defined qualitative or quantitative level of disease control (e.g., WHO's goal of eliminating leprosy by the year 2000, which is defined as reducing its incidence to a level below one case per 10,000 population).

Even as smallpox was being eradicated, public health authorities recognized that the eradication campaign was possible because of several important characteristics of smallpox and the smallpox vaccine. Smallpox was epidemiologically vulnerable because it had no natural reservoir in species other than humans; the infection was obvious and usually easily diagnosed; the duration and intensity of infectiousness were limited; persons who recovered were immune for life and often permanently scarred; and its transmission was highly seasonal in many areas. The vaccine was safe, effective even in newborns, inexpensive, easily administered, and stable in tropical climates; its effects were long-lasting; and vaccinated persons had a recognizable scar (*8*).

As a tool for international public health, eradication of well-chosen diseases has two advantages:

- Eradication is permanent, as are its benefits. In contrast, the costs of control programs continue indefinitely, along with the risks of future exacerbation of the disease following a disaster of natural or human origin. For some diseases, achieving control would require only marginally less effort than that needed to achieve eradication, but control measures would need to be continued indefinitely. Eradication is the ultimate "sustainable" improvement in public health. The recent reimportation of wild poliovirus into the Western Hemisphere more than 18 months since its last known previous occurrence (*9*) and the possibility

of changes in other pathogens in ways that can make them impervious to once-effective control measures (*10*) would not be of concern had successful eradication campaigns taken place. (Fear of the consequences of emerging resistance of malarial mosquito vectors and of the parasite itself was partly responsible for the precipitous decision in the 1950s to eradicate malaria.)

- A time-limited goal of eradication allows mobilization of support for a concentrated effort more readily than does a control program—both within countries where the disease is endemic and internationally. If developed countries have to spend resources to prevent or control importations of the disease (e.g., poliomyelitis, smallpox), such countries have additional incentive to help support an eradication campaign.

Participation in a successful eradication campaign can also be effective in improving the morale and performance of workers in public health, although this potential benefit can also be derived from a control program. An eradication campaign requires complete surveillance, rigorous administration, and operational research to a degree that may not be necessary in a control program because the standard of success in an eradication program is unambiguous and uncompromising. Another requirement of an eradication campaign may be funding to support measures to eliminate a minor focus of disease from a country where the disease has limited impact and does not constitute a national priority.

The potential negative effects of an eradication campaign, especially an unsuccessful one, must also be weighed. One study stressed the economic consequences and the potential negative impact on broader public health programs (*11*). The possible effects of competition for scarce resources and the political implications are among the factors that should be considered (*12*).

The ITFDE developed specific criteria to consider the potential for eradication of diseases other than smallpox (Table 1). These criteria acknowledge that combinations of favorable characteristics other than those that obtained for smallpox might permit other diseases to be eradicated. They generally include elements similar to previously suggested criteria (*11,12*); however, the criteria of the ITFDE distinguish scientific feasibility from sociopolitical feasibility.

A BRIEF HISTORY OF DISEASE ERADICATION

Every friend of humanity must look with pleasure on this discovery [smallpox vaccination], by which one evil more is withdrawn from the condition of man; and must contemplate the possibility that future improvements and discoveries may still more and more lessen the catalogue of evils.

— Thomas Jefferson, 1800

The eventual eradication of smallpox as a result of the use of Jennerian vaccination was predicted by Edward Jenner, as well as by Thomas Jefferson, in the early 19th century. Following the emergence of the germ theory and more systematic approaches to disease control in the mid-19th century, the concept of eradication of a disease first became popular briefly around the turn of the century. Milestones in the

history of disease eradication over the years have been summarized (Table 2). Contagious pleuropneumonia of cattle, a disease that had been imported into the United States in 1843, was declared eradicated from the country in 1892, following a 5-year, $2-million campaign to identify and slaughter infected animals (*13*).

The Rockefeller Foundation began campaigns to eradicate hookworm in 1907 and yellow fever in 1915. Both these campaigns against diseases of humans failed: the hookworm campaign because mass treatment of affected populations with anthelmintic therapy reduced the severity of individual infections but rarely eliminated them and thus did not prevent rapid reinfection (*14*); and the campaign against yellow fever because of the previously unknown, inaccessible cycle of disease among nonhuman primates living in forests (*15*). Acceptance of the concept of eradication declined during the late 1920s and early 1930s, after the futility of the eradication of hookworm and yellow fever was recognized.

The concept became popular again in the late 1940s, following the elimination of *Anopheles gambiae* mosquitoes from Brazil and Egypt, the elimination of malaria from Sardinia, reductions in the prevalence of yaws in Haiti, and the introduction of a stable freeze-dried vaccine against smallpox (*13,15*). By 1955, WHO had declared goals of global eradication of yaws and malaria, and in 1958 it adopted the goal of smallpox eradication as well. The yaws campaign failed, partly because persons with inapparent latent cases were not adequately treated, in addition to persons with clinical disease. Many such latent infections relapsed to produce infectious lesions soon

TABLE 1. Criteria for assessing eradicability of diseases and conditions

Scientific Feasibility

- Epidemiologic vulnerability (e.g., existence of nonhuman reservoir; ease of spread; natural cyclical decline in prevalence; naturally induced immunity; ease of diagnosis; and duration of any relapse potential)
- Effective, practical intervention available (e.g., vaccine or other primary preventive, curative treatment, and means of eliminating vector). Ideally, intervention should be effective, safe, inexpensive, long-lasting, and easily deployed.
- Demonstrated feasibility of elimination (e.g., documented elimination from island or other geographic unit)

Political Will/Popular Support

- Perceived burden of the disease (e.g., extent, deaths, other effects; true burden may not be perceived; the reverse of benefits expected to accrue from eradication; relevance to rich and poor countries).
- Expected cost of eradication (especially in relation to perceived burden from the disease).
- Synergy of eradication efforts with other interventions (e.g., potential for added benefits or savings or spin-off effects)
- Necessity for eradication rather than control

after mass treatment teams visited a community. Later, disease-specific control measures were withdrawn prematurely, allowing the infection to reappear in several areas (*16*).

Failure to achieve malaria eradication, after an expenditure estimated at $1.4 billion during the period 1955–1965, brought the concept of eradication into disfavor again (*17*). Resistance of some vectors to insecticides and of some parasites to treatment, the unexpected diversity and tenacity of some vectors, administrative shortcomings, and rising costs were all factors in the decision to abandon the goal of eradicating malaria (*18*). (WHO officially revised the goal to one of control in 1969.) The achievement of global smallpox eradication in 1977 and its official certification by WHO in 1980 did not at first bring about the acceptance of the concept of eradication. Concerns were raised that a new eradication effort might detract from efforts to focus attention on the need for developing comprehensive primary health services, rather than focusing on one or two diseases (*19*). However, several diseases (e.g., schistosomiasis, rotavirus diarrhea, brucellosis, and leprosy) that were then being considered as possible targets for global eradication did not have potential for success given the current technology. Several reports and conferences have considered the potential for eradicating other diseases, of which poliomyelitis, mumps, and rubella were among those most frequently cited (*18,20–23*). Reports in 1980 and 1985 both concluded that no other major disease was then a potential candidate to be targeted by a global eradication campaign (*18,20*).

After the concept of eradication was accepted again in the late 1980s, some observers considered a disease to be unsuitable for eradication to the extent that it differed from smallpox or that the intervention against it differed from smallpox vaccine (*24*). In this third period of acceptance, WHO has targeted dracunculiasis and poliomyelitis for eradication.

SUMMARY OF THE ITFDE DELIBERATIONS

Ninety-four infectious diseases were screened by the ITFDE (Appendix 1). The ITFDE considered 29 infectious diseases in depth, as well as one noninfectious condition (iodine deficiency). The latter condition was chosen in part to enable the ITFDE to apply the criteria it had developed to at least one noninfectious candidate for eradication, as an example in principle. Some infectious diseases that were already proposed for eradication by WHO or by other organizations or countries were considered by the ITFDE before the list was completed. Those diseases were not included in the list of diseases subjected to preliminary screening by the ITFDE.

