Chapter 1

The state of world health

A fatal complacency

Until a relatively few years ago, there was a sense of optimism that the long struggle for control over infectious diseases was almost over. Smallpox was eradicated. Poliomyelitis, guinea-worm disease, leprosy, Chagas disease and neonatal tetanus were targeted for eradication or elimination. Some 8 out of 10 of the world’s children were immunized against half a dozen killer diseases. Antimicrobial drugs were effectively suppressing countless infections.

But cautious optimism has turned into a fatal complacency that is costing millions of lives every year. The struggle for control, far from being over, has reached a critical stage. Infectious diseases remain the world’s leading cause of death, accounting for at least 17 million (about 33%) of the 52 million people who die each year. Apart from those 17 million — about 9 million of whom are young children — up to half the world’s population of 5.72 billion people are at risk of many endemic diseases.

Diseases that used to be restricted geographically, such as cholera, are now striking in regions once thought safe. While some diseases have been almost completely subdued, others such as malaria and tuberculosis that have always been among our greatest enemies are fighting back with renewed ferocity. The role of infectious agents in the development of many types of cancer is becoming more evident.

New diseases, new threats

New and emerging diseases, combined with the rapid spread of pathogens resistant to antibiotics and of disease-carrying insects resistant to insecticides, are daunting challenges to human health. The new diseases range from AIDS to little-known but equally lethal viral infections. In many cases, their source is unknown, as is the reason for their emergence. More often than not, no specific treatment is yet available for them.

Antibiotic resistance in hospitals worldwide threatens to leave medical and public health workers virtually helpless in the prevention or treatment of many infections. Many of the most powerful antibiotics have been rendered impotent. Disastrously, this is happening at a time when too few new drugs are being developed to replace those that have lost their effectiveness. In the contest for supremacy, the microbes are sprinting ahead. The gap between their ability to mutate into drug-resistant strains and man’s ability to counter them is widening fast.

These are tragic developments, given the achievements that have been made in global disease control. The discovery of antibiotics, the development of vaccines and, more importantly, the introduction of environmental sanitation measures coupled with better understanding of infectious disease epidemiology, have been invaluable weapons in the fight for human health.

Ironically, the present crisis is being acted out against a global economic and demographic background that again gives some cause for optimism. Industrialized countries are emerging from recession. Inflation is relatively under control. Clear signs of economic recovery are visible in many countries making the transition from central planning towards market systems.

Developing countries are enjoying relatively high rates of growth in their gross domestic product. Even in Africa, where many of the world’s least devel-
The re-emergence of infectious diseases is a warning that progress achieved so far towards global security in health and prosperity may be wasted.

The price of failure

However, the re-emergence of infectious diseases is a warning that progress achieved so far towards global security in health and prosperity may be wasted unless effective development policies are formulated, and commitments are made to implement them nationally and internationally.

Infectious diseases range from those occurring in tropical areas (such as malaria and dengue haemorrhagic fever, which are most common in developing countries) to diseases found worldwide (such as hepatitis and sexually transmitted diseases, including HIV/AIDS) and foodborne illnesses that affect large numbers of people in both the richer and the poorer nations.

Infectious diseases are also classified according to their mode of transmission from their source (human, animal or environmental) to a new host. Transmission can happen by direct person-to-person contact, through insects and other vectors, by way of contaminated vehicles such as water or food, and in other more complex ways. The reality today is that there are ominous trends on all fronts. By focusing on the way diseases are transmitted, this report explains how the present situation has arisen, and what human interventions are needed in order to achieve prevention or control.

The struggle for control

A few examples illustrate the impact of infectious diseases on human health and development:

- **Malaria** – the worst of the insect-borne diseases – still strikes up to 500 million people a year, killing at least 2 million.
- **Acute lower respiratory infections** kill almost 4 million children every year. Tuberculosis, similarly spread from person to person, kills 3 million people a year and one-third of the global population carries the bacilli that cause it.
- **Diarrheal diseases**, spread chiefly by contaminated water or food, kill nearly 3 million young children every year. Cholera epidemics are occurring in countries ranging from South-East Asia to the Middle East, and as far apart as western Africa and South America.
- **HIV**, the virus that causes AIDS, is predominantly transmitted sexually, and has already infected up to 24 million adults, of whom at least 4 million have died. More than 330 million new cases of other sexually transmitted diseases occurred in 1995.
- **Viral hepatitis** is another major problem worldwide. This term is used to describe a group of several distinct infections which are similar in many ways, but which nevertheless differ in some of their characteristics, and in their prevention and control. At least 350 million people are chronic carriers of the hepatitis B virus, and another 100 million are chronic carriers of the hepatitis C virus. At least a quarter of them will die of related liver disease.
- **Some of the ten million new cases of cancer** diagnosed in 1995 were caused by viruses (hepatitis B and hepatitis C among them), bacteria and parasites. WHO estimates that 15% of all new cancer cases could be avoided by preventing the infectious diseases associated with them.

Breaking the chains

In all types of infectious disease, prevention and control depend on breaking the chains of transmission. A handful of diseases are within range of elimination or eradication in the next few years and others are under control, thanks largely to effective public health measures (particularly global immunization pro-
grammes) and other interventions. Poliomyelitis and guinea-worm disease, for example, could be eradicated by the end of the century. Other diseases, such as leprosy, could be eliminated as public health dangers by reducing their prevalence to a very low level.

Attaining freedom from infectious disease is one of humanity’s foremost preoccupations. But breaking the chains that shackle people to these diseases is an immensely difficult task. It has been fully achieved only once, with the last reported case of smallpox in 1977. The fact that such success has not been repeated is due not primarily to lack of knowledge or tools, but more to logistical problems and a series of events and developments, some natural and others man-made, that have occurred in recent years. Some are poverty-related, while others are the consequences of economic prosperity.

**Obstacles to success**

Poverty is on the increase, so that hundreds of millions of people are bound by their living conditions to the daily hazard of infectious disease. More than one-fifth of the world’s population lives in extreme poverty. Almost a third of all children are undernourished. Half the people in the world lack regular access to the most needed essential drugs.

Continuing global population growth, combined with rapid urbanization, means that many millions of city dwellers are forced to live in overcrowded and unhealthy conditions, where lack of clean water and adequate sanitation provide breeding grounds for infectious diseases. High-density populations raise the risk of respiratory diseases and those transmitted through contact with pathogens in food and water.

In addition, more than 90% of expected population growth in the coming decades will be in the developing regions of Africa, Asia and Latin America – the regions of richest biological diversity. Human encroachment on tropical forests has brought populations with little or no disease resistance into close proximity with insects that carry malaria and yellow fever and other, sometimes unknown, infectious diseases.

Because of the economic and social crises that still affect many countries, health systems which should offer protection against disease have, in extreme cases, either collapsed or not even been built. The immediate result is a resurgence of diseases that were once under control or should be controllable, given adequate resources. Disabled by these diseases, some societies are unable to get themselves back on their feet and cannot afford the health services that they need.

Migration and the mass movement of millions of refugees or displaced persons from one country to another – as the result of wars, civil turmoil or natural disasters – also provide fertile breeding grounds for infectious diseases and keep them on the move (Box 1).

In many countries, health systems which should offer protection against disease have, in extreme cases, either collapsed or not even been built.
Box 1. Migration and infectious diseases

The impact of international migration on the global spread of infectious diseases is likely to increase as more people move around the world, faster and over longer distances than before. History shows what can happen. Smallpox and measles were unknown in the Americas before the arrival of the Spanish conquistadors 500 years ago. International anxiety over recent outbreaks of plague in India and Ebola fever in Zaire reflected the deeply rooted perception that foreigners can carry contagious, possibly dangerous diseases.

Three-quarters of the world’s population live in developing countries. The economic polarization between them and wealthier countries is leading to increased migration, as are internal conflicts. The workforces of many industrialized nations increasingly depend on youthful immigrants from poorer countries. Today, approximately 120 million passers live outside their country of birth, and millions move every year in search of better living conditions.

The great majority of immigrants to developed countries come from areas where many infectious diseases flourish. In general, most migration-related diseases manifest themselves shortly after migration; most, such as intestinal worms, are fairly harmless. Relatively few outbreaks of migration-related malaria and other mosquito-borne diseases have occurred in recent years. International migration may pose challenges to the national services concerned with surveillance and control of infectious diseases, particularly when those coming have not been immunized to the same extent as the host population, or are not in the age group targeted by national immunization programmes.

Due to wars, civil strife and natural disasters, many displaced persons and refugees find themselves in camps where conditions are ideal for the spread of diseases — inadequate sanitation, contaminated water supplies and gross overcrowding. Initially, during the first weeks or months of makeshift camps or disorderly mass movements of populations, high death rates result from diarrhoeal diseases and acute respiratory infections.

Migrants should not be seen as conveyors of infectious diseases. There are as many businesspeople, tourists and other short-stay visitors crossing international borders per day as there are migrants per year. Although most of those other travellers have the means to stay in clean hotels, there is ample evidence that they do not avoid close contact with the native population they visit, and do bring home their share of infectious diseases.

A worldwide review of disease detection and prevention strategies is required. The situation is complex, given the diversity of travellers and migrant groups, the geographical points of departure and arrival, and the differing health policies of countries. Differences in national approaches, as witnessed during the plague outbreak, will only fuel people’s fears. Assessing and dealing with new and emerging infectious diseases require intensive cooperation between countries and multidisciplinary collaboration within countries.

These approaches must occur in a non-punitive, non-discriminatory setting that protects human rights. Policies to prevent the importation of migration-related disease can be misguided, ineffective and counterproductive. In recent years, many countries introduced border restrictions or mandatory HIV testing of immigrants. Such screening measures spark unfounded suspicion of foreigners and are useless to control HIV epidemics.

Source: International Organization for Migration (personal communication).

and marketing; and altered eating habits.

Social changes place certain age groups at higher risk from infectious diseases — for example the clustering of young children in day-care centres, and the growing numbers of the elderly in nursing homes.

Expanding areas of human habitation put additional millions of people at risk from pathogens previously rare or unknown as causes of human disease. The effects of climatic change may give some diseases the opportunity to spread to new geographical areas (Box 2). Antimicrobials have become ubiquitous. Microbes, meanwhile, continue to evolve and adapt to their environment, as they have always done, adding antimicrobial resistance to their evolutionary pathways.

For all the reasons given above, controlling infectious diseases remains a global challenge. In addition, the social and economic costs of infectious diseases are far from negligible for individuals, families and communities (Box 3).

The call for action is directed not just at those working in the field of health, but the reasons for the present crisis are multiple. They are political, social, environmental and to a significant extent self-inflicted — the by-products of the modern world.

This report does not attempt to be a comprehensive reference work on infectious diseases. Diseases included for illustrative purposes (Table 1) were selected in the following way:

- diseases targeted by WHO for eradication, elimination or control;
- diseases of significance to one or more WHO regions (e.g. Chagas disease);
- other new and emerging diseases and issues which are a global threat.

The list includes all the diseases identified for international health action by the World Summit for Children (1990), the Earth Summit at Rio (1992), the International Conference on Population and Development (1994) and the World Summit for Social Development (1995).

Drawing on the most up-to-date information available, this report provides
an assessment of the global impact of many of these diseases, identifies priorities for action against them, and recommends measures to be taken nationally and internationally.

**The global situation — 1995 update**

As already mentioned, there were glimmers of hope for the world in 1995: rising and sustainable economic growth, decreasing birth and death rates, and slowing growth of urban populations. At the same time, it is clear that deep pockets of poverty, ill-health and suffering persist in many parts of the world, and are at their worst among urban populations and in areas torn by internal strife, conflict and political instability.

The burden of infectious disease, illustrated by mortality and morbidity rates for infants, children and adults — and reflected in life expectancy — is heaviest of all for these populations, and has serious public health implications for the rest of the world. For control of infectious diseases is not merely a medical or biological issue: it is a challenge for society and human development.

This section gives an overview of global issues relevant to human health in general and to the control of infectious diseases in particular.

**The world economy**

Present optimism about the world economy is based on 1995 evidence of the most rapid growth in real world output — and thus total income — of the 1990s. Real output per capita has risen in most countries in the last 15 years. Less than a third of countries were expected to experience a decline in output in 1995, compared to more than half in 1993.

Developed market economies that account for about 75% of world output are gradually emerging from recent recession, with inflation relatively under control. For the fourth consecutive year, the global domestic product of developing countries is continuing to rise and...
Box 2. Climate change: impacts on public health

Scientific evidence suggests that trends in global warming and changing patterns of extreme weather conditions seen in the past few decades may herald unprecedented climate change. These processes are brought about by the accumulation of “greenhouse” gases in the atmosphere, due to the massive combustion of fossil fuels, large-scale deforestation and the rapid expansion of irrigated agriculture and cattle ranching worldwide. This enhanced “greenhouse” effect, combined with increased ultraviolet radiation as a result of stratospheric ozone depletion, may already be affecting human health in many parts of the world.

The various components of global environmental change conspire to alter the potential for the transmission of infectious disease. For example, changes in the geographical distribution of mosquitoes and other carriers of such vector-borne diseases as malaria, yellow fever, dengue and schistosomiasis would result from climate change, deforestation and desertification.

However, in most countries with intense urbanization, modern agriculture and industrial development there will be a relatively small risk that vector-borne diseases would occur, as many of the environmental prerequisites for transmission would no longer prevail. The well-developed health care systems in some of these countries are a further safeguard against epidemiological contingencies.

Sudden epidemics of some atypical zoonoses can occur in extreme weather conditions which are related to climate change and which favour exploitative population growth in the animal reservoir species or the vectors. Lyssavirus disease, carried by ticks, is spreading in North America and Europe because of changed land-use patterns and milder winters.

As a direct effect of global warming, heat-related mortality rates, particularly in cities, may increase among the very old, the young and those suffering from chronic respiratory and cardiovascular disorders. Although the health consequences of increased exposure to ultraviolet radiation are still poorly understood, these may lead to diminishing immunity to a variety of infectious and other diseases, including several forms of cancer.

High temperatures and ultraviolet radiation at ground level augment the formation of photochemical “smog”. Pollen levels are sensitive to increases in temperature as well as humidity. People suffering from chronic respiratory disorders (e.g. asthma, allergies) will be among the first to experience such indirect impacts of climate change.

Scientific knowledge of climate variability, climate change and the effects that these have on public health is still incomplete. The margins of confidence for current predictions of climate change, based on expected emission levels of carbon dioxide and other “greenhouse gases” and airborne particulates in the year 2050, are rather wide. Forecasting the potential direct and indirect impacts on health is therefore difficult. It is even more difficult to predict the indirect effects of climate change that may result from poorly understood changes taking place in ecosystems. The economic and demographic impacts of climate change may further alter the risks of disease transmission and the capacity of countries to deal with them in the coming decades.

WHO seeks to collaborate with other agencies in the UN system and elsewhere, in order to develop appropriate research methodologies worldwide and to promote capacity-building at the country level. The aim is to assess vulnerability and assist the planning of suitable mitigation and adaptation measures to protect human health.

The trend is expected to continue in 1996. Many countries in transition from central planning to market systems show clear signs of economic recovery. In Africa, the overall pace of output growth has increased, and per capita output is expected not to fall in 1995. Conditions for a pick-up in growth are improving in many of the world’s poorer countries.

All these trends are welcome. To gauge their influence on global health, other factors such as global politics and trends in education, migration and population growth, are reviewed below. More specific issues affecting infants, children, men and women—such as fertility, life expectancy and mortality—are also examined.

The global political situation

Startling changes in world politics and economics in recent years have provided unforeseen opportunities for some peoples and countries, but increased impoverishment, inequality and insecurity for others. Capital, goods and people now move around the globe at great speed and in a complex manner. Computerization creates jobs for some and destroys them for others; it also results in new working relations and power relations within and between countries. These are unavoidable trends in global development.

But while the expansion of liberal democracy brings freedom to many more people and offers new possibilities in nation-building and development, violent conflicts and civil wars have escalated greatly since the end of the Cold War in the 1980s. Many nations or states are embroiled in bitter feuds. Political maps are being redrawn as a multitude of ethnic and political groups emerges, making claims and parceling out new territories.

In many cases, massive refugee movements result. There are an estimated 14.3 million refugees today who have been granted asylum in another state. A further 5.4 million are displaced within their own countries, 4 million former refugees have returned to their homelands, and the welfare of another 3.5 million living outside their own
**Box 3. The cost of infectious diseases**

Apart from causing many millions of deaths, infectious diseases reduce the quality of life of millions of people, hinder children's education, reduce land availability for cultivation and human habitat, damage productivity and divert available household resources. Poverty is thus perpetuated for generations. At the 1978 Conference on Primary Health Care in Alma-Ata, WHO and UNICEF revealed not only the dependence of health on economic and social development but also the contribution that a healthy society can make to development itself. Health is not only the end but an essential means to achieve economic growth and human welfare. International evidence shows how disease eradication or control can enhance development.

The annual financial cost of common infectious diseases in the United States is estimated by the National Science and Technology Council as follows (these costs, combined with dollars spent on AIDS and tuberculosis, exceed $120* billion per year):

- **Intestinal infections**
  - $23 billion in direct medical costs and lost productivity

- **Foodborne diseases**
  - $5.6 billion in medical and productivity costs

- **Sexually transmitted diseases**
  - $5 billion in treatment costs (excluding AIDS)

- **Influenza**
  - $5 billion (direct medical costs) and
  - $12 billion (lost productivity costs)

- **Antibiotic-resistant bacterial infections**
  - $4 billion in treatment costs

- **Hepatitis B virus infection**
  - $720 million in combined direct and indirect costs

The cost of a selection of infectious diseases in developing countries is estimated as follows:

- **Malaria.** Based on case studies in Burkina Faso, Chad, Congo and Rwanda, the cost of an average case of malaria in sub-Saharan Africa has been calculated as equivalent to about 12 days of productive output. The total cost for the area in 1995 was projected at $1.684 billion or 1% of the GDP (having risen from $791 million or 0.6% of the GDP in 1987):
  - in Burkina Faso, the cost of each case of malaria amounted to over 19 days of per capita output;
  - in Rwanda, the average cost of each malaria case in 1987 was estimated at $11.8;
  - in Sudan, those affected by malaria were unable to work for 22% of the time during the course of a year;
  - in the Solomon Islands, a child suffering from malaria is absent from school for 5.3 days on average.