Of the ninety-four diseases that were screened, the ITFDE concluded that six were potentially eradicable: dracunculiasis (Guinea worm disease), poliomyelitis, mumps, rubella, lymphatic filariasis, and taeniasis/cysticercosis (pork tapeworm). Of these, only the first two had already been targeted for global eradication. The ITFDE also noted that seven other conditions or clinical manifestations of diseases might be eliminated: blindness from onchocerciasis, urban rabies, transmission of yaws and other endemic treponematoses, transmission of hepatitis B, transmission of neonatal tetanus, blindness from trachoma, and iodine deficiency disorders. Key obstacles to

TABLE 2. Milestones in disease eradication

1888	Charles V. Chapin urges eradication of tuberculosis (TB).
1892	Contagious pleuropneumonia of cattle declared eradicated from United States after 5-year campaign costing $5 million, begun in 1884.
1896	Rabies eradicated from England.
1901	Gen. William C. Gorgas eradicates yellow fever from Havana.
1907	Rockefeller Foundation establishes Sanitary Commission for Eradication of Hookworm Disease in the United States; eventually stimulates projects in 52 countries.
1915	Rockefeller Foundation establishes Yellow Fever Commission to eradicate that disease, under leadership of Gorgas. Fear of importing yellow fever to Asia via Panama Canal.
1917	Decision to eradicate bovine TB from United States.
1922	Rockefeller Foundation's hookworm campaign begins phasing out after evaluation shows little impact on transmission.
1923	Yellow fever reappears in Brazil after nearly a year's absence.
1928–1929	Other outbreaks of yellow fever in Brazil, including in Rio de Janeiro.
1930	*Anopheles gambiae* mosquito discovered in Brazil.
1933	Yellow fever realized to be widespread in South American forests; search for hidden breeding sites of *A. aegypti* vector reveals its disappearance from cities of coastal Brazil.
1934	Eradication of *A. aegypti* in Brazil is proposed.
1937	Wade Hampton Frost reports human TB is being eradicated in the United States and other countries.
1937–1938	Large fatal malaria epidemics associated with *A. gambiae* in Brazil.
1939–1941	*A. gambiae* eradicated from Brazil.
1943	Bolivia is first country to proclaim eradication of *A. aegypti*.
1943–1945	*A. gambiae* eradicated from Egypt.
1947	Pan American Health Organization (PAHO) adopts proposal for eradication of *A. aegypti* from Americas.
1950	Pan American Sanitary Conference approves goal of continental smallpox eradication and continental yaws eradication; begins collaboration with national malaria eradication programs.
1951	Malaria eradicated from Sardinia.
1954	Yaws eradication goal declared by World Health Organization (WHO).
1955	Eighth World Health Assembly (WHA) adopts goal of global malaria eradication.
1958	11th WHA adopts goal of global smallpox eradication.
1966	19th WHA adopts goal of intensified global smallpox eradication by 1976.

TABLE 2. Milestones in disease eradication, cont'd.

1969	WHO officially changes malaria eradication policy back to malaria control, after expenditure of estimated $1.4 billion during 1955–1965.
1970	Smallpox is eradicated from the Americas.
1975	Europe free of malaria for first time in history.
1977	Smallpox eradicated worldwide.
1978	U.S. goal of measles elimination by 1982 is announced.
1980	Smallpox eradication declared by WHO; International Conference on Eradication of Infectious Diseases held in Washington; India begins national dracunculiasis eradication program.
1985	PAHO sets goal of poliomyelitis elimination from Americas by 1990; Europe sets goal of measles elimination by 2000.
1986	39th WHA declares goal of dracunculiasis elimination.
1988	41st WHA declares goal of global poliomyelitis eradication by 2000; African Region of WHO sets goal of dracunculiasis elimination from Africa by 1995.
1989	International Task Force for Disease Eradication meets for first time.
1990	WHO meeting on criteria and procedures for certification of dracunculiasis elimination; PAHO's Executive Committee begins considering other potential candidates for elimination in the Americas by 2000.
1991	44th WHA declares goal of global dracunculiasis eradication by 1995; last case of indigenous poliomyelitis in the Americas occurs in Peru.

eradication, elimination, or improved control were also highlighted by the ITFDE in its discussions of the 30 diseases that it considered in depth (Table 3).

Summaries* of the 30 background papers that were presented to the ITFDE appear below. At least two of the papers prepared for meetings of the ITFDE have been published or accepted for publication (*25,26*).

Diseases Targeted for Eradication

Dracunculiasis (Guinea Worm Disease)

Dracunculus medinensis now affects as many as 2 million persons in India, Pakistan, and approximately 16 African countries, where >100 million persons are at risk for the disease (*27*). Persons are infected by drinking water containing immature forms of the parasite. A year later, the female adult worms, each about 1 meter long, emerge through the skin, causing crippling pain that prevents these persons from car-

*The summaries were prepared by the project director, based on the working papers presented to the Task Force. The original authors have not reviewed these summaries. Incidence data for several diseases have been updated. A single reference is provided for each summary as a suggestion for further reading.

TABLE 3. Diseases considered as candidates for global eradication by the International Task Force for Disease Eradication

Disease	Current annual toll worldwide	Chief obstacles to eradication	Conclusion
Diseases targeted for eradication			
Dracunculiasis (Guinea worm disease)	<2 million persons infected; few deaths	Lack of public and political awareness; inadequate funding	Eradicable
Poliomyelitis	100,000 cases of paralytic disease; 10,000 deaths	No insurmountable technical obstacles; increased national/international commitment needed	Eradicable
Lymphatic filariasis	80 million cases	Need better tools for monitoring infection	Potentially eradicable
Mumps	Unknown	Lack of data on impact in developing countries; difficult diagnosis	Potentially eradicable
Rubella	Unknown	Lack of data on impact in developing countries; difficult diagnosis	Potentially eradicable
Taeniasis/ cysticercosis (pork tapeworm)	50 million cases; 50,000 deaths	Need simpler diagnostics for humans and pigs	Potentially eradicable
Diseases/conditions of which some aspect could be eliminated			
Hepatitis B	250,000 deaths	Carrier state, infections in utero not preventable; need routine infant vaccination	Not now eradicable, but could eliminate transmission over several decades
Iodine deficiency disorders	Unknown	Inadequate surveillance, lack of environmental sources of iodine	Could eliminate iodine deficiency disorders
Neonatal tetanus	560,000 deaths	Inexhaustible environmental reservoir	Not now eradicable, but could prevent transmission
Onchocerciasis (river blindness)	18 million cases; 340,000 blind	High cost of vector control; no therapy to kill adult worms; restrictions in mass use of ivermectin	Could eliminate associated blindness
Rabies	52,000 deaths	No effective way to deliver vaccine to wild animals that carry the disease	Could eliminate urban rabies
Trachoma	500 million cases; 6–8 million blind	Linked to poverty; ubiquitous microbe	Could eliminate blindness
Yaws and other endemic treponematoses	2.5 million cases	Political and financial inertia	Could interrupt transmission*

*Because persons may be infected for decades and the organisms cannot be distinguished from those that cause venereal syphilis, elimination of transmission—not eradication—is the goal.

TABLE 3. Diseases considered as candidates for global eradication by the International Task Force for Disease Eradication, cont'd.

Disease	Current annual toll worldwide	Chief obstacles to eradication	Conclusion
Diseases that are not eradicable now			
Ascariasis (roundworm)	1 billion infected; 20,000 deaths	Eggs viable in soil for years; laborious diagnosis; widespread	Not now eradicable
Cholera	Unknown	Environmental reservoirs; strain differences	Not now eradicable
Diphtheria	Unknown	Difficult diagnosis; multiple-dose vaccine	Not now eradicable
Hookworm disease	900 million infected; 60,000 deaths	Laborious diagnosis; adult worms may live 5 years; widespread	Not now eradicable
Leprosy (Hansen's disease)	11–12 million cases	Need for improved diagnostic tests and chemotherapy; social stigma; potential reservoir in armadillos	Not now eradicable
Measles	Almost 1 million deaths, mostly among children	Lack of suitably effective vaccine for young infants; cost; public misconception of seriousness	Not now eradicable
Pertussis (whooping cough)	40 million cases; 400,000 deaths	High infectiousness; early infections; multiple-dose vaccine	Not now eradicable
Rotaviral enteritis	80 million cases; 870,000 deaths	Inadequate vaccine	Not now eradicable
Schistosomiasis (bilharziasis)	200 million infected	Reservoir hosts; increased snail-breeding sites	Not now eradicable
Tuberculosis	8–10 million new cases; 2–3 million deaths	Need for improved diagnostic tests, chemotherapy and vaccine; wider application of current therapy	Not now eradicable
Yellow fever	>10,000 deaths	Sylvatic reservoir; heat-labile vaccine	Not now eradicable
Diseases that are not eradicable			
Amebiasis	500 million cases; 40,000–110,000 deaths	Asymptomatic infections; difficult diagnosis, treatment	Not eradicable
Bartonellosis	Unknown	Asymptomatic infections; difficult diagnosis, treatment	Not eradicable
Clonorchiasis	20 million cases in China alone	Animal reservoir; asymptomatic infections; carrier state	Not eradicable
Enterobiasis	Unknown	Widespread; mild disease	Not eradicable
American trypanosomiasis (Chagas' disease)	15–20 million infected	Difficult diagnosis, treatment; animal reservoirs	Not eradicable
Varicella zoster	3 million cases in USA alone	Latency of virus; inadequate vaccine	Not eradicable

rying out their daily activities for periods of weeks or months. When infected persons wade or bathe, the immature forms of the worms enter the water to continue the cycle. Most infections, which induce no immunity and may affect over half a village's population during planting or harvest seasons, are not fatal, but secondary bacterial infections may be life threatening.

Dracunculiasis can be prevented by teaching residents of areas where the disease is endemic to prevent affected persons from entering drinking water sources and to boil or filter their drinking water; by providing water from safe sources such as wells; or by using a chemical to kill the water fleas that harbor the larval parasite. The global eradication campaign began with the International Drinking Water Supply and Sanitation Decade (1981–1990). In 1986, the World Health Assembly (WHA) adopted the goal of eliminating dracunculiasis. The goal of eradicating dracunculiasis by 1995 was declared by the WHA in 1991. No technical barriers remain, but more social mobilization and funding are needed.

Poliomyelitis

WHO estimates that about 100,000 cases of paralytic poliomyelitis still occur annually worldwide, mostly in Asia and Africa, with approximately 10,000 deaths (*28*). For every paralytic case, 100 asymptomatic persons carry the virus and can infect others. This virus is transmitted mostly by airborne droplets from infected persons. Persons who recover are immune. The incidence of poliomyelitis has been reduced as a result of the increases in vaccination rates during the drive to vaccinate at least 80% of the world's infants by December 1990. (About 85% were vaccinated against poliomyelitis.) Protection against poliomyelitis requires three or four injections or oral doses of vaccine.

In 1985, the Pan American Health Organization declared the goal of eliminating poliomyelitis from the Americas by 1990—a goal that apparently has been achieved, with the final cases reported from Peru in September 1991. In 1988, the WHA declared the goal of eradicating poliomyelitis from the world by the year 2000. WHO now estimates that the external costs of eradicating poliomyelitis will be about U.S. $1.1 billion. Poliomyelitis eradication appears to be technically feasible and would be facilitated by development of a vaccine that requires fewer doses or is more heat stable. The most urgent need is for adequate supplies of the existing vaccine and additional funding.

Diseases that Could Potentially Be Eradicated

Lymphatic Filariasis

Lymphatic filariasis is caused by any of three species of parasitic worms: *Wuchereria bancrofti*, *Brugia malayi*, or *Brugia timori* (*29*). Nearly 80 million persons are infected in the tropics and subtropics after long exposure to the bites of certain mosquitoes. Adult worms can live in the lymphatic system for 10–15 years. Female worms discharge microfilariae into the blood, where they can infect other mosquitoes and through them, other humans. Humans are the only reservoir of infection, except for *B. malayi*, which has a reservoir in nonhuman primates that does not appear to contribute to transmission to humans. Complications include swellings of limbs or other

appendages (elephantiasis) from interaction of the parasite with the host's immune system. Many infected persons have no symptoms, and the infection is not fatal.

The impact of this infection and disease has been reduced in several areas by mass treatment of populations with diethylcarbamazine (DEC). DEC also has some adulticide effect. Ivermectin is another effective drug that is inexpensive and easily administered. Some side effects may occur after either drug, which may be administered once a year. Improved tests are needed for detecting and monitoring infection. More data are needed about costs of intervention and the effects of ivermectin mass treatment of onchocerciasis on filariasis in West Africa. This disease may be eradicable by using single doses of invermectin, DEC, and salt containing DEC.

Mumps

Mumps is a viral disease that occurs worldwide and usually affects children (*30*). It is characterized by fever and painful swelling of the parotid salivary glands. Complications may include orchitis, meningitis, and encephalitis, but inapparent infections are common. Spread by direct contact and airborne droplets, mumps is less contagious than measles or varicella. Humans are the only reservoir of this infection, which confers lifelong immunity. The global impact of mumps is unknown but is perceived to be less than that caused by rubella.

Mumps vaccine is highly effective in a single dose when administered after 1 year of age. Most commonly the vaccine is administered in combination with rubella and measles vaccines as MMR vaccine, which requires refrigeration and is administered by injection. Several countries in the Americas, Western Pacific, and Europe include MMR vaccine among the standard group of vaccines recommended for children. Mumps meningitis reportedly disappeared in Cuba following increased vaccination of young children with MMR vaccine. Additional studies are needed to evaluate the impact of mumps (and rubella) in developing countries, as well as the impact of mumps vaccine, including effects of underimmunization (partial suppression of wild virus). The potential synergy of a combined campaign against mumps along with measles and rubella is perhaps the factor most favoring its eradication. Mumps is probably eradicable with MMR vaccine.

Rubella

Rubella causes mild disease when acquired postnatally, but it can cause severe birth defects in at least 20%–25% of infants born to women infected during the first trimester of pregnancy (*31*). It occurs worldwide. Most infections are subclinical, but these do not appear to play an important role in transmission. Little is known of the disease's impact in developing countries, but serologic surveys indicate that most African children are immune to the virus by their tenth birthday. There is no animal reservoir of infection, and this disease is less contagious than rubeola.

The live-virus vaccine is effective in a single dose and is often administered as part of a triple vaccine against measles, mumps, and rubella (MMR), so that its marginal cost is extremely small. Use of the vaccine has reduced or interrupted transmisssion in several countries, including Cuba, Sweden, Finland, and the United States. Immunization strategies include universal vaccination of children and susceptible women of childbearing age. The potential for increasing susceptibility in women by underimmunization of children (partial suppression of wild virus) must be avoided. An increasing

number of countries include MMR vaccine in their routine immunization services. Rubella can be eradicated, and the availability of the MMR combined vaccine has lowered the marginal costs of rubella eradication. More data regarding rubella's impact in developing countries are needed. A strategy that does not inadvertently increase the number of susceptible women should be used.

Taeniasis/Cysticercosis (Pork Tapeworm)

Human beings are the only definitive hosts of *Taenia saginata* (beef tapeworm) and *Taenia solium* (pork tapeworm) (*26*). The beef tapeworm is associated with cattle husbandry; it is the more widespread of the two and is increasing in Europe. Both species are most prevalent in Latin America, Asia, and Africa. Humans are infected by eating inadequately cooked, contaminated beef or pork. The eggs of *T. solium* are also infective to humans, who may develop a life-threatening dissemination of larvae to cause cysts in various tissues. Epileptic seizures are a major manifestation when such cysts occur in the brain. Approximately 50 million persons are infected with both parasites; some 50,000 die of cysticercosis annually.

Effective means now exist for surveillance to identify foci of transmission of *T. solium* and for mass treatment of humans (e.g., praziquantel and niclosamide) to help eliminate such foci. This parasite causes a substantial economic burden to the pork industry. *T. solium* has disappeared gradually from most European countries even without targeted control measures. Research priorities include development of a more sensitive diagnostic test for use in pigs and a better way to identify infected persons. *T. solium* cysticercosis is potentially eradicable through surveillance and available interventions, but such feasibility needs to be demonstrated in a sizable geographic area.

Diseases of which Some Aspect Could Be Eliminated

Hepatitis B

Hepatitis B is a viral disease that is responsible for more than 250,000 deaths per year worldwide (*32*). High incidences are found in Alaska and other arctic areas, Africa, China, Southeast Asia, and the Amazon. Many infections are asymptomatic. Hepatitis B is transmitted in early childhood, often perinatally from mother to infant; sexual and other transmission by direct contact also occur. About 5% of infections occur *in utero*. More than two thirds of persons infected in infancy become persistent carriers of the virus. Deaths result from liver cancer or chronic liver disease, including cirrhosis.

A vaccine to prevent hepatitis B was introduced in the late 1970s. Three doses are required, beginning at birth or in early infancy in areas where the disease is highly endemic. Some countries have begun routine mass vaccinations of infants against hepatitis B as a part of their Expanded Programme on Immunization. An alternative approach is to vaccinate only infants of infected mothers who have been identified by prior screening. At the current cost of U.S. $7.60 per dose of vaccine, hepatitis B could be eventually eliminated from the United States at a cost of about $120 million per year, compared with an estimated annual cost of $750 million for treating persons who contract the disease. Reduction of disease would not begin to be evident for

about 15 years. It is not possible to eradicate hepatitis B now, but it is technically feasible to eliminate its transmission by universal vaccination programs.

Iodine Deficiency Disorders

More than a billion persons are at risk for this noninfectious condition, which is the leading preventable cause of intellectual impairment in the world (*33*). The number of persons affected is unknown, but prevalences of the most severe form, cretinism, often reach 3%–15% in areas where the disease is highly endemic. Goiter and hypothyroidism are other manifestations of the deficiency. The main risk factor involved is exclusive or nearly exclusive consumption of locally grown foods in areas where the soil is deficient in iodine.

Interventions include adding iodine to salt, tea, fish paste, or bread, at a cost of US $0.02–0.04 per person per year for iodized salt. Iodized oil is available in injectable or oral forms. Interventions for iodine deficiency can also be combined readily with interventions for vitamin A and/or iron deficiency. A new assay is available to measure levels of thyroid hormone in samples of blood from a fingerstick. Methods such as iodized salt were used to eliminate iodine deficiency disorders more than 40 years ago in Australia, England, New Zealand, Switzerland, and the United States. Bolivia and Ecuador have almost eliminated the condition. WHO has endorsed a goal of elimination of iodine deficiency disorder by the year 2000. There is great need for improved surveillance and estimates of the prevalence of these disorders and of their economic impact. Iodine deficiency disorders can be eliminated.

Neonatal Tetanus

WHO estimates that as of 1990 approximately 560,000 deaths caused by tetanus infections in newborns occurred annually in developing countries, mostly in Asia and Africa (*34*). Newborns are infected by spores of the bacterium *Clostridium tetani* when the umbilical stump is contaminated by unclean instruments or hands used to cut the cord at birth and/or dressings applied to the area in the first few days of the infant's life. The spores are found widely in the environment, where they are associated with the feces of ungulates. Most infected infants die of the disease.