**Onchocerciasis.** Since the WHO Onchocerciasis Control Programme was launched in 1974 in West Africa, more than 1.7 million additional years of productive labour have become available as a result of control measures. An additional 25 million hectares of usable land could be made available for agricultural production. This could feed 17 million more people a year.

Treatment of intestinal helminth infections improved the results of cognitive function tests among schoolchildren and reduced school absenteeism in Jamaica.

Treatment of schistosomiasis among sugar-cane cutters in the United Republic of Tanzania increased their productivity.

**AIDS.** The cost of treating existing cases in Rwanda potentially amounts to 60% of the public health budget.

**Guinea-worm.** In Nigeria, rice production loses about 12% of personnel days as a result of this disease.

For families, the direct costs of medical care and lost income often result in severe financial problems. Assets such as livestock and land are sold (as in Kenya, where ill-health is the cause of 24% of land transactions). In Côte d'Ivoire, average medical expenditure at the time of an illness exceeds full-time minimum-wage earnings lost as a result of the illness.

Initial findings of a WHO study confirm relationships among improvements in health status indicators such as infant mortality rate and life expectancy at birth, and subsequent increases in the productivity of the economically active population in agriculture and service sectors. The relationship with productivity in the industrial sector is less marked but nevertheless positive.

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**Education**

Education is essential for national development. Globally, more than 75% of the adult population were literate in 1995 but rates of literacy varied from less than 50% for the least developed countries to about 70% for the developing...
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<th>Selected disease/conditions by main mode of transmission</th>
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world and 99% for the developed world. Although literacy rates for people aged 15 years and above have increased in all regions, most significantly among women, nearly two-thirds of the world’s illiterate adults are still women (565 million); most of them live in the developing regions of Africa, Asia and Latin America. Worldwide, the absolute number of illiterates is expected to decline slightly from about 900 to 870 million by the year 2000, but the day when adult illiteracy will totally disappear remains distant.

Over a billion young people – nearly one-fifth of the world’s population – are enrolled in formal education today compared to around 300 million in the early 1950s; but quarter of the world’s girls are estimated to be out-of-school compared to around one-sixth of the world’s boys. While disparity between male and female literacy rates appears to be diminishing in most developing regions, it is expected that illiteracy will become an increasingly female phenomenon by the year 2000. Yet achieving rapid advances in the educational participation of girls is tied closely to overall development prospects in general. Although women are increasing their presence in higher education, they still encounter major obstacles when they try to apply their education to social and economic advancement.

Population and its growth

In mid-1995, the global population was about 5.7 billion people. It is projected to reach 7.9 billion in 2020, and 9.8 billion in 2050. The current population growth rate of 1.6% a year is the lowest recorded since the Second World War, and is expected to decline further, to 1.3% a year by 2010 and 0.5% by 2050.

Not surprisingly, the decline is slowest in the world’s 48 least developed countries, with an estimated growth rate of 2.9% in 1995, projected to reach 1.1% by 2050. The overall picture is of the global population growing by about 90 million a year for the next 20 years, and falling to about 50 million more a year by 2050. By then, the least developed countries will have a population of about 1.7 billion, or 17% of the total population, compared to about 589 million (about 10%) today. The developing world will have a population of 8.5 billion in 2050, 86% of the total population.

These figures suggest that, for the foreseeable future, the heaviest burdens of ill-health will continue to fall on those who live in developing countries, especially in those countries whose populations are growing fastest, and which are least able to sustain economic development.

Most of the world’s countries are WHO Member States (190 in all), covering a total population of 5701 million, or 99.7% of the world population in 1995.

Migration

International migration is an important factor in the changing world of the 1990s, and has influenced the composition of societies in at least 120 countries in the last five years. Migrants are usually at the peak of their childbearing years and contribute to increases in established foreign or foreign-born populations within recipient countries. They tend to follow in the footsteps of their fellow countrymen and live concentrated in particular areas. Cultural differences within a community raise issues of ethnic relations, social integration and equality that can pose problems for host countries.

Between 1990 and 1995 the influx of migrants has been most marked in Europe, the Americas and Africa. By contrast, more people have emigrated from South-East Asia, the Western Pacific and the Eastern Mediterranean than have migrated to those regions. African migration consists mainly of refugee movements confined to the same region, with the origin in one country and the destination in a neighbouring country (Box 1).

The heaviest burdens of ill-health will continue to fall on those who live in developing countries, especially those least able to sustain economic development.
Urbanization

The world is becoming increasingly urbanized. By 1995, about 45% or 2.6 billion of the world's population were living in urban areas. The proportion is expected to reach 60% by the year 2025. It is expected that, by the first decade of the 21st century, the number of urban dwellers in the developing world (excluding the least developed countries) will equal and thereafter exceed the rural population; the actual number of persons in the rural areas will also begin decreasing for this group of countries (Fig. 1).

About 200 million people now live in cities with populations exceeding 10 million. That figure is expected to rise to 450 million in the next 20 years, almost all of the increase taking place in the developing world. In 1950, only Los Angeles and London had populations of 8 million or more; there were 20 such "megacities" in 1990 and the number is expected to reach 33 - with a combined population of more than 500 million people - by the year 2015.

Population growth in Asian megacities is largely fuelled by rapid economic growth, and their residents generally enjoy improved living standards. In Latin America, however, middle-class households in many cities have been experiencing declining standards of living and are moving to less expensive peripheral areas. Many of the poor, on the other hand, have moved back to city centres, and are compelled to live in substandard housing due to the inadequacy of residential public services in central city areas. For them, severe overcrowding, inadequate waste disposal facilities and poor water and air quality are among the consequences. Water supply problems are among the most serious hazards.

Many cities have grown so rapidly and in such an unregulated way that their waste disposal needs, already unmet, will be very much greater in the coming decades. Some cities, particularly those in low-lying land that is vulnerable to flooding, will be at increased risk of being inundated in their own waste.

Human habitats

In the industrialized world, increasing urbanization has been accompanied by declining rates of population growth, increasing average age, smaller families and inner-city poverty. Some industrialized countries have launched long-term urban development and renewal projects aimed at improving housing, education, sanitation and other facilities. In others where this has not happened, urban decay has accelerated and adverse conditions have been the result, disproportionately affecting the poor.

In the developing world, shortage of affordable housing for the majority of low-income urban dwellers has caused a proliferation of shums and squatter settlements. Despite extensive efforts to provide decent accommodation, most developing countries find it increasingly
difficult to meet the demand for housing, and have had to lower standards. At least half of the urban population of developing countries live in poor-quality housing, with slums and squatter settlements growing twice as fast as large cities.

In this context, the provision of safe and adequate drinking-water, sanitation and solid-waste disposal facilities is a major factor in reducing ill-health and suffering due to infectious diseases. Large numbers of people lack these facilities. One of the problems of providing them is that whereas "old" slums were usually located near city centres, today’s "new" slums are more often in peripheral areas unsuitable for conventional development, such as swampy plains and steep hillsides.

Often services are non-existent and opportunities for connecting to city water, sewerage and power supplies are poor. Consequently, there are increased risks of waterborne and foodborne diseases, and therefore of growing poverty, for sickness means inability to work and loss of earnings.

**Fertility**

Women are having fewer babies. Between 1950 and 1970, women had an average of 4.7 babies. The average declined rapidly to 3.7 births by 1980; to 3.2 by 1990, and is 3 today. Increasing use of contraceptives is the main explanation; higher age at marriage has also contributed to lowering fertility rates in some countries.

The rates have not fallen uniformly worldwide. While the rate in industrialized countries is only 1.8 births, it is 3.1 births in developing countries and 5.8 in the least developed countries. The latter countries are lagging at least 20 years behind other developing nations and most of them have not even begun to see a sustainable decline in fertility.

Although the world’s total fertility rate has fallen by more than a third in the last 30 years, the annual number of births has actually risen during 1980-1995 by 12% because of the increase in the number of women in the reproductive age group. Thus, in 1995 about 139 million babies were born – 16 million in the industrialized world, 25 million in the least developed countries, and 98 million in other developing countries.

About 80% of the mothers are estimated to be 20-35 years old. But there are about 15 million births to teenagers or women over 35 every year. Birth rates among young women aged 15-19 are twice as high in the developing world as in the industrialized one. However, the teenage fertility rate in North America is as high as in the developing world. Whatever the level of development of a country, the number of years of schooling seems to play a significant role in early pregnancy among women (Table 2).

**Contraceptive practices**

The rise in contraceptive use has been most spectacular in developing countries where by 1990, 53% of married couples were using a method of family planning compared to below 10% 25 years earlier. Contraceptive practice was already 67% in the more developed regions by 1965 and reached 72% in 1990. But it was only 18% in Africa as a whole in 1990 – ranging from 31% in northern Africa to only 13% south of the Sahara. In other developing countries of Asia, Oceania, Latin America and the Caribbean, it has reached 58%, while in eastern Asia – China, Hong Kong and the Republic of Korea – it is 79%.

Globally 18% of couples resort to female sterilization and 4% to male sterilization. Female sterilization has increased in prevalence more rapidly than other methods, often accounting for almost all the recent increase in contraceptive prevalence. Worldwide, an estimated 15% of married women use the pill as their contraceptive; there is however a high prevalence of pill use among never-married women, mostly in the industrialized countries. Intrauterine devices (IUDs) account for one-fifth of the contraceptive use worldwide and condom use about 8%, mostly among men. With the advent of the AIDS

<table>
<thead>
<tr>
<th>Selected countries</th>
<th>Percentage of women by years of schooling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cameroon</td>
<td>81</td>
</tr>
<tr>
<td>Kenya</td>
<td>70</td>
</tr>
<tr>
<td>Nigeria</td>
<td>66</td>
</tr>
<tr>
<td>United States</td>
<td>59(^a)</td>
</tr>
<tr>
<td>Guatemala</td>
<td>58</td>
</tr>
<tr>
<td>Mexico</td>
<td>55</td>
</tr>
<tr>
<td>Indonesia</td>
<td>52</td>
</tr>
<tr>
<td>Egypt</td>
<td>51</td>
</tr>
<tr>
<td>Colombia</td>
<td>46</td>
</tr>
<tr>
<td>Philippines</td>
<td>40</td>
</tr>
</tbody>
</table>

\(^a\) Women aged 20–24 who had given birth by age 20, by years of schooling, latest available data.

\(^b\) < 12 years of education.

\(^c\) ≥ 12 years of education.
Table 3. Estimated global magnitude of reproductive health concerns, worldwide, 1995

<table>
<thead>
<tr>
<th>Category</th>
<th>Annual number (millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal deaths</td>
<td>0.6</td>
</tr>
<tr>
<td>Severe maternal morbidity</td>
<td>20</td>
</tr>
<tr>
<td>Perinatal mortality</td>
<td>7.6</td>
</tr>
<tr>
<td>Infants with low weight at birth</td>
<td>23</td>
</tr>
<tr>
<td>Unsafe abortions</td>
<td>20</td>
</tr>
<tr>
<td>Curable sexually transmitted diseases</td>
<td>333</td>
</tr>
<tr>
<td>New cases of cervical cancer</td>
<td>0.5</td>
</tr>
<tr>
<td>Invasive cervical cancer</td>
<td>2</td>
</tr>
<tr>
<td>Female genital mutilation</td>
<td>85–110</td>
</tr>
<tr>
<td>Couples with unmet family planning needs</td>
<td>120</td>
</tr>
<tr>
<td>Infertile couples</td>
<td>60–80</td>
</tr>
</tbody>
</table>

* Figures indicate total number.

Life expectancy

Globally, average life expectancy at birth in 1995 was more than 65 years, an increase of more than three years since 1985. In 1995, life expectancy at birth in developed market economies was more than 77 years. It was 64 years for the developing world, and more than 52 years for the least developed countries.

The life expectancy gap between the industrialized and the developing world has narrowed to 13.3 years in 1995 from 25 years in 1955. But the gap between least developed and other developing countries has widened from 7 years to more than 13 years during the same period.

Life expectancy in Africa as a whole has increased by 4.5 years since the early 1980s, with an average of 53 years in 1995. The world's lowest life expectancy is in Sierra Leone, at only 40 years—about half that of Japan, which has the world's highest life expectancy, at 79.7 years.

Almost two-thirds of the world's population live in 48 countries, including China and India (these two accounting for 40% of the world population), where life expectancy is between 60 and 70 years. In 1995, life expectancy at birth in 121 WHO Member States was 60 years and above. Of 50 countries with expectancies lower than the health-for-all minimum target of 60 years, 37 were in Africa, and of these, 18 had a level below 50 years.

Mortality

About 52 million people died in 1995. The number is almost the same as it was 35 years ago, but the global population has almost doubled in that time. The declining death rate, from 16.5 deaths per 1,000 population in 1960 to 9.1 now, is reflected in global population growth and the increasing proportion of the elderly in developed countries. The developing world's death rate has declined sharply from 20 per 1,000 population in 1960 to about 9 in 1995, due to mortality reduction at every age but particularly in the youngest age groups. The least developed countries, with a death rate of about 14.4 per 1,000 population, lag about 25 years behind other developing nations in the decline of death rates. The rate is highest in Africa and the second highest is in Europe. The explanation is simple: low life expectancy in Africa, a very high proportion of elderly in Europe.

Sex differentials in mortality

On average, a woman living in 1995 could expect to live more than 4 years longer than a man—67.2 versus 63 years. The female advantage is greatest in Europe—8 more years—and smallest in South-East Asia, where it is only one year. It is three years in Africa. Africa and Latin America have the largest male excess in child mortality, and South-central and eastern Asia a higher child mortality rate for girls than for boys.
From a recent study on maternal mortality jointly carried out by WHO and UNICEF, it is estimated that globally some 585,000 maternal deaths (pregnancy-related) occur every year; that is, nearly 80,000 more deaths per year than previously reported. About 99% of these deaths occur in developing countries: 55% in Asia (which accounts for about 60% of the world's births) and 40% in Africa (which has 20% of the world's births). Developed countries, by contrast, account for 12% of births and less than 1% of total maternal deaths. The estimated burden of reproductive ill-health falling overwhelmingly on women is shown in Table 3. Most maternal deaths and pregnancy complications can be prevented if pregnant women have access to good-quality antenatal, delivery and postpartum care, and if certain harmful birth practices are avoided. However, less than 60% of pregnant women in developing countries have antenatal care and only about 55% of women deliver with the help of trained persons, with the quality of care received, and the effective skills of the "trained", being unknown.

Age distribution of death
About 34 million of the 52 million deaths in 1995 occurred at the extremes of life – over 11 million children died before reaching the age of 5; over 22 million died after surviving at least 65 years. In Africa, more than 40% of all deaths were among children under 5.

During 1980-1995, there were significant reductions globally in overall mortality rate but the pace of reduction has not been uniform among populations of different age groups. The decline in the number of deaths was highest (2.5 million) among children aged under 5, particularly infants, and much less for school-age children and adolescents. But deaths actually increased for the adult population aged 20-64 years (1.6 million). The worrying feature in this pattern is the anticipated increase in deaths among this adult (economically active) population group in the early 21st century (Fig. 2).
Child mortality

Child mortality is defined as death under 5 years or the probability of dying by age 5. The global average in 1995 was 81.7 per 1,000 live births. In the developed market economies, the rate was 8.5 per 1,000; in the developing world, it was 90.6 per 1,000; in the least developed countries it was 155.3 per 1,000—18 times higher than the low rate of an industrialized nation. Bad as that last rate is, it is not so bad as it was 40 years ago, when in the poorest countries 287 children in every 1,000 died before their fifth birthday.

Child mortality has declined significantly during the last 25 years, although the pace of decline has not been uniform among children of different ages and in different groups of countries (Fig. 3). Globally child mortality declined from 134 per 1,000 live births in 1970 to about 80 in 1995; that is, about 40% during the period 1970-1995. The decline was 40% for both the developed and the developing world.

The world’s infant mortality rate has fallen by more than 37% since 1970, from 97 deaths in the first year of life per 1,000 live births to 60 per 1,000 in 1995. Even so, some 8.4 million infants died last year before their first birthday. There were only 6.9 infant deaths per 1,000 live births in the most developed countries, but 106.2 per 1,000 in the least developed countries. The average in developing countries was 66.6 per 1,000. Twenty-four countries had rates higher than 100 infant deaths per 1,000; 17 of these are in Africa. The worst rates were in Sierra Leone (160), Afghanistan (159), Mali (154), Mozambique (143) and Malawi (139).

Although infant mortality declined significantly during 1970-1995, the drop was greatest for the developed market economies (66%) and lowest for the least developed countries (30%). The developed world had a much greater reduction in infant mortality compared with child mortality, while in the developing world the situation was the reverse.

WHO estimates that in 1995, there were more than 5 million neonatal deaths (deaths during the first four weeks of life) globally, or 56 deaths per 1,000 live births, most of them in developing countries. Neonatal mortality varied from 53 per 1,000 live births for the least developed countries to about 5 per 1,000 live births for the developed market economies (Fig. 4). About 70% of infant deaths were neonatal deaths in the developed world—developed market economies and economies in transition—but only 50% in the least developed countries.

The global value for perinatal mortality (deaths during late pregnancy or the first week of life) was 53 per 1,000 live births in 1995 and varied from 83 per 1,000 in the least developed countries to 8 for the developed market economies. Overall in developing countries it is estimated that in 1995, about 30% (3.3 million) of total deaths among children under 5 occurred among newborns within a week after birth, about 45% (5 million) among neonates...
and 73% (8.2 million) among infants aged less than 1 year.