Neonatal tetanus can be prevented by promoting clean deliveries and by vaccinating women of childbearing age and children. Based on this strategy, in 1989 WHO declared the goal of eliminating neonatal tetanus by 1995. As of 1990, only about 58% of women of childbearing age worldwide (43% in developing countries) had received the two injections of vaccine required to protect their infants. To achieve better control, the number of doses of vaccine required to confer protection should be reduced and surveillance of the disease and monitoring of vaccination coverage should be improved. The reservoir of tetanus spores in the environment is the major barrier to elimination of neonatal tetanus, which cannot be eradicated. Preventing transmission of this disease by continuing the interventions mentioned above, however, is possible.

Onchocerciasis (River Blindness)

Onchocerciasis is caused by a parasitic worm, *Onchocerca volvulus*, which is transmitted to persons by biting blackflies that breed in fast-flowing rivers (*25*). The adult worms live for up to 15 years in nodules beneath the skin and muscles of infected persons, where they produce millions of embryos (microfilariae) that invade the skin,

eyes, and other tissues. Some microfilariae are taken up from the skin by blackflies to continue the reproductive cycle. About 18 million persons are affected, mostly in Africa (99%), Yemen, and Latin America. Both living and dead microfilariae cause severe itching in the skin and sometimes blindness after many years. Approximately 340,000 persons have become blind from the disease.

Until the 1980s, the main control measure was to use larvicides to kill immature blackflies in rivers. This method has been used effectively by the multicountry Onchocerciasis Control Program to reduce the incidence of the disease in part of West Africa over the past 2 decades, but it is expensive. Since 1987, the drug ivermectin has been provided by the manufacturer free of charge to control programs for treating persons with onchocerciasis. This treatment is effective in a single oral dose, administered once annually; it prevents accumulation of microfilariae in persons at risk. No drug suitable for mass treatment can kill the adult worms in the host's body, and onchocerciasis cannot be eradicated without such a means. The blindness, however, can be eliminated.

Rabies

More than 50,000 persons die of rabies each year, mostly in China and India (*35*). Humans are infected by saliva introduced into wounds by the bite of a rabid wild or domestic animal, usually a dog. Canine rabies is endemic throughout most of Asia, Africa, and Latin America. Rabies also is endemic among some wild animals (e.g., foxes, raccoons, skunks, and bats) in North America and Europe. Rabies is almost always fatal.

Some developed countries have virtually eliminated rabies in humans by mass vaccination of domestic dogs and destruction of stray dogs. This approach is difficult to apply in rural areas of most developing countries, where animals may not be privately owned, destruction may be unacceptable, and such campaigns may be expensive. Some Latin American countries are conducting successful campaigns in cities, however. Attempts are being made to control rabies in wildlife by development of oral vaccines that can be safely distributed in baits. Eradication of rabies is not feasible, primarily because of the extensive, varied animal reservoirs of the virus and the inability to eliminate those reservoirs through available technology. It is possible to eliminate human rabies in urban areas, although the costs and benefits of doing so should be considered.

Trachoma

Trachoma is a chronic inflammatory disease of the eye caused by repeated infection with certain types of *Chlamydia trachomatis,* which often results in blindness (*36*). Approximately 500 million persons are infected worldwide, some 6–8 million of whom have become blind. The disease progresses to blindness in about 5%–20% of the infected population. It is transmitted mainly among children and from them to women, perhaps during child care. Important risk factors include low socioeconomic status and inadequate supplies of water.

Effective interventions include mass treatment with tetracycline ointment, which is effective in the short term. The disease, however, usually returns within 6–12 months to pretreatment levels in a community. Promotion of increased face-washing and surgery of the scarred eyelids to prevent continued damage to the cornea by turned-in

lashes are other interventions. There is need for more research into the costs and benefits of interventions, the epidemiology of various risk factors, and documentation of previous successes in control of the disease. It appears scientifically feasible to eliminate blindness caused by trachoma—but not the infection or agent itself— by a combination of community-based education to promote face washing and targeted antibiotic treatment.

Yaws and Other Endemic Treponematoses

Each year, approximately 2.5 million persons, mostly children, contract yaws, endemic syphilis, or pinta—all closely related infections that are transmitted nonsexually, mainly by skin-to-skin contact (*37*). These diseases rarely are fatal but often disfigure or cripple affected persons by invading their skin, bones, and cartilage. Endemic treponematoses occur in poor rural communities in tropical Africa, Asia, or Latin America. All three diseases are characterized by a positive serologic test that cannot be distinguished from the positive test caused by venereal syphilis. For each person with obvious skin lesions, two or more persons have latent infections.

Mass treatment campaigns conducted during the 1950s and 1960s with injectable penicillin pushed yaws almost to extinction. Yaws and endemic syphilis have since resurged, especially in West Africa. Serologic testing, treatment with penicillin, and improvement in personal hygiene are the main interventions, all of which could be implemented as a part of primary health care. Similar infections have been seen in a few nonhuman primates but do not appear to be epidemiologically important. Development of tests to reliably distinguish these treponemes and their serologic reactions would facilitate control efforts. The potential for emergence of penicillin-resistant strains lends urgency to the need for better control. Eliminating transmission of these diseases seems feasible.

Diseases that Are Not Eradicable Now

Ascariasis (Roundworm)

Ascariasis, caused by the intestinal parasite *Ascaris lumbricoides* (large roundworm), is one of the most common infections of humans, affecting an estimated one billion persons at any one time (*38*). It affects ≥50% of populations in tropical and subtropical areas. Its clinical effects include respiratory or abdominal symptoms and discomfort, with or without associated malnutrition, especially in young children. Potential complications include obstruction of the bile duct by a worm or, more commonly, intestinal obstruction by a mass of worms. Globally, ascariasis causes an estimated 20,000 deaths per year. Humans are infected when they ingest soil contaminated (by human feces) with eggs of the parasite on their food, fingers, or drink.

An adult ascaris may live up to one and a half years. Humans are the only reservoir, but the eggs may remain viable in soil for years. Diagnosis requires careful examination of a fecal sample by a trained microscopist. Control measures include sanitation and education to promote using latrines, washing hands and food, and avoiding use of uncomposted human feces as fertilizer; mass chemotherapy; and provision of safe water for household use. Modern anthelmintics administered in a single dose are safe and relatively inexpensive and are effective for several months. Ascariasis is not now

eradicable, but it could be better controlled through mass chemotherapy and hygiene education of schoolchildren.

Cholera

Cholera, characterized by severe watery diarrhea, dehydration, and high mortality in untreated cases, is caused by the bacterium *Vibrio cholerae* 01 (*39*). Many infections are asymptomatic. Although cholera disappeared from much of the world in the 19th century, the current pandemic of the El Tor cholera biotype has been exacerbated by larger human populations, faster travel, and greater survival in the environment. The disease has appeared in more than 100 countries in the past decade and >70,000 cases were reported to WHO in 1990, but the global prevalence of cholera is unknown. It is associated with unsanitary conditions and may be spread by fecal contamination of food, water, or hands. No effective immunity develops.

There is no known animal reservoir, but foci of the organism are now known to persist for years in aquatic environments in the Gulf of Mexico and eastern Australia. The current vaccine gives only limited protection for several months. Oral rehydration can reduce mortality rates. Antibiotic drugs may shorten the duration of illness and stop excretion of the vibrios. Cholera is not now eradicable, although better control is possible by providing clean water, sanitation, and health education. Priority research needs are to understand the environmental reservoirs better (e.g., how does the organism survive? are there other such foci?) and to understand the molecular basis for differences among strains of *V. cholera*.

Diphtheria

This disease, caused by infection with *Corynebacterium diphtheriae*, is characterized by respiratory obstruction and/or myocarditis as a result of a toxin released by some strains of the bacteria. It is spread by direct contact and airborne droplets (*40*). Less harmful infections of the skin occur more commonly in developing countries. An asymptomatic carrier state may follow infection. In the prevaccine era, diphtheria was a major cause of illness and death in children in urban temperate areas. The global toll is unknown, but cases reported to WHO declined from 77,000 in 1974 to <24,000 in 1988. It is not known if the nontoxigenic strain of diphtheria induces immunity to infection. Humans are the only reservoir.

The vaccine is an antitoxin, which usually is administered as a part of the DTP or DT vaccines, in at least three doses administered by injection at 1-month intervals. Booster doses are also necessary. Widespread use of this vaccine has reduced the incidence of diphtheria in developed and many developing countries. In the United States, fewer than five cases were reported annually during the 1980s. No cases were reported in Sweden for a 24-year period. Recently, DTP vaccine has been used more widely in developing countries. There has been a recent resurgence of this disease in Russia. Diphtheria might be eradicable, but its effects in developing countries and the epidemiologic impact of immunization are not completely understood.