**Causes of death and disease**

About 17 million of the 52 million deaths a year are classified as due to infectious diseases of major significance.

Most deaths due to infectious diseases occur in Africa and South-East Asia, and a small proportion in the Americas and Europe.

Of more than 11 million deaths among children under age 5 in the developing world, about 9 million have been attributed to infectious diseases, about 25% preventable by immunization. In respect of infant deaths, 60% (5 million) of the total of 8.2 million were due to infectious diseases, while about 36% (1.8 million) of neonatal deaths have been attributed to infections.

Among adults aged 15-59 years, infectious diseases appear to be responsible for 20% of deaths (2.5 million).

**Control of infectious diseases**

**Emerging diseases**

During the past 20 years, at least 30 new diseases have emerged to threaten the health of hundreds of millions of people. For many of these diseases there is no treatment, cure or vaccine, and the possibility of preventing or controlling them is limited.

Emerging infectious diseases are those whose incidence in humans has increased during the last two decades or which threatens to increase in the near future. The term also refers to newly appearing infectious diseases, or diseases that are spreading to new geographical areas – such as cholera in South America and yellow fever in Kenya. It refers also to diseases that were easily controlled by chemotherapy and antibiotics, but which have developed antimicrobial resistance (Map 2).

The diseases in question involve all the major modes of transmission – they are spread either from person to person,
by insects or animals, or through contaminated water or food. Examples of diseases — whether "new" or "old" — in each of these are examined later in this chapter.

The most dramatic example of a new disease is AIDS, caused by the human immunodeficiency virus (HIV). The existence of the virus was unknown until 15 years ago, but it has since infected an estimated 24 million adults worldwide, and that number could grow to a cumulative total of 40 million by the year 2000.

The origins of HIV are unknown, but it is related to viruses which cause AIDS-like illness in monkeys. Microorganisms constantly undergo changes that enable them to cope with an increasingly hostile environment in their hosts. For example, HIV exploits weaknesses in the host’s defenses by damaging the human immune system, thereby allowing other "opportunist" infections to take advantage.

A new breed of deadly hemorrhagic fevers, of which Ebola is the most notorious, has struck in Africa, Asia, the United States and Latin America. Ebola appeared for the first time in Zaire and Sudan in 1976; it has since struck in Côte d'Ivoire in 1994 and 1995, Liberia in 1995 and again in Zaire in 1995, where it was fatal in 77% of cases. The natural carrier of the Ebola virus — presumably an animal — has not been identified (Box 4).

The United States has seen the emergence of hantavirus pulmonary syndrome, characterized by respiratory failure and a case fatality rate of over 50%. Since it was first recognized in 1993, this type of hantavirus infection has been detected in more than 20 states in that country, and has also surfaced in Argentina and Brazil. This hantavirus is carried by rodents, particularly deer mice, and other hantaviruses have been recognized for many years in Asia, where they cause hemorrhagic fever with renal involvement in humans.

Epidemics of foodborne and waterborne diseases due to new organisms such as cryptosporidium or new strains of bacteria such as Escherichia coli have hit industrialized and developing countries alike. The O157:H7 strain of E. coli was first reported in 1982 and has since then been implicated in many serious outbreaks of diarrhoeal illness, sometimes leading to kidney failure. The strain has been linked to undercooked hamburger beef and unpasteurized milk.

A completely new strain of cholera, O139, appeared in south-eastern India in 1992 and has since spread north and west to other areas of India, into western China, Thailand and other parts of South-East Asia.

The threat of a new global influenza pandemic is increasing. Major shifts in

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**Box 4. The Ebola epidemic: a model for rapid response**

The epidemic of Ebola haemorrhagic fever in Zaire in mid-1995 focused international attention on emerging diseases to an almost unprecedented degree, even though the number of people affected — 316 cases including 245 deaths — was tiny compared to many other infectious diseases.

The intense public and media interest in Ebola haemorrhagic fever was stirred by its deadliness — the epidemic had a 77% mortality rate — its infectiousness and its dreadful symptoms. The average age of those who died was 35 years; patients ranged from a three-day-old baby to a 71-year-old man. Many of the victims were health care workers. Despite fears that the disease might spread to other parts of the world, the epidemic was confined to a relatively small corner of Zaire.

This was due largely to the rapid national and international response to the outbreak. Staff from WHO’s headquarters in Geneva and regional office in Brazzaville, Congo, arrived at the site of the epidemic within 24 hours of notification in Zaire. At the same time, diagnosis of the disease was confirmed at the WHO Collaborating Centre on Arboviruses and Viral Haemorrhagic FEVERs, at the Centers for Disease Control and Prevention, in Atlanta, Georgia, USA.

By arriving promptly, WHO experts and their Zairian public health counterparts were able to set up a disease detection system and train medical students in its operation so that all cases could be found and isolated. As international partners in outbreak investigation and control arrived, WHO’s role became one of ensuring synergism among those partners, providing logistics support, and identifying and ensuring essential intraepidemic research. An International Scientific and Technical Committee, established in Zaire by the Zairian health ministry and WHO, directed the epidemic control operations and set up a follow-up surveillance system. Research was launched in an effort to identify the natural host of the Ebola virus.

This and other recent outbreaks of infectious diseases highlight a weakened ability to detect and contain such threats at a national, regional or global level. One lesson learned was that WHO can, and must, play a proactive role to support national efforts to control outbreaks. The Organization has therefore established a new rapid response system including teams of experts and supplies from regional offices, with headquarters support, to be available for immediate field operations at 24-hour notice.
the make-up of influenza viruses occur every 20 years or so, triggering large epidemics in many parts of the world, and causing many thousands of deaths. The next such shift is expected to take place very soon.

Epidemic strains of influenza viruses originate from China. The influenza virus is carried by ducks, chickens and pigs raised in close proximity to one another on farms. The exchange of genetic material between these viruses produces new strains, leading to epidemics of human influenza, each epidemic being due to a different strain.

New strains such as those of cholera and influenza do not follow the usual pattern of being more common in younger people. They affect all age groups, since older people have not acquired immunity to them from previous infection.

The emergence of drug-resistant strains of microorganisms or parasites is promoted by treatments that do not result in cure. The increasing use of antimicrobials worldwide, often in subtherapeutic doses and sometimes in counterfeit form, guarantees that this problem will increase in the foreseeable future, as mentioned in later sections of this report.

Changes in lifestyle, behaviour (including injecting and non-injecting drug use) and cultural or social values are behind the emergence of some infectious diseases such as syphilis. Increases in the number of sexual partners have been the main factor in the spread of HIV infection and other sexually transmitted diseases.

Travel, including tourism, also plays a role. The spread of syphilis in the 18th and 19th centuries was related to the movement of armies. Today, the introduction of HIV in many parts of the world is due to greatly increased human mobility. Studies show that whereas only a few generations ago most people in their lifetime travelled no further than 40 kilometres from their birthplace, many today go up to 1 000 times further, travelling the whole world.

The practices of modern medicine also contribute. The spread of viral hepatitis is related in part to techniques such as kidney dialysis and multiple blood transfusions, as well as to other forms of transmission.

Relaxation in immunization practices can quickly result in the resurgence of diseases, as, for example, the recent spread of diphtheria in the Russian Federation and other former republics of the USSR.

New animal diseases pose potential foodborne risks to human health that are sometimes difficult to evaluate or predict. An example that has caused much public concern in Europe is bovine spongiform encephalopathy ("mad cow disease"). Fears have grown that the infectious agent responsible may be passed through the food chain to cause a variant of the incurable Creutzfeldt-Jakob disease in humans, in which the brain is attacked. The British beef market has been seriously affected and stringent public health safeguards have been introduced.

The reasons for outbreaks of new diseases, or sharp increases in those once believed to be under control, are complex and still not fully understood. The fact is however that national health has become an international challenge. An outbreak anywhere must now be seen as a threat to virtually all countries, especially those that serve as major hubs of international travel (Map 3).

Despite the emergence of new diseases in the last 20 years, there is still a lack of national and international political will and resources to develop and support the systems that are necessary to detect them and stop their spread. Without doubt diseases as yet unknown, but with the potential to be the AIDS of tomorrow, lurk in the shadows.

**Responding to epidemics**

The process of response encompasses a multitude of activities including: diagnosis of the disease; investigation to understand the source of transmission; implementation of control strategies and programmes; research to develop adequate means to treat the disease and prevent its spread; and the production and distribution of the necessary drugs and vaccines.
Map 3. Selected emerging and re-emerging disease outbreaks in 1995

The first step is to establish mechanisms and procedures for the surveillance of infectious diseases so that national authorities can be alerted to outbreaks and epidemics and advised on how best to deal with them.

An international network of collaborating centres is being set up and their activities coordinated by WHO, to help ensure that changing disease conditions are rapidly recognized.

Antimicrobial resistance

Resistance by disease-causing organisms to antimicrobial drugs and other agents is a major public health problem worldwide. It is making a growing number of infections virtually untreatable, both in hospitals (as discussed in the later section on hospital infections) and in the general community. It is having a deadly impact on the control of diseases such as tuberculosis, malaria, cholera, dysentery and pneumonia, all of which are discussed in more detail later in this chapter.

Antimicrobial resistance is not a new problem, but it has worsened dramatically in the last decade. During that time, the pace of development of new antimicrobials has slowed down while the prevalence of resistance has grown at an alarming rate. The increase in the number of drug-resistant bacteria is no longer matched by a parallel expansion in the arsenal of agents used to treat infections.

In this situation, doctors and their patients are more and more helpless. All age groups are affected. The elderly, the very young, the chronically ill and people whose natural defences are weakened by disease or medical treatment such as surgery are at greater risk of drug-resistant infections, but healthy people in the prime of life can also be attacked. Resistance to antibiotics and other drugs means that people with infections are ill for longer periods, and are at greater risk of dying, and that disease epidemics are prolonged.

All bacteria possess an inherent flexibility that enables them, sooner or later,
to evolve genes that render them resistant to any antimicrobial. By killing susceptible bacteria, an antimicrobial provides selective pressures that favour overgrowth of bacteria carrying a gene that confers resistance. The continuous use of antimicrobial agents encourages the multiplication and spread of resistant strains.

There is strong evidence that a major cause of the current crisis in antimicrobial resistance is the uncontrolled and inappropriate use of antibiotic drugs, in both industrialized and developing countries. They are used by too many people to treat the wrong kind of infection, in the wrong dosage and for the wrong period of time.

The implications are awesome: drugs that cost tens of millions of dollars to produce, and take perhaps 10 years to reach the market, have only a limited life span in which they are effective. As resistance spreads, that life span shrinks; as fewer new drugs appear, the gulf widens between infection and control. So far, the pattern of excessive or inappropriate use and the development of resistance has been repeated after the introduction of each new antimicrobial.

The overuse of expensive drugs designed to cover a range of infections is a particularly serious problem in industrialized countries. In developing countries, the problem is compounded by the ready availability of over-the-counter drugs. This allows patients to treat themselves, either with the wrong medicine, or in quantities that are too small to be effective. Substandard and counterfeit drugs which lack adequate amounts of active ingredients further exacerbate the resistance problem.

Resistance has no natural barriers; its development in the most remote locations can lead rapidly to a worldwide impact, aided by international air travel.

Furthermore, enormous amounts of medical antimicrobials are used for the production of animal food around the world. Some 170 billion tons of animal meat are produced worldwide every year. More than half the total production of all antimicrobials is used in farm animals, either for disease prevention or for growth promotion. Drug-resistant bacteria are passed through the food chain to the consumer, where they may cause disease or transfer the resistance to human pathogens.

**Examples of bacterial resistance**

Enterococci contribute to some of the most common infections acquired in hospitals, causing intra-abdominal abscesses, endocarditis, and infections of the urinary tract and soft tissues. In some countries, infections resulting from strains resistant to the main groups of antibiotics, such as the beta-lactams and the aminoglycosides, can only be treated with vancomycin, an expensive intravenous drug. Even resistance to vancomycin has developed in the last 10 years or so. In the United States in 1994, 14% of enterococci isolated from patients in intensive care units were resistant to vancomycin.

Staphylococci, which can contribute to skin infections, endocarditis, osteomyelitis, food poisoning and other serious disorders, have developed resistance to all antibiotics except vancomycin. If vancomycin-resistant strains were to emerge, some of the most prevalent hospital-acquired infections would become virtually untreatable (see also the section on hospital infections, below).

Streptococci have become increasingly resistant to some antibiotics in the last 25 years. They are among the most common disease-causing bacteria, responsible for infections of the throat, middle ear, skin and wounds, and also necrotizing fascitis and gangrene.

Pneumococci and *Haemophilus influenzae* are the most common bacteria causing acute respiratory infections in children, particularly pneumonia. Both of these organisms are becoming more and more resistant to drugs. Strains of pneumococci, once uniformly susceptible to penicillin, are currently resistant to it in up to 18% of cases in the United States and 43% in South Africa. In addition, they are becoming resistant to many other commonly used antibiotics, including cotrimoxazole, the drug recommended by WHO for treatment of pneumonia. The most virulent type of *Haemophilus influenzae* is today frequently resistant to ampicillin, and
strains have been identified that are resistant to other drugs, including cotrimoxazole. In brief, doctors worldwide are losing some of the most useful and affordable antibiotics against the two bacteria which are the major cause of death in children.

*Neisseria gonorrhoeae*, cause of one of the most common sexually transmitted diseases, has acquired such resistance to penicillin and tetracyclines in many countries that the use of these antibiotics to treat it has become unacceptable and this infection now requires the use of much more expensive drugs which are often unavailable.

*Shigella dysenteriae* has been causing outbreaks of severe diarrhoeal disease in central and southern Africa in recent years, including those in refugee camps, with the epidemic strain acquiring increasing resistance to standard antibiotics. Epidemic dysentery caused by this strain results in the death of up to 15% of those infected.

*Salmoneella typhi*, the bacterium responsible for typhoid fever, has developed resistance to antibiotics commonly used in the past for treatment. Resistant strains have caused outbreaks of the disease in India and Pakistan in recent years. Without effective antibiotic treatment, typhoid fever kills almost 10% of those infected. In South-East Asia, 50% or more of the strains of the bacteria may already be resistant to several antibiotics.

More than half of the antibiotics produced worldwide are used in animals, largely at subtherapeutic concentrations which favour the onset of drug resistance. As a result, two important human pathogens of animal origin, *E. coli* and *salmonella*, are today highly resistant to antibiotics in both industrialized and developing countries. For instance, in the United Kingdom, the increase of multidrug-resistant strains of *Salmonella typhimurium* isolated from cattle is paralleled by increasing resistance among strains of human origin. In Thailand, *salmonella* isolated from food animals are also highly resistant to the common antibiotics. These bacteria cause diarrhoeal disease and can lead to life-threatening complications. Due to the globalization of food supply and international travel, antimicrobial resistance among animal bacteria can affect consumers anywhere in the world.

Strains of *M. tuberculosis* resistant to antituberculosis drugs are widespread, although attention has recently focused on the alarming outbreaks of tuberculosis caused by multidrug-resistant strains in the United States. Drug resistance is the result of poor prescribing practices, or poor patient compliance with treatment. It is low in the few countries with effective tuberculosis programmes. The most dangerous form of the multidrug-resistant disease occurs when cases become virtually incurable and doctors face situations similar to those of the pre-antibiotic era.

Malaria presents a double resistance problem: resistance of the *Plasmodium* parasites, which cause the disease, to antimalarial drugs and resistance of the *Anopheles* mosquitoes, the vectors of the disease, to insecticides. The arsenal of antimalarial drugs is limited. Most of them act by killing parasites when they are multiplying in the blood stream of the human host. Unfortunately, due to inadequate regimens, poor drug supply, and poor quality and misuse of drugs, rapid development of drug resistance has occurred in most areas of the world. Drug resistance is particularly important in falciparum malaria, the most severe form of the disease. Resistance to chloroquine, the most commonly used drug, has been found in all endemic countries except those of central America and the Caribbean. Resistance to multiple drugs is common in South-East Asia.

This serious obstacle to malaria control efforts is further complicated by mosquito resistance to insecticides. Many mosquitoes are reported to be resistant to the three classes of insecticides available for public health use, and some are becoming resistant to pyrethroids, widely promoted for bednet and curtain impregnation.

**Outlook**

The next few years are certain to be critical for the future of antimicrobial
drugs. Antimicrobial resistance will increase if present trends continue. Doctors in many parts of the world could find themselves resorting to methods that date back to before the antibiotic era. For instance, in New York City patients with multidrug-resistant tuberculosis who will not voluntarily comply with recommended treatment are sometimes isolated on a former prison island, used much as sanatoria were used in the past.

Disease control strategies will be seriously threatened by mounting drug resistance levels among bacteria which cause the most important and frequent diseases worldwide. Developing countries, where the burden of infectious diseases is the highest, will be facing the impossible task of controlling diseases with only scarce expensive drugs which will not be affordable for all sick persons.

Box 5 illustrates WHO's work on surveillance of bacterial resistance to antimicrobial agents.

Rationale of use of drugs

Controlling resistance poses a substantial challenge. The use of an increasing array of vaccines to prevent infections rather than risking resistance by treating them, will be helpful for some diseases. More appropriate use of drugs by doctors and patients is essential to slow the emergence of resistance. For this reason, WHO is taking several steps to encourage more appropriate use.

In the Model List of essential drugs published by WHO in 1989, a separate section on so-called "reserve antimicrobials" and monitoring resistance was introduced. However, this concept is of practical relevance only if certain conditions are met: all prescribers should have access to guidelines on the rational use of drugs and to information on drug susceptibility patterns of common microorganisms; antimicrobials should be of proven quality; and appropriate regulations should be in place concerning drug promotion and accessibility.

If the availability of innovative products to populations in need is to be ensured, there must be a reassessment of the role and relevance of the pharmaceutical industry and the need for a closer monitoring of market forces.
of how the future development of antimicrobials in particular can be geared to public health requirements. Infected diseases remain the foremost cause of death worldwide; yet the acknowledged priorities of the developing world remain largely unsatisfied.

WHO has been collaborating for some 20 years with governments, research institutions, other agencies and the pharmaceutical industry to ensure that treatments are made available for diseases which are prevalent in developing countries.

**Hospital infections**

Hospitals are intended to heal the sick, but they are also sources of infection. Ironically, advances in medicine are partly responsible for the fact that today, hospital infections are a leading cause of death in some parts of the world.

At any one time, many millions of people in the world suffer from infectious complications acquired in hospitals. About 2 million such cases occur every year in the United States alone, including about 70,000 related deaths. The spread of these infections is a growing threat to both patients and health care workers. It also imposes huge economic costs—up to $10 billion a year in the United States, $450 million in Mexico, and ¥40 million in Thailand.

WHO studies have shown the highest frequencies of hospital infections in the Eastern Mediterranean and South-East Asia regions, followed by the Western Pacific and Europe. In Mexico, hospital infections (also known as nosocomial infections) take third place in the list of major causes of death, after intestinal infections and pneumonia, but before ischemic heart disease and diabetes.

Infections are most common in intensive care units and acute surgical and orthopaedic wards. The most frequent are surgical wound infections, which represent 25% of all hospital infections. Urinary tract and lower respiratory tract infections each account for more than 20% of the total. The infections range from trivial to life-threatening conditions such as septicemia (blood poisoning).

The problem is getting even more serious, largely because of increasing microbial resistance to drugs used to treat even the most common infections (see also the section on antimicrobial resistance, above). Antibiotic-resistant bacteria are responsible for up to 60% of hospital-acquired infections in the United States.

Some organisms are resistant to at least one drug and often as many as 10. This is leading to the use of much more expensive drugs, more prolonged hospitalizations, higher death rates and higher health costs.

Antibiotic resistance in hospitals dates back to at least 1950, when penicillin-resistant staphylococci became common. By the early 1980s, many hospitals had also begun to detect methicillin-resistant *Staphylococcus aureus* infections, which cause wound infections and pneumonia, and which remain a problem. In many cases they are treatable only with vancomycin, an antibiotic that is increasingly regarded as the last defence. But if methicillin-resistant bacteria also became resistant to this drug, many life-threatening infections would be untreatable, and hospital outbreaks involving these strains would be very difficult to contain. More recently, multidrug-resistant strains of the tuberculosis organism have appeared in hospitals, especially among patients with HIV infection. Some of these strains are resistant to as many as seven of the standard tuberculosis drugs.

Patients receiving treatment in hospitals are likely to have lowered natural resistance to infection. In industrialized countries with modern, well-equipped hospitals, other reasons for the rise of infections include the growing number of surgical and medical procedures and invasive techniques which create many routes of infection. In poorer countries, hospitals may lack the equipment or the trained staff to reduce infections.

All hospitals should introduce infection control policies. Their success depends on such aspects as careful training in good hygienic practice; the provision
of isolation facilities; high standards in sterilization, disinfection, cleaning and waste disposal; and the provision of guidelines for doctors and other health staff on the use of drugs to reduce or prevent antibiotic resistance.

**Infectious diseases according to mode of transmission**

New approaches to disease prevention and control are needed which focus on breaking transmission chains and on ecological approaches that facilitate the participation of local and global communities and non-health agencies. This section examines infectious diseases grouped according to their mode of transmission (Table 4, Fig. 5). Although each disease can have more than one mode of spread, only the main mode of transmission is considered here. Even the relative importance of the various modes of transmission of the agent may vary from one environment to another. The polioviruses, for example, are transmitted by the fecal-oral route in communities with poor sanitation, while in communities with good sanitation, their transmission by droplet becomes more important. The same is true for hepatitis B, which can be transmitted through exposure to infectious body fluids such as may occur during sexual intercourse; through the use of needles and other intravenous or surgical instruments contaminated with blood; or from mother to child during birth.

Infectious diseases spread from the reservoir to the susceptible host in a chain sometimes called a cycle of infection, which involves three main links: the agent, the environment and the susceptible host. The following sections illustrate ways of breaking this chain, using as examples a number of diseases considered to be of global or, in some instances, of significant regional concern (shown in Table 1).

**Person-to-person transmission**

In today's overcrowded world, the risks of diseases spreading from person to person are increasing rapidly. The main danger zones are the densely-populated slums of the largest cities where infections flourish. But today all cities are interconnected. Every day, scores of thousands of people cross the globe from one city to another in less time than it takes many diseases to incubate. Many of these travellers get infected in one country and fall ill—and infect others—in a different country.

The combination of population growth (especially in cities), international air travel, incessant migration and the ebb and flow of refugees, means that the peoples of the world are more intermingled now than at any time in history. Thus, human transmission could become the predominant way in which diseases are spread quickly, not just from person to person but from continent to continent.

Ominous trends confront us. The global spread of HIV, hepatitis B and other sexually transmitted diseases, the international resurgence of tuberculosis, and outbreaks of diphtheria—all transmitted from person to person—illustrate the growing threats from infectious disease.

Many millions of people die every year and hundreds of millions fall ill as a result of human transmission of disease. Many diseases can be spread in more than one way, but usually one mode predominates. The modes include airborne and droplet spread; sexual transmission; bloodborne transmission and direct contact.

**Airborne and droplet transmission**

All the diseases that are spread primarily through this route exploit enclosed spaces, crowding and poor hygienic conditions. These are precisely the living conditions of about half the inhabitants of cities in the developing world. They exist also in the poorest inner-city areas of many industrialized countries.

Children are predominantly affected by most of the major diseases in question—measles, pertussis (whooping cough) and other acute respiratory infections, meningococcal meningitis and diphtheria. These diseases claim the
Table 4. Global health situation: mortality, morbidity and disability, selected infectious diseases of global and regional concern, all ages, 1995 estimates

<table>
<thead>
<tr>
<th>Selected infectious diseases by mode of transmission</th>
<th>Deaths</th>
<th>New (incidence)</th>
<th>All (prevalence)</th>
<th>Disabled persons (permanent and long-term)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Person to person</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acute lower respiratory infection (ALRI)(^b)</td>
<td>4 416</td>
<td>394 750</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>3 672</td>
<td>8 888</td>
<td>22 000</td>
<td></td>
</tr>
<tr>
<td>Hepatitis B, viral</td>
<td>1 156</td>
<td>4 149</td>
<td>350 000(^d)</td>
<td></td>
</tr>
<tr>
<td>Measles</td>
<td>1 068</td>
<td></td>
<td>42 000</td>
<td>5 590</td>
</tr>
<tr>
<td>AIDS</td>
<td>1 663</td>
<td>1 125</td>
<td>1 538</td>
<td></td>
</tr>
<tr>
<td>Whooping cough (pertussis)</td>
<td></td>
<td></td>
<td>10 000</td>
<td></td>
</tr>
<tr>
<td>Meningococcal meningitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poliomyelitis, acute</td>
<td>35</td>
<td>350</td>
<td></td>
<td>45</td>
</tr>
<tr>
<td>Leprosy</td>
<td>9</td>
<td></td>
<td>82</td>
<td>85</td>
</tr>
<tr>
<td>Sexually transmitted diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gonorrhoea</td>
<td></td>
<td>62 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syphilis, venereal</td>
<td></td>
<td>12 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chancroid</td>
<td></td>
<td>7 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trachoma</td>
<td></td>
<td>20 040</td>
<td>153 832</td>
<td>5 553</td>
</tr>
<tr>
<td>Diphtheria(^c)</td>
<td></td>
<td></td>
<td>35</td>
<td></td>
</tr>
<tr>
<td><strong>Food-, water- and soilborne</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diarrhoea(^e)</td>
<td>3 115</td>
<td>4 002 000(^b)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neonatal tetanus</td>
<td>459</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hookworm diseases</td>
<td>65</td>
<td></td>
<td>151 000</td>
<td></td>
</tr>
<tr>
<td>Aseania</td>
<td>60</td>
<td></td>
<td>250 000</td>
<td></td>
</tr>
<tr>
<td>Scolosomiasis</td>
<td>20</td>
<td></td>
<td>200 000</td>
<td></td>
</tr>
<tr>
<td>Cholera(^d)</td>
<td>11</td>
<td>364</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trichinosis</td>
<td>10</td>
<td></td>
<td>45 530</td>
<td></td>
</tr>
<tr>
<td>Trichuriasis (foodborne only)</td>
<td>10</td>
<td></td>
<td>40 000</td>
<td></td>
</tr>
<tr>
<td>Dracunculiasis (guinea-worm infection)</td>
<td></td>
<td>122</td>
<td>122</td>
<td></td>
</tr>
<tr>
<td><strong>Insect-borne</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>2 100</td>
<td>300 000–500 000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leish manialis</td>
<td>80</td>
<td>1 750</td>
<td>12 000</td>
<td></td>
</tr>
<tr>
<td>Onchocerciasis (river blindness)</td>
<td>47</td>
<td></td>
<td>10 000</td>
<td>360</td>
</tr>
<tr>
<td>Chagas disease (American trypanosomiasis)</td>
<td>45</td>
<td>800</td>
<td>18 000</td>
<td></td>
</tr>
<tr>
<td>Dengue/Dengue haemorrhagic fever</td>
<td>24</td>
<td>592</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleeping sickness (African trypanosomiasis)</td>
<td>20</td>
<td></td>
<td>300</td>
<td></td>
</tr>
<tr>
<td>Japanese encephalitis</td>
<td>11</td>
<td>43</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Plague(^d)</td>
<td>0.2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow fever(^d)</td>
<td>0.2</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filariasis (lymphatic)</td>
<td></td>
<td></td>
<td>120 000</td>
<td>43 000</td>
</tr>
<tr>
<td><strong>Selected infectious diseases (total)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rabies (dog-mediated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALL CAUSES</strong></td>
<td>17 312</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ALL CAUSES</strong></td>
<td>51 882</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\(^a\)\) Figures do not include lower respiratory infections related to measles, pertussis and HIV infections.
\(\(^b\)\) Incidence figure refers to epidemics.
\(\(^c\)\) Chronic HBV carriers.
\(\(^d\)\) Officially reported figures only.
\(\(^e\)\) Figures relate to acute watery diarrhoea, persistent diarrhoea and dysentery, but do not include measles- and HIV-associated diarrhoea.

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lives of more than 4 million children a year. Adults are also affected by acute respiratory infections, the best example being influenza, which is estimated to kill 1 million adults a year.

Acute lower respiratory infections, of which pneumonia is the most deadly, kill more than 4 million people a year, most of them the under-5s. They are the leading cause of death in that age group, and 99% of deaths occur in developing countries.

Pneumonia, especially pneumococcal pneumonia, is the chief culprit. The causative agent, Streptococcus pneumoniae, is carried in the noses and throats of healthy people worldwide, but infants and young children have little resistance to it, or to Haemophilus influenzae, the second most frequent bacterial cause of childhood pneumonia in developing countries. Young children whose health is already weakened by low birth weight, malnutrition or other infections, are more vulnerable to infection and have high case-fatality rates. Spread by droplets in the air, these acute bacterial infections of the lungs typically begin with the sudden onset of shaking chills and fever. In infants, vomiting and convulsions may be the first symptoms. The incubation period is only a few days at most.

Millions of these children are dying — at the rate of one every few seconds — when theoretically the lives of most of them could be saved for a few cents each. The bacterial infections can be treated by antibiotics given orally for five days, at an average cost of only $0.20 per child. However, with several hundred million such cases occurring every year, the aggregate cost of treating all of them would be substantial.

But providing antibiotics is not a simple matter in communities with little access to health care or health education. Families may delay seeking treatment for their child, or not receive that treatment, until it is too late. Shortages of doctors and health workers trained in the management of such cases compound the tragedy. National strategies to reduce the toll have been introduced in many countries. But they are absent or lagging behind in many others that have inadequate health infrastructures, particularly the poorer nations of Africa.

The burden of acute lower respiratory infections is not only in loss of lives. They are an expensive drain on meagre health resources, accounting for 30-50% of visits by children to health facilities everywhere. They are the condition for which antibiotics are most often prescribed — and misused — worldwide.

In contrast, while the majority of acute upper respiratory infections that affect the ear, nose and throat are also very common worldwide, particularly among children under age 5, they are seldom life-threatening. The most important exception is rheumatic fever, a complication that develops from certain bacterial throat infections, and which can lead to rheumatic heart disease. An estimated 12 million people are affected by these related conditions, with almost 500,000 deaths a year. Rheumatic fever can be cured by prompt, appropriate and adequate treatment with antibiotics.

Despite the availability of vaccines against them, four airborne infections continue to kill some 1.4 million children a year. The diseases are measles, pertussis (whooping cough), meningo-coccal meningitis and diphtheria.

Before a vaccine became available in the 1960s, measles killed between 7 and 8 million children a year and caused an estimated 135 million cases a year worldwide. Today, it still kills about 1 million children of the estimated 42 million who are sick, the great majority in developing countries. Thus measles is still the leading killer among vaccine-preventable diseases of childhood, taking its toll mainly among malnourished children whose natural defences have been weakened by other infections, and who live in crowded urban conditions.

Measles is one of the most readily transmitted infectious diseases, caused by a virus spread by droplets or direct contact with nose or throat secretions of infected persons. It produces fever and a characteristic red rash, and can lead to serious and fatal complications in-
Diphtheria can make a deadly comeback if immunization is not maintained.

including pneumonia, diarrhoea and encephalitis (inflammation of the brain). Many children subsequently suffer deafness, impaired vision or blindness.

Pertussis (whooping cough) was a major killer of babies and children under the age of 1, until it became vaccine-preventable around 1960. Since then, the worldwide number of cases and deaths has dropped dramatically. But it is estimated that 40 million are currently sick, and that 355,000 die each year.

Whooping cough occurs worldwide but most deaths are in countries of Africa, Asia, and Central and Latin America. Cases are on the increase in some eastern European countries. It is one of the most lethal diseases of infants and young children who have not been immunized, particularly those with underlying malnutrition and other respiratory infections such as pneumonia.

The disease is caused by bacteria spread by droplets discharged from the nose or throat of an infected person, often an older child in the same family. It causes an increasingly violent cough, forcing the victim to expel air in the lungs and then gasp desperately for breath. The rapid intake of air produces the high-pitched whoop which gives the condition its name. Complications include brain damage, convulsions, blindness and deafness.

Meningococcal meningitis is a serious illness which ends fatally in as many as 80% of untreated cases, and in up to 10% of those treated. Young children are most at risk. WHO’s conservative estimate is of some 350,000 cases and 35,000 deaths a year, but the figures are higher during epidemic waves, which occur at unpredictable and irregular intervals in many countries. The occurrence of the disease among schoolchildren and groups of young adults such as army recruits is a cause of concern.

Epidemics have been occurring worldwide in recent years, from the “meningitis belt” of Africa, spanning a dozen countries from Ethiopia in the east to Senegal in the west, to the Americas, Asia and Europe. The reasons are unclear, but may include large population movements, overcrowded households and poor living conditions. Acute respiratory infections may also contribute to the development of the disease. Certain climatic conditions, such as dry seasons and dust storms, also increase the risk of infection.

The disease is caused by a bacterium discharged in droplets from the nose and throat of infected persons. It strikes suddenly with fever, intense headache, nausea, vomiting and a stiff neck, and can progress to coma and death. The disease takes its name from inflammation of the meninges, the membranes that cover the brain and spinal cord.

Although vaccines against meningococcal meningitis exist and are used in some military recruit populations and for epidemic control, the existing vaccines are not very effective in the first two years of life and are not a routine component of infant immunization programmes.

Diphtheria was also a leading cause of death in childhood until the introduction of a vaccine 50 years ago. Mass immunization campaigns since then have made it extremely rare in industrialized countries. The true numbers of diphtheria cases and deaths are unknown because of incomplete reporting from most countries where the disease occurs. WHO estimates that there are about 100,000 cases a year and up to 8,000 deaths.

The recent epidemics of diphtheria in the Russian Federation, Ukraine and other countries of the former USSR are a warning that this disease can make a deadly comeback if immunization is not maintained. Up to 25% of those affected in the current outbreaks have died as a result.

The epidemics in eastern Europe began in the Russian Federation in 1990 and have since involved 15 countries. From January to June 1995, a total of about 25,000 cases was reported, and there are signs that the epidemic is beginning to stabilize. A death rate as high as 50% has been reported among children under the age of 2 in Turkmenistan.

These epidemics are largely due to decreasing immunization coverage among infants and children, waning
immunity to diphtheria in adults, movements of large groups of population in the last few years, and an irregular supply of vaccines. Diphtheria is caused by a toxin produced by a bacterium that infects the nose and throat and is spread by airborne droplets or by touch. A sore throat and mild fever are the main symptoms; serious complications occur when the toxin enters the bloodstream. It can then cause heart failure or damage to the nervous system, including paralysis of the throat or limbs.

The diphtheria vaccine is usually administered as part of the combined diphtheria-pertussis-tetanus vaccines (DPT). Approximately 80% of the world’s children receive three doses of the combined vaccine in the first year of life. There are other diphtheria vaccines for older children and adults.

An estimated 8.9 million people developed tuberculosis in 1995, bringing the global total of sufferers to about 22 million, of whom about 3 million will have died in the same space of time. This huge toll is the price the world is paying for complacency. It is the cost of learning that tuberculosis is not, after all, a disease of the past.

The magnitude of the problem is such that WHO declared it a global emergency in 1993. If the effectiveness and availability of tuberculosis control measures do not improve substantially, more than 30 million tuberculosis deaths and nearly 90 million new cases are expected to occur in the last decade of this century. Without prompt and effective action, the epidemic can be expected to worsen.