Hookworm Disease

Hookworm infections in humans are usually caused by *Ancylostoma duodenale* or *Necatur americanus*, which together infect an estimated 900 million persons in tropical and subtropical areas (*41*). Local prevalence rates vary from 10% to 90%; they

peak in the later teenage years and among young adults. Infections become clinically important when enough worms are present to cause anemia from loss of blood as a result of the worms, which live in the intestine. About 60,000 persons die of the infection annually, but many infections do not cause symptoms. Hookworm is transmitted when skin comes into contact with moist soil or vegetation that harbors infective larvae hatched from eggs in the feces of an infected person. Adult worms may live 1–5 years. Larvae in soil remain viable for 3–4 weeks. Humans are the only known reservoir of this infection.

Preventive measures and treatment are similar to those for ascariasis, except that wearing shoes also protects against hookworm larvae and administration of iron supplements can reverse the resultant anemia. Sociologic barriers to control include the association of the disease with poverty, poor personal hygiene and defecation practices, and use of human feces as fertilizer—all factors that are difficult but not impossible to change. An attempt to eradicate hookworm in the United States early in the 20th century failed, and there is little or no political support for another attempt. Hookworm is not now eradicable.

Leprosy (Hansen's Disease)

This chronic infectious disease caused by *Mycobacterium leprae* affects an estimated 11–12 million persons worldwide (*42*). Leprosy is usually nonfatal but may be severely disfiguring and disabling, and affected persons are often ostracized. Prolonged contact with an infected person is required for transmission. Wild infected armadillos shed the bacteria into the soil and may transmit the disease from animal to animal.

The introduction of sulfones for chemotherapy in the 1940s was a major breakthrough, although many years of therapy were required for cure. Combination therapy with two to three drugs has had a major impact on the severity of the disease over the past decade. The new drug regimens are shorter but still require 6–24 months of therapy. Resistance of leprosy bacilli to chemotherapeutic drugs is an increasing problem. China, Japan, and South Korea have rapidly reduced the incidence and prevalence of this disease in recent years. India and China established national programs with goals of halting transmission of leprosy by 2000. In 1991, WHO set the goal of eliminating leprosy (defined as incidence <1/10,000 population) worldwide by 2000. This disease is not now eradicable. Impediments include absence of a fast, simple diagnostic test; persistence of organisms, even in treated persons; cost and side effects of drugs; duration of chemotherapy; patient compliance; and the social stigma associated with the disease.

Measles

Almost a million persons, mostly infants and young children, die annually from measles. Especially in Africa, it often leads to death from pneumonia, diarrhea, and malnutrition (*43*). Measles is highly contagious and spreads by airborne droplets exhaled by infected persons up to 2 days before the characteristic rash appears. Persons who recover are immune to reinfection for life. The successful global campaign to improve vaccination levels by 1990 reduced the incidence of measles substantially. A

single injection of vaccine is usually sufficient to confer long-lasting immunity, but to be effective it must be administered after the infant's maternal immunity has waned.

Measles vaccine has been used to reduce the incidence of the disease in the United States, Canada, Cuba, and some European countries, but the disease has not yet been eliminated from any large country. In 1977, the United States established the goal of eliminating measles from the country by 1982. It reduced reported cases to <3000 per year from prevaccine levels of >100 times that number, only to have the disease rebound to 25,000 cases in 1990. European and Caribbean countries plan to eliminate measles by 1995. WHO has established the goal of reducing the global incidence of measles by 90% by 1995. The ineffectiveness of the vaccine for infants at birth or soon after and the high degree of contagion of the infection are the principal barriers to eradication of measles.

Pertussis (Whooping Cough)

This disease, caused by the bacterium *Bordetella pertussis*, occurs worldwide (*44*). It primarily affects infants and young children, with peak incidence in the first 2 months of life, and is characterized by a severe, protracted cough. Globally, pertussis still causes about 40 million cases and 400,000 deaths annually. It is spread from person to person by direct contact and airborne droplets and is highly contagious. Persons who recover are immune. Humans are the only reservoir of the infection.

Pertussis vaccine is part of the combined Diphtheria-Tetanus-Pertussis vaccine (DTP), which is administered by injection and requires three to four doses to be effective. Use of this vaccine has reduced pertussis incidence by more than 99% in the United States since 1940. The high infectiousness of pertussis, the occurrence of much of its impact within the first 2 months of life, and the need to administer at least three doses of vaccine (each dose at 1-month intervals) to achieve adequate protection are major impediments to control. Better control could result from an improved vaccine (e.g., fewer doses, greater efficacy, and safety for adults), improved diagnostic methods, and study of the epidemiology of pertussis in developing countries. If a safe antigen were available for use in adults, researchers could investigate the possibility of protecting infants by booster vaccination of pregnant women. Pertussis is not now eradicable.

Rotaviral Enteritis

Some 80 million episodes of moderate to severe diarrhea and an estimated 870,000 deaths per year are due to rotavirus, which is the most common cause of severe diarrhea in children (*45*). It is found in both developed and developing countries. The virus is spread mainly by the fecal-oral route, but the mode of spread among young children is uncertain. Some infections in India may originate from cattle. Infection appears to protect children against subsequent attacks of severe disease.

Improved hygiene, including handwashing, is the main available mode of preventing spread of the disease. Use of oral rehydrating solution can mitigate clinical effects. An effective vaccine is not yet available for preventing this infection. Priority research needs include development of an effective vaccine, studies of the antigenic diversity of strains of the virus in developing countries, development of an animal model, and

further investigation of mechanisms of immunity. Rotaviral enteritis is not now eradicable.

Schistosomiasis (Bilharziasis)

Most human infections with this debilitating disease are caused by *Schistosoma mansoni*, *S. japonicum*, or *S. hematobium* (*46*). All three parasites, except possibly *S. hematobium*, have important nonhuman reservoir hosts. About 200 million persons are affected in Asia, Latin America, and especially Africa. Infection is usually acquired in childhood, with peak prevalence and intensity among persons 10 to 19 years of age. Untreated, chronic infection may last 3–4 decades. Persons are infected when they enter fresh water sources and larval forms of the parasite penetrate the skin. Such sites are contaminated by egg-bearing feces or urine from infected persons, allowing the worm to enter snails and multiply before becoming infective to humans. Modern dams and irrigation projects have often increased the habitat of the snails.

Modern mass chemotherapy has increased the potential for control of this disease—as demonstrated already in parts of Brazil, China, and Egypt. Single oral doses of some anthelmintics can decrease worm burdens for ≥1 year, depending on the drug and parasite species. Health education to reduce contamination of and exposure to transmission sites and provision of safe water and sanitary facilities are also vital. Schistosomiasis is not now eradicable, but better control is possible, especially by mass chemotherapy and hygiene education for schoolchildren.

Tuberculosis

Tuberculosis (TB) infects 8–10 million persons and kills an estimated 2–3 million annually (*47*). It occurs in all countries but is an especial public health problem in many developing nations. This bacterial infection is spread from person to person by respiratory droplets, especially in crowded, poorly ventilated conditions. Recently, its spread has been facilitated by the concomitant infection of many patients with human immunodeficiency virus (HIV).

Improved living conditions, case finding, drug treatment, isolation of infectious patients, and selective chemoprophylaxis reduced TB incidence in many industrialized countries in the 20th century. Bacille Calmette-Guerín (BCG) vaccine has been used in some countries to help protect infants and young children from potentially fatal complications of TB. Emergence of strains of *Mycobacterium tuberculosis* that are resistant to one or more of the drugs used for treating the disease has complicated and hampered control programs in the past few decades. In the late 1980s, the United States declared a goal to eliminate TB in the country by 2010 (defined as an annual case rate of <1/1,000,000 population). There is need for more accurate, rapid diagnostic tests; shorter and less expensive therapies; better case finding in persons at risk; and a safer, more effective vaccine. It is not now feasible to eradicate TB.

Yellow Fever

Yellow fever is believed to cause more than 10,000 deaths annually in South America and Africa, but its incidence varies because of sporadic epidemics, in addition to ongoing endemic transmission of the disease (*48*). It is usually transmitted to humans by bites of *Aedes aegypti* mosquitos in urban areas or by bites of other mosquito

vectors in sylvatic settings. A permanent cycle of the virus is maintained in jungle-dwelling primates.

An effective vaccine has been available for more than 50 years, although it must be refrigerated and administered by injection. It is recently being included in Expanded Programmes of Immunization in some African countries, as recommended by WHO. Research to improve the current vaccine would be helpful. More aggressive use of the current vaccine could stop urban yellow fever and reduce epidemics in rural areas. Because of the sylvatic reservoir of infection, however, yellow fever cannot be eradicated.

Diseases that Are Not Eradicable

Amebiasis

Amebiasis is caused by the protozoan *Entamoeba histolytica*, a parasite that usually lives in the large intestine of humans, who are its only reservoir (*49*). Some 500 million persons may be infected worldwide, of whom 38 million may develop serious complications (e.g., liver abcess and colitis); 40,000–110,000 persons may die annually. The disease is associated with specific strains of the parasite that have characteristic enzyme patterns. It is especially prevalent in parts of Latin America, Africa, and Asia. The infection is spread by ingestion of the hardy cysts on food or hands or in contaminated drinking water. Most infected persons are asymptomatic; some may excrete cysts for years.