Eight out of ten of all those struck by tuberculosis are in the economically productive age group of 15-59 years. About 95% of sufferers are in the developing world, with South-East Asia, the Western Pacific and Africa the worst-affected regions.

To make the global situation worse, tuberculosis has formed a lethal partnership with HIV. The AIDS virus dan-
Tuberculosis is not limited to poor countries or poor populations.
placental neglect of the disease by health authorities and the breakdown of tuberculosis control programmes.

The world is only a few years away from witnessing the elimination of leprosy as a public health problem. This means that the prevalence in any community will not exceed one case in 10,000 people. The elimination of a disease that has always haunted mankind should rank as one of the great achievements of the 20th century.

There is still some way to go and much work to be done before the target is reached. Today there are an estimated 1.8 million people with leprosy in 70 countries. Over half a million new cases are detected every year. But the total number of cases has dropped by a remarkable 67% from the estimate of 5.5 million in 1991, and by 85% since 1985, when there were about 12 million cases.

Today most persons with leprosy – 1.26 million – are in South-East Asia. There are 220,000 people with leprosy in both Africa and the Americas, 70,000 in the Western Pacific, 60,000 in the Eastern Mediterranean and 6,000 in Europe.

Numbers alone cannot express the dreadful physical and social burden caused by leprosy. The disease does not kill but can cause permanent and progressive physical disability including severe mutilation of the face and extremities and widespread damage to nerves, bones, eyes and vital organs.

The psychological trauma is as important as the physical effects: until 50 years ago there was no effective cure and countless sufferers were isolated for life in institutions. Those that were not isolated invariably became the victims of extreme social stigmatization. That continues to be true today, and the same applies to their families, and often even to the communities where they live. But contrary to popular belief, leprosy is not highly contagious, and only people living in prolonged close contact with an infected person are at risk.

Leprosy is caused by a bacterium which affects mainly nerves and skin and is spread from person to person by droplets from the nose of an infected individual. It is the response of the body's immune system to the bacteria, rather than the infection itself, which causes the physical symptoms. Damage to nerves produces numbness and severe scarring in the hands and feet, sometimes with the loss of fingers or toes. Muscles become paralysed and bones gradually destroyed. Blindness and deformity are among the consequences.

The first antileprosy drug was introduced in the 1950s but within 20 years had become largely ineffective because of bacterial resistance. Newer and better drugs were developed and the real breakthrough came in 1981 with the adoption of the WHO-recommended multidrug therapy as the standard for leprosy control programmes. This treatment, consisting of a combination of drugs given over a period of 6-24 months depending on the form of the disease, is highly effective in achieving a cure.

The phenomenal results and the prospects of further gains led in 1991 to leprosy being targeted for elimination as a public health problem by the year 2000.

The greatest natural catastrophe to assault mankind was almost certainly the influenza pandemic in 1918-1919. Sweeping across the world, it killed 20-40 million people in the space of a few months. Many of these deaths came after a very brief illness in otherwise healthy adults. Such is the power of a virus.

Yet today, most people don’t take “flu” very seriously, regarding it as little more trouble than the common cold. Such general complacency to this and many other infectious diseases is extremely dangerous. In the United States alone, 10,000-40,000 people, mostly elderly, die in an average influenza season.

The disease, a respiratory infection, is spread easily among people by airborne droplets and possibly also by direct contact. It strikes in temperate climates such as those of North America and Europe during winter, and during the rainy season in the tropics, or sporadically throughout the year. Symptoms include fever, headache, muscle pain, sore throat and cough, and may develop into life-threatening pneumonia. Severe
symptoms and death occur mainly among the elderly or people in poor health due to other underlying diseases.

Official statistics on influenza cases worldwide scarcely exist and give only a fraction of the real total. One reason is that most people with influenza-like illness do not seek medical care unless they become seriously ill; another is that influenza-like illnesses can be induced by other viruses. Undoubtedly, many millions of cases go unreported every year, and influenza imposes a heavy socioeconomic burden. Epidemics disrupt the ability of whole communities to function. When as many as a third of the local population may be affected and unavailable for work, it is difficult to secure transport, communication, industrial output or the medical care which will be in high demand.

An effective influenza vaccine may protect up to 80% of recipients when it is closely matched to the subtypes of virus in global circulation. To get the closest match possible, the vaccine composition needs to be updated each year on the basis of scientific information supplied by WHO through a network of influenza monitoring centers around the world. The vaccine is used primarily to prevent deaths, but it can also shorten the duration of the illness. Yet the shortcomings of even a closely-matched vaccine and the need for yearly administrations mean that influenza epidemics cannot be entirely prevented.

Could the 1918 catastrophe happen again? Scientists know that another influenza pandemic will occur, but neither the timing of its arrival nor its impact can be predicted. Research may eventually result in a new influenza vaccine that gives longer-lasting immunity and protection against a wider variety of viral strains than those that now exist, which have to be updated every year. In the meantime, global vigilance against influenza is essential.

Direct contact diseases in children

Vast areas of the world are becoming completely free of poliomyelitis, and WHO's campaign for the global eradication of this crippling and sometimes fatal disease by the year 2000 looks likely to be achieved. The only disease that has already been eradicated is smallpox.

Cases of poliomyelitis have declined by about 85% since the eradication campaign was launched in 1988. Only 8,549 cases were reported worldwide in 1994, although WHO estimates that fewer than 1 case in 10 is actually reported, and the true figure may be as high as 90,000 cases. The viruses that cause polio have disappeared from the Americas - the last case was reported in Peru in 1991. The Western Pacific region is rapidly becoming polio-free. It has been more than a year since wild polioviruses have been found in China, and more than two years in the Philippines. The Indian subcontinent remains heavily affected, reporting more than two-thirds of all cases. Other areas which remain endemic are West and Central Africa and some countries in the Middle East and the Horn of Africa.

Poliomyelitis is caused by three closely-related viruses and is spread most often by direct contact through close association with infected individuals. Faecal contamination of food or water can spread the disease in situations where sanitation is poor. The disease typically strikes very young children, 80-90% of them under 3 years of age. Poliovirus infection produces only minimal symptoms for most children, but in about 1 in every 100, the virus enters the spinal cord and brain, causing paralysis of the muscles. The legs are most often affected, but in some severe cases the muscles of breathing and swallowing can be paralysed, threatening life.

The first effective, injectable vaccines against polio were introduced in 1955. Mass immunization of children in the 1960s with oral polio vaccines led to the elimination of poliomyelitis from most industrialized countries. With the assistance of WHO, UNICEF and many other donors, immunization programmes now exist in every country. Under the banner of the Expanded Programme on Immunization, 85% of infants born in 1990 received three doses of oral polio vaccine. Most unimmunized children live in developing coun-
tries which, consequently, bear the major burden of this disease.

Progress towards eradication is being made. To mark WHO's World Health Day in 1995, 18 contiguous countries in the Middle East, Caucasus and Central Asia immunized over 63 million children — the biggest multi-country effort of its kind. In a single day, China immunized more than 80 million children, and India 82 million. During 1995, more than 300 million children were immunized in 51 countries during mass campaigns aimed at eradicating polio.

Trachoma is a major preventable cause of blindness in developing countries. In addition to some 5.6 million people who are at present blind or visually disabled, there are some 154 million others with the active form of the disease, and a total of 540 million at risk of infection. Most blindness is found in African and Asian countries.

Trachoma is transmitted by close personal contact but may also be spread by means of contaminated towels or handkerchiefs. The disease causes a discharge from the eyes, in which it can be passed from person to person. Children living in crowded and unhygienic conditions are particularly affected and are likely to be constantly reinfected through contact with infected persons.

The development of severe, blinding trachoma is characterized by repeated infections during childhood and adolescence. The infection is caused by the microorganism Chlamydia trachomatis, which resembles a bacterium but, like a virus, can only reproduce itself within living animal cells. Trachoma causes inflammation in the membrane lining the inside of the eyelids. Over a period of years this leads to the formation of scars which in turn begin to damage the surface of the cornea. Visual loss and blindness follow unless the infection is treated.

**Sexually transmitted diseases**

The HIV pandemic which began in the late 1970s has now affected every continent. Largely due to direct, person-to-person transmission, around 20 million adults are currently infected, and more than 4.5 million of them have developed AIDS since the beginning of the pandemic. By the year 2000, it is estimated that there will be some 26 million adults living with HIV worldwide. Fig. 6 shows the number of adults infected with HIV, and the prevalence rate for selected countries.

HIV stands for human immunodeficiency virus, a name that indicates what the virus does: it weakens the body's natural defences, or immune system, leaving it vulnerable to all sorts of other infections. Normally, the body can

**Fig. 6. HIV infection, adults aged 15 to 49 years, selected countries, 1994 estimates**

![Diagram showing the number of HIV cases and prevalence rates in selected countries.](image)

- Zimbabwe: 31 000 cases, 1.35% prevalence
- Thailand: 2 115 cases
- United States: 1 514 cases
- Brazil: 652 cases
- Yemen: 541 cases
- Botswana: 1 092 cases
- Sudan: 1 692 cases
- Spain: 1 057 cases
- France: 297 cases
- Pakistan: 1 079 cases
- Malaysia: 365 cases
- Australia: 115 cases

As a cause of death, AIDS ranks lower than tuberculosis, acute respiratory infections and malaria, each of which kills millions of people a year. But AIDS is unlike most other infectious diseases. It incapacitates and kills young and middle-aged adults who are at their most productive, and so far it has mainly affected skilled and managerial workers of the kind that developing countries in
Box 6. Preventing HIV and AIDS: lessons from Thailand

In the last ten years, Thailand has achieved dramatic economic growth, averaging 8-10% annually, and now has one of the strongest economies in the developing world. But the future prosperity of this country of some 56 million people is threatened by the spread of HIV/AIDS.

The HIV epidemic hit Thailand in the late 1980s. The first wave was among injecting drug users. The prevalence of HIV infection in this group peaked from zero to 35% between 1987 and 1993. The second wave was among sex workers, reaching 33% by December 1994. The third wave was among their clients — over 8% of men attending clinics for sexually transmitted diseases (STDs) in 1994 were HIV-positive. Infection among women attending antenatal clinics increased to about 1.7% in 1994, and a growing number of HIV-positive children are being cared for in Thai hospitals — evidence of the fourth and fifth waves of the epidemic.

Fortunately, Thailand is a good example of how a country can move quickly from complacency to action against HIV/AIDS. The Thai response has been rapid and comprehensive, with the government launching one of the biggest prevention efforts seen anywhere. Television has played a key role in national education campaigns. Use of condoms has been promoted first in the commercial sex industry and then among the broader public, with up to 70 million condoms distributed free each year and about the same number again sold over the counter each year. To support government efforts, NGOs have developed a wide range of AIDS prevention programmes and activities, together with support projects for people affected by HIV and AIDS.

The condom use campaign and other educational schemes appear to have achieved considerable success. The incidence rates of gonorrhea and syphilis have dropped from respectively 2.4 and 1.1 per 1,000 persons in the age group 15-49 in 1990 to 0.3 and 0.2 per 1,000 in 1993. The overall incidence of all STDs among men fell by over 80% between 1987 and 1993. The prevalence of HIV among young military recruits fell from 7.5% in 1992 to 3.4% in 1994.

But the death of people with AIDS also represents a loss of income, and affects the welfare of other family members, including extended family and the community in general. The indirect costs of AIDS care, and also those of discrimination and stigmatization, mean that in rural areas family income is drastically reduced, borrowing is increased and up to 15% of children may be removed from school and put to work in order to supplement family income.

The economic implications of the epidemic are enormous. Direct consequences include the medical costs of treating a growing number of people with HIV-related diseases, which is expected to reach 10 times the current number of hospital beds in Thailand within a few years. Indirect costs will stem from AIDS-related deaths and illness among adults in their prime productive years, whose contribution to the national economy will be lost. Economic experts predict that as a result of HIV and AIDS, Thailand's GDP may be reduced by up to 25%. But it is also estimated that if the current AIDS control campaign is sustained throughout this decade, at least one-third of projected losses could be averted.
course – that is, without the use of a condom – in which one of the partners is HIV-positive. Condoms act as a barrier to prevent the virus passing from one person to another.

WHO estimates that at least 333 million new cases of sexually transmitted diseases, other than HIV infection, occurred in 1995. These diseases are chlamydial infection (89 million), gonorrhoea (62 million), syphilis (12 million) and trichomonas (170 million).

The burden of these diseases is far greater than the symptoms of discomfort, pain and discharge caused by initial infection. They may cause serious complications, especially in women, including pelvic inflammatory disease – a major cause of infertility. Chlamydial infection, gonorrhoea and syphilis can be passed on to infants during pregnancy and childbirth. Their effects range from abortion and stillbirth to severe eye infections and pneumonia in the newborn.

Furthermore, there is strong evidence that these four diseases greatly increase the risk of sexual transmission of HIV, especially when accompanied by genital ulcers, a common symptom of some sexually transmitted diseases, which may give HIV easier entry into the bloodstream. Studies suggest that the risk of HIV infection is about four times greater in the presence of a genital ulcer.

**Bloodborne infections**

Six different viruses are known to cause hepatitis, an infection of the liver. They are identified by the letters A, B, C, D, E and tentatively, G. They are not all transmitted in the same way. Of the six viruses, hepatitis B and C, which are the most serious due to their long-term effects, are transmitted by exposure to contaminated blood and blood products.

More than 2 billion people alive today have been infected with hepatitis B. Some 350 million of them are chronically infected and therefore at risk of serious illness and death from liver cirrhosis and liver cancer. Every year, more than a million hepatitis B carriers die as a consequence of these two conditions.

Hepatitis B is the most infectious of the hepatitis viruses, and is one of the most tragic examples of person-to-person transmission of a disease. The infection can be passed from a mother to her newborn child, from one child to another, from children to adults, and from adult to adult. It is tragic because children who get infected early in life, especially those infected at birth, become the chronic carriers who are the main spreaders of the disease. And it is more tragic still because there is a vaccine that protects against it – one of the safest and most effective vaccines yet developed against any disease.

Hepatitis B leads to one of three outcomes. An infected person may die within days or weeks of the onset of the disease (a rare event); may recover and develop lifelong immunity; or may develop the “chronic carrier” state, a persistent infection which usually lasts for life. The age at which a person becomes infected is the major factor in determining the outcome, the newborn and the young child having a higher propensity to develop the chronic carrier state.

Acute hepatitis B may first strike following an incubation period of 45 to 180 days after infection. Extreme fatigue, jaundice, dark urine and abdominal pain are the main symptoms. The infection itself is rarely fatal, but sufferers may lose several weeks or months of work because of their illness. There is no specific treatment for acute hepatitis B.

The hepatitis B virus (HBV) can be transmitted through blood, blood products, semen and vaginal fluids. Sexual transmission, both heterosexual and homosexual, accounts for most cases of adult transmission.

Contaminated needles and syringes used by drug addicts are another important means of spread. The infection may also be transmitted through contamination of cuts, wounds or other skin injuries. Accidental transmission by sharing toothbrushes or razors can also happen. The disease is the major infectious occupational hazard to health care workers who have not been immunized.

More than 2 billion people alive today have been infected with hepatitis B.
Box 7. Hepatitis C infection: an emerging global issue

Infection with the hepatitis C virus (HCV) has become an issue of global significance. Since the virus was first identified in 1989, it has been recognized worldwide as a major cause of chronic hepatitis, cirrhosis and liver cancer. Up to 100 million people are chronically infected with it, including 3.5 million in the United States and over 10 million in Europe. There is no vaccine, no successful treatment and prevention is difficult, particularly in developing countries where it is most common.

The virus is transmitted mainly through transfusions of contaminated blood or blood products. Risks of this type of transmission have been largely eliminated in industrialized countries through anti-HCV screening techniques. However, for health care workers it is an occupational hazard requiring adherence to universal precautions — cleaning and disinfection of instruments, machines and surfaces that are routinely touched, avoidance of sharing articles between individuals, frequent hand-washing and the systematic use of gloves. Intravenous drug users who share needles are at high risk of infection.

Major prevention problems persist in developing countries. Many of them cannot afford the anti-HCV blood test kits, which cost $5 per test. The use of contaminated equipment for injections and other medical and dental procedures is widespread.

Traditional practices such as circumcision, tattooing and scarification with contaminated instruments can spread HCV infection.

Efforts are therefore necessary to persuade the manufacturers of tests to lower the costs for developing countries. Health education programmes are also needed to inform the general public and health care workers about the risk of transmitting infection with the use of unsterile equipment.

Surveillance on a global scale needs to be strengthened in order to improve medical knowledge of transmission of the virus.

Interferon is the only drug that has been found effective in the treatment of HCV infection. However, treatment is very expensive — thousands of dollars for the drug alone — and must be administered by injection several times a week for several months. Moreover, some patients experience serious side-effects. Also, about half of the patients go into remission, but 50% relapse when treatment is stopped: only 25% have long-term remission. Such rates pose ethical questions on such matters as the need to obtain the informed consent of patients who are offered the treatment, and the responsibilities of governments in subsidizing the cost of the treatment. Given its cost, only a minority of patients can afford it or are likely to be offered it.

Studies involving less costly, orally administered drugs are continuing, but results so far have been disappointing.

For a number of technical reasons, the development of a vaccine to prevent HCV infection is unlikely for many years.

Women with HBV infection can pass it to their baby around the time of childbirth (perinatal transmission), one of the most efficient and serious ways in which HBV is spread, at least in Asia. Infected women have a high risk of infecting their newborns, and almost all of these babies will become HBV carriers themselves. They will grow up to infect other children in the community, and eventually when they are adults, they will infect their own offspring.

Transmission from child to child, often called horizontal transmission, is responsible for the majority of HBV infections and carriers in parts of the world other than Asia. The spread occurs, researchers believe, through physical contact between children with skin conditions such as impetigo and scabies, or with cuts or grazes. Horizontal transmission occurs when children play together or share the same bed.

Researchers have divided the world into areas where the presence of the infection is "high", "intermediate" or "low", with carrier rates of more than 5%, respectively. In the first category, where most of the population becomes infected, either as newborns or in childhood, are Africa, Asia east of the Indian subcontinent, the Pacific Basin, the Amazon Basin, the Arctic Rim, the Asian republics of the former USSR, and portions of the Middle East, Asia Minor and parts of the Caribbean.

The "intermediate" areas include parts of southern and eastern Europe, the Middle East, western Asia through the Indian subcontinent, and some parts of Central and South America. In these areas, both child-to-child and adult-to-adult transmission occurs. The "low" areas include North America, western Europe, Australia and parts of South America. Here, most infections occur in adults through sexual activity, needle-sharing during drug abuse, or during occupational exposure to blood.

Until a few years ago, the only types of viral hepatitis that could be confirmed were types B (which is described above) and A, which is transmitted through contaminated water and food, and is described in the next section. All oth-
Preventing and controlling diseases transmitted from person to person

The root causes which underlie the major airborne and droplet infections are poverty, overcrowding, particularly in big city slums and shanty towns; the mass migration of people, either from rural to urban areas or as refugees; and gaps in education.

Some airborne diseases are in general well controlled, requiring little more than firm commitment to continuing action against them. Others persist in countries or areas where lack of resources is a major handicap. Yet others have made a return because of drug resistance, complacency, or deterioration of public health services. Specific actions tailored to individual diseases, such as immunization, treatment, surveillance and public education, need to be strengthened.

WHO has set the target of reducing deaths from acute respiratory infections in children under age 5 by one-third by the year 2000 — equal to more than 1.4 million lives saved per year. But achieving this target is threatened because, as mentioned earlier, the two cheapest and most effective antibiotics to treat pneumonia, the leading killer among acute respiratory infections, are now much less effective due to bacterial resistance. This means that either more expensive drugs must be used, or that more children will die from these infections.

Excellent progress has been made in measles control in recent years. The Region of the Americas has implemented a periodic mass immunization strategy combined with strengthening of surveillance to interrupt measles transmission and eliminate the disease by the year 2000.

This initiative helped to revive interest in improving measles control worldwide. Mass immunization in poor urban areas has been adopted as a strategy to reduce the measles disease burden in environments where case fatality is highest. Efforts to develop surveillance of measles have resulted in wider understanding of the changes brought about in measles epidemiology by measles immunization and in the more accurate prediction of measles outbreaks.

Some countries have successfully carried out mass immunization to prevent epidemics. In spite of this progress, global measles coverage has remained stagnant at around 80% for the last four years. In some countries, mostly in Africa, measles vaccine coverage is below 50%, which means that the disease will continue to be endemic there.

Effective global control of pertussis depends on countries using the vaccine in national immunization programmes in which it is combined with diphtheria and tetanus toxoids. New pertussis vaccines are being developed.

Meningococcal meningitis is potentially preventable through vaccination of both children and adults and the use of antibiotics to protect close contacts of those already infected. When used in rapid mass immunization campaigns they can bring epidemics to a halt. New vaccines are being developed which, if proven to be protective in infants and young children, could be integrated into immunization programmes in areas at high risk of the disease.

Specific actions tailored to individual diseases, such as immunization, treatment, surveillance and public education, need to be strengthened.
Better control of diphtheria worldwide depends on high immunization coverage; prompt recognition and management of diphtheria cases; and rapid identification and effective management of close contacts to prevent further spread of outbreaks. National diphtheria control plans have been elaborated for the republics of the former USSR affected by outbreaks, and mass immunization campaigns, begun in 1994, were extended in 1995.

The best prevention of tuberculosis is detection and cure of the infectious cases. WHO is urging all countries to adopt the strategy known as "directly-observed treatment, short-course" or DOTS, in which health workers or volunteers watch patients under their care swallow each dose of the medicines for at least the first two months of treatment. Each patient then completes the course of treatment. One of the reasons for past failures in tuberculosis control has been that patients do not take the full course of their medicines for the required period of time. The strategy is already showing remarkable success in some countries. Tuberculosis programmes in many countries are having to be rebuilt after being neglected for many years; in many other countries they simply do not exist.

Almost 6.7 million people with leprosy were cured by multidrug therapy between 1985 and 1994, and another million patients are currently undergoing treatment. No cases of resistance to multidrug therapy have been reported. The global average cost of implementing the leprosy elimination strategy has been $100 per patient. A cost-effectiveness analysis indicates that the cost per year of healthy life gained ranges from $10 to $38 – a public health bargain.

WHO is taking part in planning for the occurrence of influenza pandemics. The plans should provide governments with essential guidelines for the best response to a pandemic.

Although a single dose of poliomyelitis vaccine costs only $0.08, the quantities required and the logistics involved mean that immunization programmes will cost some $2.5 billion between 1996 and 2000. WHO calculates that the countries still fighting the disease meet 80% of the eradication costs. The remaining 20% – equal to $100 million a year until the year 2000 – is being sought from donor countries and agencies.

Eradication cannot be achieved without continuing donor assistance. Rotary International has been supporting polio eradication since the inception of the programme and will have provided a total of more than $300 million by the end of the initiative. Apart from the lives saved and the suffering prevented, there is another bonus. Since smallpox was eradicated in 1977, the world has saved over $20 billion in costs associated with prevention, control and treatment. The potential worldwide savings resulting from polio eradication have been calculated to exceed $1.5 billion a year.

Trachoma can be controlled in several ways, including treatment with antibiotic eye ointment, improving personal and environmental hygiene, and simple surgery. Personal hygiene, particularly keeping the face clean, is important in reducing the spread of trachoma among children. Face-washing a few times a day, even with only a little water, removes dirt from the eyes, while the discharge is the main source of infectious spread. Educational programmes for mothers on effective face-washing with very limited quantities of water have been designed. Availability of adequate water can dramatically reduce the spread of infection.

Infection with HIV and other sexually transmitted diseases is preventable. The adoption of safer sex practices and the increasing availability of condoms as a result of strategies for HIV prevention appear to have played an important role contributing to the declining rates of sexually transmitted diseases that have been reported in some countries.

WHO recommends a comprehensive approach to these diseases which includes promotion of safer sexual behaviour; widespread availability and affordability of condoms; integration of care for the diseases into all basic health care facilities; good-quality case man-
Foodborne, waterborne and soilborne diseases

Water, food and soil are essential for life, but when contaminated they also transmit bacteria, viruses and parasites that cause some of the world's most menacing diseases, such as diarrhoea, cholera, typhoid, intestinal worms, hepatitis and tetanus. The organisms that are the main causes of these diseases are ingested with water or food or conveyed to the mouth by contaminated fingers. Where there is no proper sanitation, they find their way to other water sources from which they again infect other people. Soil can also be the breeding ground for a wide range of infections to which children are particularly vulnerable, and for intestinal parasites.

Almost half the world's population suffers from diseases associated with insufficient or contaminated water, and is at risk from waterborne and foodborne diseases. Their vital importance as a public health problem is often overlooked, because their true incidence is difficult to evaluate and the severity of their health and economic consequences is often not fully understood.

Diseases are classified as waterborne or foodborne based on epidemiological evidence that implicates consumption or use of water and ingestion of a common food as the source of infection. They are perhaps the most widespread health problems in the contemporary world and an important cause of low or lack of economic productivity. They range in severity from mild indispositions to life-threatening illnesses.

Apart from their immediate effects, foodborne diseases may cause serious and chronic health problems.

Apart from their immediate effects, foodborne diseases may cause serious and chronic health problems. Some of these diseases - for instance, listeriosis - are particularly dangerous during pregnancy, as they may either be fatal to the fetus or cause severe deformities. In the latter case, the child runs a risk of severe congenital, cerebral or ocular damage.
The economic impact of cholera epidemics, in losses of trade and tourism, can be enormous.

Diseases caused by contaminated food and water

Diarrhoeal diseases caused more than 3 million deaths in 1995, of which more than 80% were among children under age 5. About 50% of diarrhoeal deaths are due to acute watery diarrhoea, 35% to persistent diarrhoea, and 15% to dysentery.

It was long thought that contaminated water supplies were the main source of pathogens causing diarrhoea but it has now been shown that food has been responsible for up to 70% of diarrhoeal episodes. Infections due to pathogenic E. coli are the most common cause of diarrhoea. Weaning food contaminated with pathogenic E. coli causes up to 25% of all diarrhoeal episodes in infants and children, while campylobacteriosis and shigellosis account for another 5-15% and 10-15% respectively.

In 1993, the United States suffered the biggest outbreak of diarrhoea in its history. More than 400,000 people in the city of Milwaukee became ill for an average of 10 days with watery diarrhoea and more than 4,000 needed hospital treatment. The source was municipal water supplies contaminated with the parasite Cryptosporidium parvum.

About 200 million people in Asia, Africa and Latin America have symptoms of the intestinal infection giardiasis; there are some 500,000 new cases a year, the vast majority of them among children. The infection causes acute and persistent diarrhoea, abdominal pain and rapid weight loss. Lack of sanitation and poor basic hygiene assist its spread. The main mode of transmission is in faecally-contaminated water, but foodborne and person-to-person spread also occur. The disease has become a serious problem in day-care centres in developed countries.

Epidemics of cholera and dysentery are frequent, striking adults as well as children. Cholera alone causes 120,000 deaths a year, and is particularly deadly in Africa, where epidemics have become more widespread and more frequent since the 1970s, and death rates among sufferers are generally the highest. Seventy-nine million people are estimated to be currently at risk of cholera infection in Africa. A substantial proportion of cases and deaths have been among the displaced and refugee population in Somalia and Zaire.

A pattern of global cholera pandemics — called pandemics — that literally circle the world is being repeated. At least seven such pandemics have been recorded in the last 150 years. The seventh pandemic of the disease caused by Vibrio cholerae O1 biotype El Tor, which started in 1961 in Indonesia, spread to Peru in 1991 and then to other countries in South and Central America. In 1993, cholera was reported as endemic in some 80 countries, affecting several hundreds of thousands of people. In an important number of cases, food has been found to be the vehicle for transmission.

A new strain of cholera, code-named 0139, emerged in India in 1992. It spread west to Pakistan and east to China, and in the early months of 1993 caused an estimated 100,000 cases and 1,000 deaths in southern Bangladesh. It has not spread rapidly since then, but remains a threat.

The economic impact of cholera epidemics, in losses of trade and tourism, can be enormous. For example, the 1991 epidemic in Peru cost the country a loss estimated at $70 million, almost a fifth of its total exports in a normal year.

Several countries, especially in Africa, have to cope with the emerging problem of recurrent epidemics of bacillary dysentery. The spread of epidemic dysentery started in 1979 in eastern Zaire and since then has invaded all African countries. For several months in 1994, dysentery was the main cause of death in refugee camps in Burundi, United Republic of Tanzania and Zaire. Epidemic dysentery also occurs in Asia and Latin America.

The control of epidemic dysentery is complex because of the limited therapeutic options available. There is increasing resistance of Shigella dysenteriae type 1 strains to the usually recommended antibiotics, including nalidixic acid. Alternative antibiotics are expensive.
Typhoid fever causes about 16 million cases and more than 500,000 deaths a year. Almost 50% of cases and deaths are in Asia, and most of the others occur in Africa and Latin America. The socioeconomic impact of the disease is huge, because typhoid survivors take several months to recover and resume work. Since 1950, the organism’s resistance to antibiotics has also been a growing problem; by 1989 resistance was reported in a number of countries, particularly in Asia and the Middle East.

Schistosomiasis, also known as bilharziasis, leads to chronic ill-health. About 200 million people in 74 tropical countries have acquired this infection from bathing or wading in infested rivers, lakes and irrigation systems, and 500–600 million are at risk. Because their daily work brings them into frequent contact with infested water, women are vulnerable to the disease.

It is caused by parasitic flatworms or blood flukes called schistosomes, which can penetrate the skin, enter the bloodstream and develop into worms that inhabit the blood vessels of the intestines or bladder. Female worms lay hundreds of eggs in the blood vessels every day for an average of five years, and it is the eggs rather than the worms that damage the intestines, bladder and other organs. The disease causes some 20,000 deaths a year and can lead to a form of bladder cancer which is the primary cause of death among men under 44 years in Egypt. It also takes a high toll in many parts of Africa.

Water development projects, especially large-scale irrigation systems that are intended to boost agricultural output, can spread the disease to previously unaffected areas. Dam construction in three African river deltas—the Nile, the Senegal and the Volta—has led in recent years to schistosomiasis infection in up to 75% of local villagers, and even among people as far as 500 kilometres upstream of the dams.

The disease is also being spread by mass migration from the countryside to urban centres, and has become a serious problem in some big cities of Africa and Brazil.

Infections due to helminths are also a worldwide public health problem, particularly affecting developing countries. Examples are Trichinella spiralis, Taenia saginata, and Taenia solium, which are acquired through consumption of undercooked or uncooked meat.

Some 40 million people, particularly in Asia, Africa and Latin America, have trematode infections. More than 10% of the world’s population is at risk of becoming infected by these parasites, which are transmitted through the consumption of raw or inadequately processed freshwater fish, shellfish or aquatic plants.

Dracunculiasis (guinea-worm disease) is the only parasitic disease that may be totally eradicated from the world in the near future. Although widely distributed at the beginning of the 20th century, the disease is now found only in sub-Saharan Africa, the Arabian peninsula and India. It is still endemic in 18 countries, of which 16 are in Africa and 10 are in the category of least developed countries. Approximately 122,000 cases were reported from fewer than 8,000 endemic villages in 1995, as compared with 3.5 million in 1986 and 1 million in 1989.

This parasitic disease is transmitted by drinking polluted water in regions where water is a rare commodity. It affects men, women and children equally and has adverse effects on health, agricultural production and school attendance. Horribly painful and incapacitating, it can affect 50% or more of the population in areas where the disease is endemic. Incapacity results from pain and secondary infections associated with the emergence of guinea worms (which are 60-100 cm long and 0.2 cm in diameter) through the skin of the hands, feet or other parts of the body. Those affected do not develop immunity, so people may suffer repeatedly from the disease.

No medicines or vaccines are available to prevent or cure this parasitic disease; however, dracunculiasis is extremely easy to combat and should no longer be prevalent. WHO, together with national programmes, is taking...
Guinea worm disease has been reduced by 97% since 1986. Only 1–4 cases remained in most endemic villages in 1995.

measures to break this transmission cycle and put an end to the scourge.

The population at risk of infection is estimated at 130 million in Africa and 10 million in Asia. So the fight must continue, and even be reinforced, because the last cases are to be found in the most inaccessible areas. The least interruption of these efforts now would imperil the successes achieved after many years of strenuous effort. The estimated cost of complete eradication ranges from $50,000 in Chad to $3 million in Sudan, with the proviso that there are parts of the country presumed endemic which remain inaccessible due to armed conflict (Map 5).

The hepatitis E virus, discovered in the United States in 1990, exists in many parts of the world, causing outbreaks of hepatitis in Asia, North Africa and Central America, particularly in countries where environmental sanitation is inadequate. The virus is probably a major cause of acute hepatitis in these countries, but does not lead to chronic disease. The infection is mainly transmitted by contaminated water, although person-to-person spread by the fecal–oral route is also likely. Preliminary evidence suggests that a hepatitis E vaccine could be developed in the not-too-distant future (Box 8).

The problem of foodborne diseases is very serious in developing countries, but is not limited to them. The estimated annual incidence of foodborne diseases in the United States ranges from 6.5 million to 80 million cases. Surveys in several other industrialized countries suggest that annually, up to 10% of the population may be suffering from a foodborne disease.

Salmonellosis especially has increased tremendously in industrialized countries on both sides of the Atlantic over the past few years. In many countries, poultry meat, eggs and foods containing eggs have been identified as the predominant sources of this pathogen. In certain countries, up to 60–100% of poultry meat is contaminated with spe-
cies of Salmonella, and beef, frog's legs, chocolate and milk have also been implicated. In 1985, some 170,000 to 200,000 persons were involved in an outbreak of salmonellosis in Chicago (United States) caused by contaminated pasteurized milk.

In addition, many industrial countries are experiencing outbreaks of diseases due to relatively newly identified types of foodborne pathogens such as Campylobacter jejuni, Listeria monocytogenes and Escherichia coli O157:H7. Campylobacteriosis has increased to such an extent that it is now the leading foodborne disease in several industrialized countries, for example the United Kingdom. As in the case of Salmonella, the main vehicles for the transmission of Campylobacter are poultry meat and unpasteurized milk. Listeria monocytogenes may cause severe foodborne infections, with a high fatality rate in susceptible individuals. The fatality rate, especially in newborns and adults with lowered immunity, is in the range of 27-32%. The microorganism has been implicated in several important outbreaks, involving different types of food such as milk, cheese, vegetables and meat products. At present there is no clear understanding of its biology, but it is known to be able to grow at refrigeration temperatures, and at a wide range of pH values; it is thus of major concern to food industries producing products that are subjected to extended cold storage, such as cheese.

Outbreaks caused by E. coli O157:H7 are giving rise to concern in many countries, as the pathogen causes severe damage to health, and may even lead to death, particularly in children. The number of known outbreaks is increasing (Map 6). In 1993, a major outbreak due to consumption of undercooked minced beef (hamburgers) affected more than 500 people in the north-west of the United States. Many children were affected, some suffered from the haemolytic uraemic syndrome and four children died as a result. In Africa, a large outbreak affecting thousands of people in 1992 was also reported to have been caused by E. coli O157:H7.