Diagnosis usually requires examination of fecal specimens by a skilled microscopist. Serologic tests and imaging techniques to detect internal abcesses are also used. Drug therapy can eliminate the parasite in the intestine and other organs, but most such drugs must be administered for several days. Proper disposal of human feces, education of persons at risk, and detection and treatment of infected persons are key interventions. Amebiasis is not now eradicable. Current barriers might be overcome if an effective, safe drug became available that could be administered to large groups in a single oral dose without prior testing. Control would also be facilitated if it can be established that only amoebae from symptomatic persons cause symptomatic disease in others.

Bartonellosis

This bacterial infection (*Bartonella bacilliformis*) is limited to certain mountainous areas of Peru, Ecuador, and Colombia, where it is transmitted by the bite of an infected sandfly (*50*). It also can be transmitted by transfusion of blood from an infected person. Infected persons may harbor the bacterium in their blood for many years. The disease may manifest as severe anemia with fever or as a painful skin eruption accompanied by pain in the muscles and joints. The number of persons affected is unknown, but approximately 40% of cases may be fatal and as many as 5% of populations in areas where the disease is endemic may harbor asymptomatic infections. Humans are the only known reservoir of the infection. Persons may remain infective to sandflies for many years.

The infection is diagnosed by microscopic examination of blood or affected skin or by culturing blood on special media. Treatment requires administration of high doses

of antibiotics for at least 7 days. The risk of sandfly bites can be reduced by appropriate insecticides and other protective measures. This infection is not eradicable.

Clonorchiasis

This infection (caused by the parasite *Clonorchis sinensis*) is endemic in parts of China, Japan, Korea, and Southeast Asia (*51*). More than 20 million persons are infected in China alone. Persons become infected by eating raw or inadequately cooked freshwater fish (e.g., carp species or crayfish). In humans, the parasite lives in the bile ducts, and its eggs are discharged in the feces, sometimes for as many as 30 years. After the eggs are discharged, the parasite must first enter a snail, then a fish as intermediate host. Infection in humans is often asymptomatic, but it can cause abdominal pain, gallstones, and cancer of the biliary tract. Pigs, dogs, cats, and rats are also reservoirs of this parasite. Transmission is most frequent, however, in areas where human feces are used to fertilize fish ponds and where harvested fish are eaten raw.

Diagnosis is made by identifying the eggs in fecal specimens, but the eggs of a similar parasite (*Opisthorchis*) are identical. Serologic testing is also helpful. Drug treatment for 1–2 days is effective. Preventive measures include proper disposal of human feces and thorough cooking or freezing of freshwater fish for at least 5 days. This infection is not eradicable because of the nonhuman reservoir, the many asymptomatic infections of humans, and the fact that some infected persons can shed eggs for decades. Its prevalence could be reduced, as with that of several other infections, by promotion of sanitary disposal of human feces.

Enterobiasis (Pinworm)

Enterobiasis is an extremely common parasitic infection, often of young children, in temperate and tropical countries (*52*). Humans are the only hosts of the infection, which is caused by pinworm, *Enterobius vermicularis*. The tiny adult worms live in the large intestine for ≥90 days. They deposit larvae-containing eggs on or near the anus, where their presence causes itching. Children are infected by putting fingers that have been contaminated from scratching into their mouths or by inhaling and then swallowing the eggs, which may become airborne with household dust. The eggs can remain viable in the environment for approximately 2 weeks. Associated pathology is unusual, but the parasite may cause chronic appendicitis or invade the female genital tract.

Diagnosis is made by identifying the microscopic eggs in scrapings or on adhesive tape that has been pressed to perianal skin. Several anthelmintic drugs are effective when administered in a singe oral dose, but infected persons, their families, and other close contacts usually should be treated simultaneously at least twice, at 2-week intervals. It would be nearly impossible to arouse support for the eradication of this widespread infection, since its clinical effects are usually mild or nonexistent.

American Trypanosomiasis (Chagas' Disease)

Approximately 15–20 million persons in impoverished rural areas of the Americas from Mexico to Chile are infected with the parasite *Trypanosoma cruzi* (*53*). The infection is transmitted by the bite of a triatomine bug ("kissing bug") or by blood transfusion, after which there is a long latent period with few or no symptoms. Manifestations may include swelling of the eyelid, followed by fever and enlargement of

the internal organs. Sudden death due to acute cardiac problems can occur in infected young adults. More than 150 species of domestic and wild animals are hosts of this parasite, of which there are many strains. Many epidemiologically important species of the insect vector live in thatched roofs, cracks in walls, and other dark places.

Housing improvements to reduce suitable habitat for the insect vectors and use of residual insecticides are the main bases for preventive interventions in national control programs. Diagnosis, whether by blood smear or serology, and treatment are difficult. Improved diagnosis, methods for screening blood, and treatment are needed. Chagas' disease is not eradicable at present.

Varicella (Chickenpox) and Zoster

Varicella-zoster virus causes two diseases: varicella, which mainly affects children and causes generalized rash and fever; and zoster, which produces a painful localized rash in adults when latent infection from a prior attack of varicella is reactivated (*54*). The virus is transmitted by the airborne route from sources in the respiratory tract and skin. Varicella is highly contagious, comparable with measles. Humans are the only reservoir of infection, and most who recover are immune for life. The global toll is unknown, but approximately three million cases of varicella and 300,000 cases of zoster occur annually in the United States alone, including about 100 reported fatal cases. Varicella appears not to spread as much in tropical countries as in the United States.

A live attenuated vaccine is expected to be licensed in the United States soon, but it is not as effective as other common live-virus vaccines. Moreover, the durability of such induced immunity and its potential effect on the incidence of zoster are unknown. Antiviral therapy with acyclovir can accelerate recovery if it is administered early in the course of the disease. Immune globulin is an effective prophylactic if administered soon after exposure to the virus. The main barrier to eradication of this disease is the ability of the virus to reactivate from latency to produce zoster, which is about 25% as infectious as varicella. This infection is not eradicable.

THE FUTURE

The concept and practice of disease eradication are now accepted as useful, respected tools of international public health, to be employed with scientific discretion. The likely achievement of the next two declared targets for global eradication, dracunculiasis by 1995 and poliomyelitis by 2000, together with the precedent already established by the eradication of smallpox in 1977 (1 year later than the target date), should ensure the survival and application of the principle of eradication (Table 2).* By the time dracunculiasis and poliomyelitis are expected to have been eradicated, interim targets for measles (Table 4) should have been attained and progress should have been made toward the control of other potential targets for eradication that have been identified by the ITFDE (e.g., mumps, rubella, cyticercosis, and lymphatic filariasis). Thomas Jefferson's "catalogue of evils" may be steadily diminished with these attainments and with advances in tools for controlling other potential targets such as

*The full text of the World Health Assembly resolutions regarding disease eradication is available on request to the World Health Organization.

onchocerciasis (or *Haemophilus influenzae* b, for which conjugate vaccines have been licensed).

If the epidemiologic benefits of eradication are not incentive enough, the fiscal rewards may help ensure the concept's acceptability. The United States alone has been recovering its total investment of about $30 million in the global Smallpox Eradication Program every 3–4 months since the early 1970s. Since smallpox was eradicated in 1977, that total investment has been returned to the United States every 26 days. Based on the current rate of progress towards eradication of poliomyelitis, WHO predicts that campaign will "produce [global] savings of half a billion dollars by the year 2000, increasing to U.S. $3 billion annually by the year 2015."

The main obstacle to the concept's current acceptance is that if the concept of eradication is invoked against inappropriate or unattainable targets, it can again be brought into disrepute. The declared targets of "elimination" of neonatal tetanus by 1995 and of leprosy by 2000 are potential examples of such dangers. Care should be taken to reserve use of the terms "eradication" and "elimination" only for carefully chosen diseases that have a high likelihood of being eradicated.

Continued advocacy is required to maintain appropriate consideration of the issues considered and suggestions made by the ITFDE. The Task Force for Child Survival and Development, which includes several key members of the ITFDE, will review updates of this topic annually. If new information or the appearance of new control measures, for example, suggest the need for it, a group may be reconvened to consider other diseases in depth (e.g., *H. influenzae* b) or reconsider diseases that were discussed by the ITFDE. In the interim, the most urgent task for promoting the concept of disease eradication is to ensure the successful eradication of dracunculiasis by 1995 and of poliomyelitis by 2000.

TABLE 4. Diseases targeted for eradication/elimination

1990	Poliomyelitis elimination in Americas [achieved in 1991]
1991	Dracunculiasis elimination in Pakistan [achieved in 1993]
1995	Dracunculiasis eradication
	Poliomyelitis elimination in Europe, Western Pacific
	Measles elimination in English-speaking Caribbean
	Neonatal tetanus elimination
2000	Poliomyelitis eradication
	Measles elimination in Europe
	Leprosy elimination (defined as <1 case/10,000 population)
2007	Elimination of onchocerciasis in the Americas

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The International Task Force for Disease Eradication (ITFDE) was established in 1988 to systematically review potential candidate diseases for eradication and to provide leadership and advocacy for the concept of eradication where appropriate and useful. The secretariat for the ITFDE was supported by a grant from the Charles A. Dana Foundation to William H. Foege, M.D., M.P.H., then the Executive Director of the Carter Center of Emory University.