**Box B. Hepatitis E**

The infection caused by the hepatitis E virus (HEV), which was discovered in 1990, is essentially a waterborne disease. Water or food supplies contaminated by faeces in which the virus is excreted have been implicated in major outbreaks reported in all parts of the world that have a hot climate. After an incubation period of 2-9 weeks, a self-limiting acute viral hepatitis appears, lasting for a period of several weeks, which is followed by recovery. No case of chronic disease has been reported. Mainly young adults, aged 15-40, have been affected by acute hepatitis E.

In addition, HEV has a propensity to induce a fulminant form of the acute disease (the mortality ranges between 0.5% and 4%), particularly in pregnant women, up to 20% of whom develop fulminant hepatitis E, with a mortality that reaches about 80%. The importance of intrauterine infections due to hepatitis E infection during pregnancy, responsible for abortions, intrauterine death, and high perinatal morbidity and mortality, is currently under investigation.

The first major epidemic was reported in New Delhi in the winter of 1955-1956. After the flooding of the river Yamuna, 30,000 cases of jaundice were described, and retrospectively attributed to hepatitis E. China reported 100,000 cases of jaundice between 1986 and 1988. Since then, additional outbreaks have been reported from Borno, India, Indonesia, Mexico, Myanmar, Nepal, Pakistan, Somalia and southern Russian Federation.

However, hepatitis E outbreaks or even sporadic cases are rare in temperate climates. In Central Europe and in North America, hepatitis E has been diagnosed only in patients returning from countries with high endemicity for viral hepatitis. But screening of blood donors in these areas has shown a prevalence of anti-HEV antibodies of up to 2.5%. The findings were similar for blood donors from South Africa (1.4%) and Thailand (2.8%). Seroprevalence in blood donors from Saudi Arabia and Egypt were significantly higher (9.5% and 24% respectively). It remains to be determined whether these findings correspond to real post subclinical infections.

Diagnosis is made by the level of anti-HEV antibodies in the serum. No confirmatory assay is currently available. Anti-HEV IgM antibodies have been determined; however, their usefulness for the diagnosis of acute hepatitis E infection remains to be confirmed. There is no need to treat acute hepatitis E because recovery is always complete. For the fulminant form where mortality can reach up to 80%, there is no specific treatment, merely supportive measures.

For prevention, travellers to highly endemic areas are recommended to take the usual elementary food hygiene precautions. No vaccine or specific immunoglobulin prophylaxis is available. Preliminary studies in primates indicate that protection through vaccination may be achievable in the foreseeable future.

The vehicles of transmission in this outbreak were believed to be contaminated drinking-water and cooked maize.

**Hepatitis A** is common all over the world: some 10 to 50 persons per 100,000 are affected annually. Shellfish grown in contaminated water have often been recognized as a source of this disease. An epidemic of shellfish-borne
hepatitis A in China in 1988 affected some 292,000 persons (with 32 fatalities), and was related to consumption of contaminated clam. Food contaminated by food-handlers and not subsequently sufficiently heated may also transmit the disease. Many cases of hepatitis A are known to be linked to restaurants.

**Soilborne infections**

Diseases that come from the soil affect several million people annually. The most deadly of these diseases is neonatal tetanus, responsible for the deaths of at least 450,000 children every year, while intestinal worm infections are the most widespread.

**Tetanus** can affect all age groups but is a problem particularly for newborns and their mothers. It is a bacterial disease, but it does not spread from one individual to another. It occurs through the infection of a wound by the tetanus bacillus, the incubation period varying between 4 and 21 days.

Neonatal tetanus occurs as a result of contamination of the umbilical cord with tetanus spores at birth, caused by unsterile methods of handling or cutting the umbilical cord or dressing it with germ-laden substances such as ash, mud, or animal dung (common practices in many areas of developing countries).

Treatment of neonatal tetanus is difficult and generally unsuccessful, and almost all newborn babies affected die. The disease can be prevented by immunizing women of reproductive age (especially pregnant women) with tetanus toxoid and by ensuring hygienic delivery and cord care practices in institutions and at home.

In the early 1980s, between 800,000 and 1 million newborns were estimated to die of neonatal tetanus every year (up to 25% of infant deaths in many developing countries). In some countries, the
annual incidence was over 60 per 1,000 live births. By 1994 the number of
deaths had fallen to around 480,000 annually. The decline of more than
700,000 cases was mainly the result of a significant increase in immunization
coverage of pregnant women with a protective dose of tetanus toxoid between
1989 and 1994, from 27% to 48% respectively (60% excluding China). In-
tensified immunization of women of childbearing age in selected high-risk
areas also contributed to the rapid decline in reported cases observed since
1990.

Cases of neonatal tetanus do not occur evenly throughout the world.
Twenty-six countries, many of them in Africa, accounted for more than 80%
of the estimated global neonatal tetanus cases in 1994. Within countries,
cases tend to occur in clusters in areas with poor hygiene during childbirth,
harmful traditional practices and low levels of immunization coverage
of women.

In 1989, WHO’s Member countries decided to eliminate neonatal tetanus
as a public health problem by aiming to reduce its incidence to less than 1 case
per 1,000 live births for each health district. If they succeed, 1 million newborn
deaths and 50,000 maternal deaths due to tetanus will be avoided each year.

Of all soilborne diseases, intestinal parasitic infections caused by worms ac-
count for by far the greatest proportion. Those caused by hookworm, roundworm
and whipworm predominate. WHO estimates that as many as 3.5 billion
people are infected by worms, and that at any time some 450 million people, most
of them children, are ill as a result. The number of those affected is increasing,
and cases occur in all WHO regions.

While most of these conditions amount to no more than diarrhoea and
abdominal pain, they can be fatal. It is estimated that in 1995 hookworm in-
festation killed 65,000 people and roundworms killed 60,000. Chronic infections
impair the physical and mental growth, nutrition and development of children
in general and girls and young women in particular.

The infections are spreading rapidly in slums, shanty towns and squatter set-
tlements in and around many cities in developing countries. Poor sanitation,
and consequent contamination of the environment with human excreta are
among the commonest hazards contributing to transmission. Soil is the breed-
ground, when contaminated by infected individuals defecating on open spaces.

The eggs of roundworms (Ascaris lumbricoides), whipworms (Trichuris
trichiura) and hookworms, the most common soilborne parasites, need to
remain in the soil for a certain period before they become infective. The con-
taminated soil may then be carried long distances on feet or footwear into houses
and thereby into contact with people. Transmission may occur directly from
the soil through the mouth or skin, or in some cases from person to person.

Apart from the symptoms described above, iron deficiency anaemia is a fre-
quent result of hookworm infection, especially in children and pregnant
women. WHO estimates that at any time, about 44 million women are both
pregnant and infected with hookworms.

Preventing and controlling foodborne, waterborne, and soilborne diseases
So much depends on how communities deal with human faeces. At least 2.5 bil-
lion people in developing countries lack an adequate system for disposing of their
faeces. For the poor in many developing countries, faeces deposited near their
homes constantly threaten household hygiene, by direct contact with people
or by being inadvertently carried into homes and kitchens by children, domes-
tic animals or insects. Domestic, neighbourhood or district water supplies such
as wells, tanks and reservoirs may be contaminated by poorly designed or
maintained sewage disposal systems.

The cleanliness of the water is not the only issue; the importance of an ade-
quate water supply for household hygiene cannot be overemphasized. Washing
hands after defecation and before preparing food is fundamental to controlling
diseases, but even if this
principle is understood fully, hand-washing is impossible without sufficient water.

Improving the quality of drinking-water, ensuring proper sewage disposal and providing more water for both personal and domestic hygiene are the keys to the prevention or control of major scourges such as diarrhoeal diseases (including cholera), typhoid, guinea-worm disease, schistosomiasis and giardiasis. The latest estimates, relating to the developing world for 1995, indicate that about 25% of the population do not have access to safe water, and over 66% lack adequate sanitation.

Box 9. Cleaning up dirty water and keeping it clean

In many parts of the developing world, drinking-water is collected from sources outside the home and is then held in household storage vessels. It may be contaminated at the source or during storage; strategies to reduce waterborne disease transmission must safeguard against both possibilities. New disinfectant generators and better designs for storage vessels allow families to disinfect drinking-water immediately after collection (point-of-use disinfection) and to store treated water in narrow-mouthed, closed vessels designed to prevent recontamination (safe storage). This two-component prevention strategy is a practical and inexpensive way for households and communities that lack safe water to protect themselves against a variety of waterborne pathogens, and can thus greatly decrease waterborne diarrhoeal disease.

Several field tests have already been carried out in various parts of Bolivia by the Ministry of Health, CDC, PAHO and USAID. The proposed method was very well accepted, and significant improvements in the quality of the stored water were observed, as well as a decrease in diarrhoeal disease (especially among infants under 1 year old).

The evidence to date suggests that this intervention strategy is a practical means of preventing waterborne diseases such as typhoid fever and cholera. Apart from bringing a readily-available source of treated water into the home, the strategy can be successfully applied to other settings such as day-care centres and old people’s homes, and used during festivals.

Families are encouraged to use disinfected water for washing hands, foods, and kitchen utensils and for food preparation, all of which may reduce the incidence of diseases transmitted through personal contact and those transmitted by contaminated foods. Even diseases such as dengue that rely on mosquito vectors may be reduced if open water storage containers are eliminated from the household environment. The strategy lends itself well to other settings: clinics, schools, and even street vendors are attractive potential targets for this intervention. The next generation of vessels, currently being pilot-tested among Guatemalan street vendors, have a built-in soap dish, making them even more effective platforms for promoting hand-washing. With the commitment of communities and ministries of health, UN agencies, nongovernmental organizations and private industry, this low-cost, effective intervention could be implemented on a broader scale.

Source: United States Centers for Disease Control and Prevention (personal communication).

Technological advances in water supply, sanitation, drainage and solid waste management in recent years offer cost-effective solutions that can be adapted to local circumstances and can greatly improve health and environmental conditions. Personal hygiene is immensely important in the prevention of contamination of food and drinking-water. The provision of a safe and adequate water supply requires partnership between communities and the organized public and private sectors, including NGOs. Government ministries concerned with education, development and industry have a major role to play. Communities can also take local initiatives for the provision of safe water, as demonstrated in Bolivia (Box 9).

Deaths due to diarrhoeal diseases are particularly tragic because the great majority can be avoided by the prevention or treatment of dehydration, as the primary cause of death from acute diarrhoea is dehydration from the loss of fluids and electrolytes. Correct case management, both at home and in health facilities, can achieve immediate reductions in mortality from acute epidemic and non-epidemic diarrhoea in any age group. This is achieved through the prevention of dehydration in the home by providing increased amounts of fluids and continuing to provide food or breast milk. Dehydration can be treated through the use of oral rehydration salts, and the use of intravenous fluids for severe dehydration. Antibiotics should be used only for dysentery and severe cases of cholera.

Outbreaks of giardiasis can also be prevented by adequate filtration and treatment of water supplies. The illness itself can be treated with drugs, but control measures have been hampered by lack of knowledge about the biology and natural history of the giardia organism. There is increasing evidence that its natural host is to be found among animals.

Cholera, which is definitively linked to poverty, is likely to occur when there is overcrowding coupled with lack of adequate sanitation and safe drinking-water. Therefore the best long-term
strategy to prevent cholera is elimination of the factors that favour its transmission, especially by improving water supplies and sanitation.

The treatment of patients with rehydration therapy is the cornerstone of public health efforts to reduce cholera deaths. During acute emergencies, providing clean drinking-water, basic sanitation and safe disposal of human waste are high-priority preventive interventions. Immunization is unlikely to be useful in epidemics.

Safe drinking-water systems and adequate sewage disposal facilities are essential for the prevention of typhoid. Scrupulous cleanliness is necessary in food preparation and handling, as is proper storage of salads and other food served cold.

A vaccine exists, but it does not give complete protection. Because of the increasing emergence of multiresistant bacterial strains, there is a greater need for longer-lasting, more effective vaccines. Research in this field is continuing.

Treatment of schistosomiasis has been revolutionized in the last 20 years with the use of three very effective drugs – praziquantel, oxamniquine and mebendazole – which are now included in WHO’s Model List of essential drugs. Modern diagnostic techniques are simple, easy to apply and cost very little. In addition, improvements can also be achieved by reducing exposure to contaminated water and providing water which is free from parasites for drinking, bathing and washing clothes.

Dracunculiasis (guinea-worm disease) can be completely prevented by: providing safe sources of drinking-water; health education and the use of cloth filters (for water); encouraging infected persons not to enter drinking-water sources when the worm is emerging, thereby preventing transmission; chemically treating unsafe water with temephos once a month during the transmission season, under selected conditions.

The enormous health, social and economic benefits of the eradication programme are already being realized. For example, 40% increases in food production in some areas have followed reductions in cases of the disease. Areas under cultivation by farmers have increased by 25%, and school absenteeism has dropped from 60% to 13% in some areas.

An International Commission for the Certification of Dracunculiasis Eradication was created in 1995 and country-by-country certification procedures will begin in 1996 under WHO’s guidance.

The prevention and control of foodborne infections depends on improving the hygienic quality of raw foodstuffs at the agricultural level; applying food processing technologies such as pasteurization, sterilization, fermentation or irradiation; and, most critically, educating food-handlers in the principles of safe food preparation. Education of consumers and food-handlers is vital for the prevention of diarrhoeal diseases.

A vaccine for hepatitis A is available and is recommended for food-handlers. But because of its high cost, its use has not been widely promoted.

Here too, intersectoral cooperation is essential. Without it, health promotion and disease prevention cannot make headway. The responsibility for providing safe food should be shared between governments and the food industry, from producers to retailers.

Tetanus can never be eradicated because the spores which cause it will always remain in the environment to pose the risk of infection. But it can be eliminated as a public health problem – which means reducing its incidence to less than 1 case per 1,000 live births in each health district where it occurs. This requires immunization of pregnant women and all women of childbearing age in high-risk areas. Hygienic childbirth practices are also a key element of prevention, and are being promoted through a WHO “clean delivery” campaign.

Babies born to immunized mothers have a natural immunity to tetanus for up to 12 weeks. Women need two doses of vaccine to gain up to three years’ protection, and five doses to cover all their
childbearing years for maximum immune response.

The probable number of women living in high-risk areas who need three doses – which give five years' protection – is 55 million. The estimated cost of immunizing them all is $84 million – equal to $1.53 per woman.

If world efforts to immunize infants with three doses of DPT are maintained, reinforcing infant immunization with a fourth dose of DPT at 15 to 24 months prolongs tetanus immunity for another five years. A fifth dose of tetanus toxoid (given as Td or DT vaccine) at school entry will provide immunity for another 10 years. An additional dose when leaving school will ensure sufficient immunity for all childbearing-age years.

Scientists are trying to develop a slow-release tetanus vaccine which can ensure solid and long-lasting immunity with one injection. This could substantially cut costs and raise immunization coverage. But research is still at an early stage and it will be some years before such a vaccine becomes available.

Meanwhile, the goal of global elimination of neonatal tetanus will not be achieved unless many developing countries give higher priority to tetanus immunization programmes, and international donor agencies provide additional funding.

In a perfect world there would be adequate sanitation for all and shoes for everybody. In the real world, neither applies, and controlling rather than eliminating soilborne intestinal parasitic infections remains the realistic goal until they do apply.

WHO promotes the regular use of single-dose, safe, cheap and effective drugs to combat the effects of intestinal worm infections. Research shows that in populations at risk, most of the worms are harboured by a small part of the population. This implies that it is most cost-effective to identify and treat the group that is most heavily infected.

Recent WHO studies in Zanzibar (United Republic of Tanzania) indicate that regular anthelmintic treatment with mebendazole (2.8 US cents a dose) significantly improves the iron status of schoolchildren.

In areas where there is a high risk of hookworm infection and where many women have anaemia, WHO recommends that specific anti-hookworm chemotherapy should be included in strategies designed to improve the health, development and nutritional status of girls and women.

**Insect-borne diseases**

Flourishing in conditions of heat and humidity, poverty and overcrowding, insects spread deadly and disabling diseases among almost half of the world's population. They prey particularly on small children, killing more than a million of them every year. They lay vast areas of land to waste, preventing productive settlement, destroying agricultural potential, and blighting whole communities and regions.

The enormous variety of insect species includes numerous carriers of different diseases, and there can be no common approach to preventing or controlling them. Sleeping sickness, for example, is transmitted by the tsetse fly, with 55 million people at risk. The leishmaniasis group of diseases is spread by sandflies, putting 350 million people at risk. Another 100 million people in Latin America are at risk of Chagas disease, which is spread by household bugs. River blindness is carried by blackflies, and plague is carried by fleas, with millions of people at risk of infection.

**The mosquito: public health enemy number one**

But of all the insects that transmit disease, the mosquito represents by far the greatest menace. It remains mankind's most indomitable foe, resisting costly efforts to eradicate or even control it.

The mosquito is the vector for different diseases such as malaria, dengue fever and yellow fever, which together cause several million deaths, and hundreds of millions of cases every year. Mosquitos also spread lymphatic filariasis (elephantiasis), which infects about 120 million people; and Japanese encephalitis, which takes its biggest toll among children.
Different species of mosquito are involved in the transmission of different diseases, each with its own particular habits: some feed by day and others by night; some prefer to feed indoors and others prefer to do so outside; some rest after feeding and others depart; some prefer to feed on humans and others on animals; and various species choose different places for laying their eggs. Mosquito control requires a knowledge of these habits.

Today, the mosquito is literally spreading its wings as a carrier of disease and settling in new areas far from its original geographical boundaries. Some of the reasons — international travel, trade and migration — have already been outlined in the introduction to this chapter. In addition, expanding agriculture, the clearing of forests or the building of dams and irrigation schemes, and unplanned urban development provide mosquitoes with new breeding grounds, while at the same time bringing more people into contact with them. Changes in climatic conditions are enabling mosquitoes and other disease-carrying insects to survive and breed at more northern latitudes and higher altitudes.