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APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication*

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Actinomycosis	Infrequent; worldwide	Found in normal flora of oral cavity	Surgery, prolonged chemotherapy	None	—
Acquired immunodeficiency syndrome	Spreading worldwide; 200,000 deaths/year; 6–8 million infected	Sexual transmission; no natural immunity; difficult diagnosis	Health education, condoms; mitigate infection with azidothymidine (AZT)	High	—
Angiostrongyliasis	Infrequent; Pacific islands, Cuba, E. Africa	Reservoir in snails, slugs, rats	Rat control, cook seafoods	None	—
Anisakiasis	Infrequent; Asia, N. Europe, Latin America	Wide reservoir in marine fish and squid; difficult diagnosis	Avoid eating inadequately cooked marine fish	None	—
Anthrax	Sporadic, occasionally epidemic; worldwide, endemic in parts of Asia, Africa	Viable spores in soil for years, also on animal hides; zoonosis	Immunization, antibiotic treatment, disinfection	Low	—
Arenaviral hemorrhagic fever	Bolivia, Argentina; 300–600 cases reported/year	Wild rodent reservoir; no specific treatment or vaccine	Rodent control; isolation of patient	None	—
Arboviral encephalitis (eastern equine encephalitis (EEE), western equine encephalitis, Japanese encephalitis (JE), St. Louis encephalitis) (also fever)	N. America, parts of Asia (JE)	Reservoirs unknown or widespread in animals	Mosquito control, vaccine for JE, EEE	Low; epidemic economic burden	—

*To determine which diseases could qualify for further consideration by the International Task Force for Disease Eradication (ITFDE), these draft criteria were used to screen 94 infectious diseases listed in the 14th edition of *Control of Communicable Diseases in Man* (Benenson AS, ed. Washington, DC; American Public Health Association, 1985). The preliminary proposed disposition is indicated in the last column of the table under "Comment;" a line (—) means the disease was deemed unsuitable for further consideration by the ITFDE. Note that diseases discussed in the text are not listed here.

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Aspergillosis	Worldwide; uncommon	Reservoir in decaying vegetation; spread by inhalation of airborne spores	Treatment difficult	None	—
Babesiosis	N. America, Europe, rare	Rodent or cattle reservoir	Rodent, tick control; chemotherapy	Low	—
Balantidiasis	Worldwide; low incidence	Reservoir in swine, feces, possibly others; resistant to water chlorination	Sanitation, chemotherapy	None	—
Blastomycosis	Uncommon; Asia, Africa, N. America	Reservoir probably in soil; inhaled	Chemotherapy difficult	None	—
Brucellosis	Worldwide; 200 cases/ year reported in USA	Reservoir in domestic and wild animals; serologic diagnosis	Education, milk pasteurization; chemotherapy	Low	—
Candidiasis	Worldwide	Part of normal human flora	Treatment difficult	None	—
Capillariasis	Philippines; 1,500 cases since 1963; 10% case-fatality rate	Possible reservoir in aquatic birds; life cycle uncertain	Avoidance of raw fish	None	—
Chancroid	Worldwide, especially tropics	Sexual transmission; no immunity; difficult diagnosis	Oral antibiotic treatment for 7–10 days	None	—
Cat-scratch disease	Worldwide; uncommon, usually self-limited	Reservoir in cats; no specific treatment	None	None	—
Chlamydial infections (genital)	Worldwide; common; important cause of infertility	Sexual transmission; most patients asymptomatic; no immunity; diagnosis difficult	Health education; antibiotic therapy	Low	—
Chromomycosis	Worldwide; sporadic	Reservoir in wood, soil, decaying vegetation	Treatment very difficult	None	—

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Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Coccidioidomycosis	Arid parts of Americas	Reservoir in soil; inhalation; most infected persons acquire immunity; occupational exposure; diagnosis by culture and skin test	Outdoor dust control; treatment difficult	Low	—
Cryptococcosis	Sporadic; worldwide, increased incidence related to AIDS	Reservoir in soil, pigeon droppings; difficult diagnosis	Disinfection (chemical); difficult treatment	None	—
Cryptosporidiosis	Probably worldwide	Reservoir in cattle, other domestic and wild animals; fecal-oral transmission; diagnosis by fecal smear or intestinal biopsy	Personal hygiene	None	—
Cytomegalovirus disease	Common; worldwide; severe infection in some infants; some morbidity in infected adults; increased incidence related to AIDS	Humans only known reservoir; many inapparent infections; direct contact with infected secretions; viral shedding in urine or saliva for years; diagnosis by viral isolation, serology	Sanitation, hygiene; no vaccine or treatment	None	—
Dengue fever	Tropical Asia, W. Africa, Caribbean and Central America; periodic epidemics with fatalities	Possible monkey reservoir; homologous immunity; dengue hemorrhagic fever associated with *Aedes aegypti* vector; four serotypes; diagnosis by serology, culture	Mosquito control	Low	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Campylobacter diarrhea	Causes 5%–14% of all diarrhea worldwide; some traveler's diarrhea	Reservoir in many animals, including pets; diagnosis by stool isolation	Sanitation; oral rehydration, some antibiotics	Low	—
Diphyllobothriasis	N. America, Europe	From inadequately cooked freshwater fish; reservoir also in dogs and bears; diagnosis by fecal examination	Praziquantel treatment	None	—
Ebola-Marburg virus	Some parts of Africa; often fatal	Unknown reservoirs in African animals; person-to-person transmission	Disinfection; quarantine	None	—
Echinococcosis	Asia, America, Africa in association with herd dogs	Diagnosis by microscopy, x-ray, serology; contaminated hands, food, water; wide reservoir in domestic and wild animals	Hygiene, surgery; destruction or mass chemotherapy of dogs	None	—
Fascioliasis	Cattle-raising areas of Asia, Americas, Europe	Reservoir in cattle, other large herbivores; from uncooked watercress; diagnosis by fecal exam	Praziquantel chemotherapy, education	None	—
Fasciolopsiasis	Southeast Asia	Reservoir in pigs, humans, dogs; from uncooked plants; diagnosis by microscopy of feces	Sanitation, education; praziquantel chemotherapy	None	—
Giardiasis	Worldwide cause of chronic diarrhea	Reservoir in beavers; large proportion of infections asymptomatic; diagnosis by stool smear	Sanitation, hygiene, water supply; chemotherapy	None	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Gonorrhea	Common worldwide; major cause of infertility, abdominal infections (acute)	No nonhuman reservoir; chronic carrier state possible; sexually transmitted; no natural immunity; diagnosis by microscopy	Health education; condoms; chemotherapy limited by wide resistance to penicillin	Low	—
Herpes simplex	Both types common worldwide	Humans only reservoir; direct contact, sexual transmission; long latency; microscopic, serologic diagnosis	Condoms; health education; acyclovir orally or topically	Low	—
Histoplasmosis	Almost worldwide; common focal infections, clinical disease uncommon	Reservoir in dust/soil associated with chickens, bats and starlings; not transmitted person to person; diagnosis by culture, skin test, or microscopy	Disinfection; chemotherapy difficult	None	—
Hymenolepiasis	Cosmopolitan; uncommon cause of disease	Possible reservoir in mice; infections persist for years; many asymptomatic infections; diagnosis by stool smear	Hygiene and sanitation; chemotherapy	None	—
Influenza	Worldwide; major cause of morbidity and mortality; epidemic potential	Animal reservoir suspected; highly infectious by respiratory route; numerous serotypes, shifting; type-specific immunity	Partially effective vaccine; chemoprophylaxis for type A	Moderate	—
Lassa Fever	West and Central Africa; exportation to Europe, N. America; fatal in epidemics	Wild rodent reservoir; natural immunity after recovery; diagnosis by isolation, dangerous	Rodent control; quarantine; disinfection; plasma and ribavirin	Low	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Legionellosis	Nearly worldwide cause of acute pneumonia, fever; sometimes fatal	Reservoir in water systems, possibly soil; no person-to-person transmission; diagnosis by isolation or serology	Disinfection of water systems; antibiotic treatment	None	—
Leishmaniasis (cutaneous, visceral)	Extensive sporadic infection in Old and New World; estimated 12 million cases; over 400,000 new cases/year; visceral form sometimes fatal	Extensive wild and domestic animal reservoirs; multiple strains of parasite; immunity after healing; diagnosis by microscopy, serology, or biopsy	Insecticide control of sandfly; destroy animal reservoirs; chemotherapy difficult	Low	—
Leptospirosis	Worldwide zoonosis; low fatality rate; hazard in occupations with animal contact	Extensive reservoirs in wild and domestic animals; many serotypes; diagnosis by serology or isolation	Rodent control; boots and gloves; avoidance of contaminated water; limited immunization; weekly chemoprophylaxis	None	—
Listeriosis	Sporadic, uncommon infection; rarely fatal	Reservoir in infected human carriers, domestic and wild animals; diagnosis very difficult	Antibiotic treatment	None	—
Loiasis	West and Central Africa; highly endemic in some villages	Humans only reservoir; microfilariae in humans up to 17 years; no known immunity; diagnosis by microscopy of blood	Vector control of fly; fly repellents; chemoprophylaxis; treatment difficult (diethylcarbamazine); ivermectin a possibility	None	—
Lyme disease	USA, Europe, Australia	Reservoir in ticks, wild deer, rodents; clinical diagnosis, serology	Vector control; palliative treatment	None	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Lymphocytic choriomeningitis	Uncommon, localized infection	Mice, hamster reservoir; asymptomatic infections; diagnosis by viral isolation, serology	Sanitation and hygiene	None	—
Lymphogranuloma venereum	Worldwide, especially tropical, subtropical	Humans only reservoir; sexually transmitted, often asymptomatic, very chronic; diagnosis by microscopy, serology	Condoms; 2 weeks of oral antibiotics	None	—
Malaria	Mainly tropical; 1–2 million deaths/year	Humans main reservoir; relapses, asymptomatic infections; multiple strains; diagnosis by microscopy	Chemotherapy (resistance); vector control (resistance); chemoprophylaxis (resistance)	High	Legacy of failed campaign
Melioidosis	Asia, Africa, Americas; uncommon	Reservoir in some soil and water; various animals; often asymptomatic; relapses; diagnosis by isolation, serology	Chemotherapy	None	—
Meningococcal meningitis (*Neisseria meningitidis*)	Widespread; temperate and tropical; epidemic tendency, especially in hot, dry regions (Sahel); often fatal	Humans only reservoir; asymptomatic carriers; several serogroups; microscopic diagnosis	Vaccines against some serotypes; respiratory isolation; chemotherapy, chemoprophylaxis (some antibiotic resistance)	Low	—
Haemophilus meningitis	Common in USA; associated with other clinical involvement; often fatal; worldwide	Humans only reservoir; diagnosis by isolation or serology	Antibiotic treatment and prophylaxis; vaccine against type B	Low	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Infectious mononucleosis (Epstein-Barr virus [EBV])	Common, worldwide; usually mild; same agent (EBV) associated with Burkitt's lymphoma, nasopharyngeal cancer	Humans only reservoir; spread by saliva; convalescent immunity; difficult clinical differential diagnosis; laboratory tests required	Disinfection; reduce malaria to reduce incidence of Burkitt's lymphoma	Low (vaccine would elevate)	—
Nocardiosis	Worldwide; occasional, chronic	Reservoir in soil; transmitted by inhalation; diagnosis by microscopy	Some patients respond to antibiotic therapy	None	—
Paragonimiasis	Extensive in Asia, also parts of Africa, Latin America; chronic effects in lung	Reservoirs in domestic and wild carnivores; no immunity; diagnosis by stool examination, chest x-ray	Avoidance of inadequately cooked crabs; sanitation	None	—
Pediculosis (body lice)	Worldwide, not fatal	Humans only reservoir; spread by direct contact (including sexual)	Health education, hygiene; disinfection of clothing, homes; lotion or powders	None	—
Plague	Focal but worldwide distribution in wild rodents; high fatality rate; sporadic in western USA	Extensive wild rodent reservoir; pulmonary form spreads human to human; fleas infective for months; microscopic diagnosis	Wild rodent and flea control; killed bacterial vaccine; quarantine; antibiotic treatment	Moderate–high	—
Pneumonococcal pneumonia	Worldwide; often fatal in extremely old or young persons or alcoholics	Humans only reservoir; many asymptomatic carriers; diagnosis by microscopy	Polyvalent vaccine; antibiotic therapy	Low	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Psittacosis	Worldwide; sporadic human cases	Apparently healthy carriers in birds; infection by inhalation; serologic diagnosis	Destruction of infected birds; public education; weeks of antibiotic therapy	None	—
Q Fever	Worldwide; epidemics rarely fatal	Extensive reservoir in cattle, sheep, goats; serologic diagnosis	Vaccine; health education; disinfection; antibiotics	None	—
Relapsing fever	Asia, Africa, Americas; endemic fatality rates may be as high as 50%	Epidemic if borne by lice, endemic if by ticks; tick-borne reservoir in wild rodents and ticks; infected ticks can live for years; limited immunity; diagnosis by darkfield microscopy	Personal and environmental vector control; tetracycline treatment	Low	—
Tick-borne rickettsioses (Rocky Mountain spotted fever)	Americas or other, case-fatality rate up to 20%	Reservoir in ticks, dogs, rodents; diagnosis difficult, by serology	Health education, tick control, antibiotic therapy	Low	—
Salmonellosis	Worldwide, cause of diarrhea and sometimes severe infections; common	Wide reservoir in wild and domestic animals, especially raw dairy products; numerous serotypes; carrier state for months	Thorough cooking of food; education; antibiotic therapy	None	—
Scabies	Widespread cause of intense skin infection; associated with poverty	Humans only reservoir, transmission by skin-to-skin contact or via clothing	Education, topical treatment, isolation	None	—
Shigellosis	Worldwide; common cause of severe dysentery and death, especially in children	Humans are main reservoir, also in primate colonies; asymptomatic carriers; several serotypes; diagnosis by microscope, culture	No commercial vaccine; water supply, health education, hygiene and sanitation; oral rehydration, antibiotics (resistance occurs)	None	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Strongyloidiasis	Widespread in tropics and some temperate areas; autoinfection possible, potentially fatal	Possible reservoir in dogs as well as humans; larvae actively penetrate skin from fecally contaminated soil; duration of communicability up to 35 years; microscopic diagnosis	Health education, sanitation, chemotherapy, shoes	Low	—
Syphilis (veneral, congenital)	Widespread, especially urban; ≥5% prevalence in pregnant women; congenital infections severe, fatal, or chronic	Humans only reservoir; diagnosis difficult; serology; sexual transmission; partial immunity; relapses	Single-dose penicillin treatment, condoms; education; finger-stick serology, case-finding and treatment	Low	
Toxocariasis (visceral larval migrans)	Chronic disease of children worldwide; not common	Reservoir in dogs and cats; ingestion of soil contaminated by their feces; eggs viable in soil for months; diagnosis very difficult	Sanitation and hygiene; education of pet owners; chemotherapy poor	None	—
Toxoplasmosis	Worldwide; common infection; potential fatal	Wide reservoir in rodents, cats, swine, cattle; transmission to humans transplacental, via raw meat, or by ingestion of cat feces; recovered patients are immune	Sanitation and hygiene; education of pet owners; proper cooking of meat; chemotherapy	None	—
Trench fever	Endemic in parts of Europe, Africa, Latin America	Associated with body louse, no other reservoir; diagnosis difficult	Delousing; antibiotic therapy	None	—

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Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Trichinosis	Worldwide endemic, sporadic occurrences, potentially fatal	Reservoir in mice, rats, dogs, wild animals,; associated with eating poorly cooked pork, wild animal meat	Proper cooking practices, freezing of meat	None	—
Trichomoniasis	Prevalent worldwide, not fatal	Humans only reservoir; sexual transmission; often asymptomatic; diagnosis by microscopy	Health education, condoms; chemotherapy	None	—
Trichuriasis	Worldwide, especially in tropics, usually asymptomatic	Humans only reservoir; microscopic diagnosis	Sanitation and hygiene; chemotherapy	None	—
African trypanosomiasis	Only in tropical Africa; estimated 25,000 cases and 20,000 deaths per year; major problem for domestic livestock	Reservoir in wild game for one of the two types; no immunity; diagnosis by microscopic exam of blood or spinal fluid; serologic diagnosis improved	Chemotherapy improved; brush clearing for vector control; locally made tsetse traps; residual insecticides	Low–moderate	—
Tularemia	N. America, Europe, USSR, Japan; contact with wild animals	Extensive reservoir in wild animals; transmission by direct contact, inhalation, or tick bite; immunity; diagnosis by serology or culture	Gloves; live vaccine, antibiotic therapy, education	None	—
Typhoid fever	Worldwide; fatality rate up to 10%, 25,000 deaths/year	Human asymptomatic carrier state; drug-resistant strains; diagnosis by blood culture	Hygiene, water, sanitation; antibiotic therapy; partly effective vaccine	None	—

APPENDIX 1. Diseases screened for potential eradicability by the International Task Force for Disease Eradication

Disease/condition	Extent of problem	Epidemiologic vulnerability	Intervention(s) available	Political will	Comment
Epidemic louse-borne typhus	Mountainous cooler regions of Latin America, Africa, Asia; case-fatality rate 10%–40%	Zoonosis of flying squirrels in USA; asymptomatic cases; relapses after years; difficult serologic diagnosis	Chemical delousing, personal hygiene; immunization, antibiotic therapy	None	—
Murine typhus	Worldwide; milder than louse-borne typhus; in association with mice	Reservoir in rats; other wild or domestic animals may be infected	Rat, mouse control; insecticides against flea vectors, antibiotics	None	—

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