One example illustrates the role of international travel and trade. The Asian tiger mosquito, which can transmit deadly strains of encephalitis virus as well as dengue and yellow fever, has been introduced into the United States, Brazil and parts of Africa in cargoes of rubber vehicle tyres shipped from Asia. In the United States alone, this mosquito is established in at least 23 states, and can survive winters as far north as Chicago.

Malaria is endemic in 91 countries, with about 40% of the world’s population at risk. Each year there are 300-500 million clinical cases of malaria, 90% of them in Africa, and between 1.5 million and 2.7 million deaths. Among all infectious diseases, malaria continues to be one of the biggest contributors to disease burdens in terms of deaths and suffering. By undermining the health and capacity to work of hundreds of millions of people, it is closely linked to poverty and contributes significantly to stunting social and economic development.

In many parts of the world, malaria is becoming an even greater problem than before. Epidemics are recurring in areas where transmission had been interrupted, and are generally associated with deteriorating social and economic conditions.

Malaria is a febrile disease caused by the four species of human malaria parasites belonging to the genus Plasmodium and naturally transmitted to people by the bite of an infected female mosquito of the genus Anopheles. Early symptoms include fever, shivering, aches and pains in the joints and headache. In falciparum malaria, infected red cells can obstruct the blood vessels of the brain, causing cerebral malaria, which is often lethal. Other vital organs can also be damaged, with fatal consequences.

Fifty years ago there were hopes that malaria would be eradicated in a fairly short time, mainly through the intensive use of insecticides. However, malaria still remains a serious threat in endemic countries today. Those at greatest risk of dying from the disease are children under age 5 in malaria-endemic areas; pregnant women; people moving from non-malarious to malarious zones for reasons of work, migration, refugee, war or tourism; and travellers who visit endemic countries and return home with the disease.

WHO’s global malaria strategy (which is intended to prevent mortality, reduce morbidity and lead to a decrease in social and economic loss) consists of providing early diagnosis and prompt treatment; planning and implementing selective and sustainable preventive measures, including vector control; detecting early, containing or preventing epidemics; and strengthening local capacities in basic and applied research to permit and promote the regular assessment of a country’s malaria situation, in particular the ecological, social and economic determinants of the disease.
The main problems in malaria control are shortages of resources and resistance to pesticides and drugs.

Dengue fever, a severe influenza-like illness, and dengue haemorrhagic fever are closely-related conditions caused by four distinct viruses transmitted by Aedes aegypti mosquitoes. Dengue is the world's most important mosquito-borne virus disease. A total of 2.5 million people worldwide are at risk of infection. An estimated 20 million cases occur each year, of whom 500,000 need to be hospitalized. There is no cross-immunity, which means that an individual who has recovered from one remains susceptible to the other three. The haemorrhagic form of dengue (DHF) most often occurs in individuals who have previously had the infection but are infected again with a different virus type, although DHF may occasionally occur after one primary infection. The viruses move continuously between crowded urban centres, causing massive outbreaks of disease.

Dengue, and especially dengue haemorrhagic fever, cause severe headache and pain behind the eyes which worsens with movement; patients have a high fever and muscle and joint pains. In the haemorrhagic form, there is bleeding from the nose, mouth, and gums, excessive thirst and difficulty in breathing. There is no cure and as yet no vaccine.

Dengue affects more than 100 countries in all continents except Europe, and is spreading rapidly in many areas. It flourishes in conditions of poor housing, overcrowding, and inadequate sanitation, especially in cities in tropical and subtropical regions of the Americas, Asia, Africa and the Western Pacific, and in communities where there is accumulation of solid waste, especially discarded containers and tyres where mosquitoes breed.

In 1995, the worst dengue epidemic in Latin America and the Caribbean for 15 years struck at least 14 countries, causing more than 200,000 cases of dengue fever and almost 6,000 cases of dengue haemorrhagic fever. There was only limited dengue in the western hemisphere until 1981, when the first outbreak occurred in Cuba.

Dengue epidemics are increasing due to growing urban populations, expanding mosquito-breeding sites and rapid transportation which involves both the movement of infected people and the spread of dengue-carrying mosquitoes.

Many major cities of the world are at risk of potentially devastating epidemics of yellow fever. This mosquito-borne virus disease occurs in tropical regions of South America and Africa, and is maintained in a transmission cycle involving forest-dwelling mosquitoes and monkeys, often referred to as the “jungle yellow fever” cycle. Many major cities, especially in the Americas, are heavily infected with Aedes aegypti mosquitoes, and should yellow fever virus be introduced and transmission initiated, thousands of cases and deaths could occur in spite of the availability of a protective vaccine.

Yellow fever is characterized by sudden onset, fever, chills, headache, backache, generalized muscle pain, prostration, nausea and vomiting. Jaundice is moderate in the early stages but intensifies later. As the disease progresses, the pulse becomes slower and weaker, and haemorrhages may occur. The death rate ranges from less than 5% to more than 50% during epidemics.

The incidence of yellow fever is greatest in parts of western Africa, especially Ghana, Nigeria, and adjacent countries, and in northern South America, especially Peru, Bolivia, Brazil and neighbouring countries. Rural populations are at greatest risk, with most cases occurring among young adult males who enter the forests as part of their work.

Like many other insect-borne diseases, yellow fever is spreading. The largest number of cases for 40 years was reported during 1988–1990; this was followed in 1992 by the first epidemic of yellow fever recorded in Kenya (Box 10). In 1995, Peru also suffered its worst-ever outbreak, with 440 cases in the first six months of the year— the highest number recorded in the Americas since 1950.

WHO estimates that there are probably
some 200,000 cases and 20,000 deaths a year from the disease.

**Japanese encephalitis** is another mosquito-borne virus disease. Its transmission cycle involves wild birds and domestic pigs as amplifying hosts, and the most common mosquito vector is *Culex tritaeniorhynchus*, which is associated with rice-growing regions. In recent years, the disease has appeared to spread into new parts of Asia, perhaps as a result of increased rice field agriculture.

Most infections are asymptomatic, with only one in a few hundred infections leading to clinical illness. Mild cases are often characterized by febrile headache or aseptic meningitis. Severe infections are usually characterized by acute onset, headache, high fever, disorientation, coma, convulsions (especially in infants), and spinal paralysis. Among the severe cases, fatality rates may reach 60%.

An estimated 43,000 cases of Japanese encephalitis occur globally each year, with 11,000 deaths and nearly 9,000 disabled. The vast majority of cases (about 85%) occur among children less than 15 years of age. Nearly 10% of the cases are among those over 60 years, perhaps reflecting waning protective immunity. About three-quarters of the cases occur in the Western Pacific, primarily China and adjacent countries, with the remainder occurring in South-East Asia, especially India. The disease is rare in other parts of the world, and when seen, is generally associated with travelers returning from endemic areas.

**Lymphatic filariasis** or elephantiasis—the grotesquely disfiguring disease affecting the legs, arms and genitals—is the most notorious result of infection with filarial parasites transmitted by *Culex* mosquitoes. About 120 million people are infected in tropical areas of Africa (40 million), India (45 million), South-East Asia, the Pacific Islands, and South and Central America.

Lymphatic filariasis also causes acute fevers, inflammation of the lymphatic system, and the bronchial-asthmatic condition known as "tropical pulmonary eosinophilia".

**Diseases spread by other insects**

Although 350 million people in 88 countries are at risk of leishmaniasis, much of the rest of the world knows little about the disease, so its victims are largely unnoticed outside their homelands. Leishmaniasis is a grossly disfiguring disease as well as a potentially deadly one. As a result, many sufferers, particularly women and children, are social outcasts, victims of prejudice and stigmatization.

Leishmaniasis, named after Leishman, the doctor who identified the causative organism in 1910 when treating patients in India, exists in various

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**Box 10. Yellow fever in Kenya**

The first yellow fever outbreak reported from Kenya since 1943 began in September 1992 and continued until March 1993. Although only 54 cases and 28 deaths were reported, the outbreak attracted worldwide attention because of Kenya’s tourist industry and the fact that this disease appeared to be newly emerging there. The outbreak was controlled by administering nearly 1 million doses of yellow fever vaccine, in an effective display of international collaboration. It subsequently became clear that there were significant shortcomings in the national capacity to address a disease problem of this nature. Although Kenya is clearly marked as being in the yellow fever endemic zone, many years without a case had led to complacency. Clinicians did not think of yellow fever in their differential diagnoses, and if they did, the laboratory support necessary to confirm a diagnosis was not reliable, and formal surveillance did not exist to document previous cases. Consequently, a collaborative effort was begun to strengthen yellow fever capacity: two Kenyan virologists from the Kenya Medical Research Institute (KEMRI) were trained at the Centers for Disease Control and Prevention (CDC) in the United States in modern yellow fever diagnostic techniques; the Government of the Netherlands provided assistance in the development of an active yellow fever surveillance programme; and clinicians working in the outbreak area received guidance in yellow fever diagnosis and reporting. Beginning in 1994, an active yellow fever surveillance programme was initiated, supported by prompt laboratory confirmation of suspected cases. As a result, continued low-level yellow fever transmission was clearly documented, indicating that the virus continued to be transmitted among wild animals and local mosquitoes, occasionally infecting humans who had not been vaccinated during the mass campaign. When the Kenyan Ministry of Health was informed of the situation, it promptly offered yellow fever vaccine to the regional Expanded Programme on Immunization. In addition KEMRI, in collaboration with WHO and CDC, hosted representatives from other African virology laboratories at a workshop for laboratory diagnosis of yellow fever. Participants were given two weeks of intensive laboratory training, and provided with yellow fever diagnostic kits for use in their own countries. Thus the challenge of the emergence of yellow fever in Kenya was met head-on and became the entry-point for developing an effective surveillance system able to respond to other infectious disease emergencies, by combining public health intervention, infrastructure building and strong international collaboration.
forms, all due to parasites spread by the bites of many different species of sandfly.

The most serious form, visceral leishmaniasis – also known as kala-azar – can have a fatality rate as high as 100% if untreated. It is characterized by irregular bouts of fever, substantial weight loss, swelling of the spleen and liver, and anaemia. Nine out of ten cases occur in Bangladesh, Brazil, India and Sudan.

Another form, mucocutaneous leishmaniasis, can involve partial or total destruction of the mucous membranes of the nose, mouth and throat cavities and surrounding tissues. Ninety per cent of these cases occur in Bolivia, Brazil and Peru.

The commonest form, cutaneous leishmaniasis, produces skin ulcers, sometimes as many as 200 on the face, arms and legs, leaving permanent scars. Nine out of ten cases occur in Afghanistan, Brazil, Islamic Republic of Iran, Peru, Saudi Arabia and Syrian Arab Republic.

Over the last 12 years, there has been a sharp increase in the recorded number of leishmaniasis cases, reflecting the geographical spread of the disease; WHO estimates that about 1.8 million new cases occur every year globally.

The spread of the disease is accelerated by development programmes such as road building, dam construction, mining and forest exploitation that bring increasing numbers of people into contact with the disease vectors. Another factor enhancing spread is the haphazard growth of major urban centres which creates conditions that increase transmission risks. A third factor is the movement between countries or regions of migrant workers who themselves act as vehicles for the disease. A fourth factor is the halting or winding down in some countries of malaria control campaigns using insecticide sprays which were directed against mosquitoes, but which were also effective against other insect vectors. For instance, leishmaniasis al-
most disappeared from India in the 1960s because sandflies were reduced as a side-effect of DDT spraying to control malaria. But when the spraying stopped, the flies and the disease returned.

Visceral leishmaniasis (VL) is spreading in several areas of the world due to epidemiological changes which sharply increase its overlapping with AIDS (Map 7). Leishmania/HIV co-infection is considered to be a real "emerging disease", especially in southern Europe where 25-70% of VL cases in adults are related to HIV and 1.5-9% of AIDS patients suffer from newly acquired or reactivated VL (Box 11).

Sleeping sickness (African trypanosomiasis) is caused by parasites called trypanosomes, transmitted to humans through the bite of a tsetse fly. This fly is found only in certain parts of Africa. It feeds on the blood of animals and humans, acquiring or transmitting infection as it feeds. Following transmission, the trypanosomes proliferate and gradually invade all the organs of the body.

In the early stage, the main clinical signs are high fever, weakness and headache, joint pains and itching. Gradually, the initial symptoms become more pronounced and other manifestations appear, such as anaemia and cardiovascular and kidney disorders. Later, when the parasites invade the central nervous system, the disease takes a dramatic turn. The patient’s behaviour changes; he or she can no longer concentrate and becomes indifferent to or exasperated by everything. Sudden and completely unpredictable mood changes become increasingly frequent. The patient is then overcome by extreme torpor, insomnia, and exhaustion, leading to deep coma and death.

Pain, suffering and death from sleeping sickness threaten more than 55 million people in 36 countries of sub-Saharan Africa. When untreated this disease progresses until it gives no reprieve from suffering, day or night, and ends in death. If transmission is high, the effect is dramatic: whole villages are abandoned. Exclusively a rural disease, sleeping sickness smoulders steadily except for occasional epidemics, and usually has low political visibility.

Box 11. Leishmaniasis and HIV

Co-infection of visceral leishmaniasis (VL) and AIDS is emerging due to the spread of the AIDS pandemic in suburban and rural areas of the world. Meanwhile, it is estimated that 500,000 new clinical cases of VL occur annually, and 200 million people live in endemic areas. The disease is endemic in 62 countries and is spreading in several new areas owing to epidemiological changes.

Leishmania/HIV is considered to be an “emerging disease” especially in southern Europe, where 25-70% of adult VL cases are related to HIV infection, and 1.5-9% of AIDS patients suffer from newly acquired or reactivated VL. In this case, VL is the most frequent opportunistic parasitic infection. Furthermore, in the foci of southern Europe, 70% of co-infected patients are intravenous drug users and, consequently, the age distribution of the patients has changed drastically. Up to 20-25% of the population living in an endemic area may be infected, but without showing symptoms for years. However, the disease quickly appears when immunity is affected.

In 1995, the total number of leishmaniasis/HIV co-infections in the Mediterranean area was estimated at over 1,000 cases. Most of the co-infections reported in the Americas occur in Brazil. Leishmania/HIV co-infections were also reported in Africa from Cameroon, Ethiopia, Guinea-Bissau, Kenya, Malawi and Sudan. In Asia, the first cases of leishmaniasis/HIV co-infection were recently reported from India.

To better understand this new phenomenon, WHO created a network of 14 institutions in 10 countries, to collect standardized information in a central international registry, and is currently analysing data on 700 retrospective cases.

Sleeping sickness causes immense mental suffering, with early symptoms such as sleep disturbance and psychosis. Of the disease’s two forms, the western African “gambiense” form begins with a fever and then develops slowly, killing its victim only several years later. The eastern and southern African “rhodesiense” form is more acute. Severe symptoms begin within a few days, and death occurs in a few weeks to a year.

The countries currently most seriously affected by gambiense sleeping sickness are: Angola, Cameroon, Central African Republic, Chad, Congo, Sudan, Uganda and Zaire. The rhodesiense disease affects the United Republic of Tanzania most, followed by Malawi, Mozambique and Uganda. It is also endemic in Ethiopia and Zambia, but little is known about its prevalence in those countries.

River blindness (onchocerciasis) is the most dreaded but not the only sequel of infection with the filarial worm
Onchocerca volvulus, which affects some 17.6 million people in Africa, and a smaller number in Central and South America. The parasite is transmitted by blackflies that breed in fast-flowing rivers and, like the parasites of lymphatic filariasis, mature into adult male and female forms in the human host. However, rather than settling into the lymphatic system, adult worms settle into visible lumps or nodules under the skin. Then, as in other filarial disease, for some 10-14 years the female parasite produces millions of microfilariae, which in onchocerciasis invade the skin and the eye, rather than remaining in the blood.

In the skin, microfilariae cause almost unbearable itching and eventually destroy skin elasticity, texture and appearance; in the eye, over time they can destroy the retina and make the cornea and lens opaque. Key factors determining the outcome are the intensity of transmission and infection and the species of worm involved; some species are mainly responsible for blindness and others for itching and other skin manifestations.

Onchocerciasis affects 17.6 million people, of whom 15 million, or more than 85%, now live outside the 11-country region of the Onchocerciasis Control Programme in West Africa. Throughout the region covered by the Programme, the disease is under control as a public health problem, but outside the region, onchocerciasis remains a major cause of blindness in the central and eastern parts of the savanna belt of the tropics, including parts of Cameroon, the Central African Republic, Chad, Nigeria and Sudan – areas where some 6.5 million people are infected.

In other endemic areas of Africa – where 8.6 million people are infected – the disease causes severe skin problems and other systemic consequences.

Onchocerciasis is still endemic in six countries of the Americas but new foci have been found and the disease may spread still further as infected workers continue to exploit areas of virgin forest. The situation is also complicated by the presence of large numbers of human-biting blackflies in areas from which onchocerciasis is at present not reported. However, studies over the last decade have indicated that while the geographical borders of the southern focus of the disease have been extended, the epidemiological characteristics have remained stable. Concentrated efforts were made to control the disease in areas where it is endemic through coordination of ivermectin distribution activities. A conference held in 1991 resulted in the launching of a regional onchocerciasis elimination programme to reduce morbidity through the mass distribution of ivermectin in Brazil, Colombia, Ecuador, Guatemala, Mexico and Venezuela, integrated with other measures such as hepatitis B vaccination of children, and the use of primary health care workers. In accordance with a strategic plan of action, a multilateral, multiagency and multidonor coalition was formed to support activities for eliminating onchocerciasis as a public health problem.

Plague is often regarded as a scourge of medieval times, from which the world is now largely free. But the latest evidence suggests that incidence of the disease is on the increase. During 1995, at least 1,400 cases of human plague (including at least 50 deaths) were notified to WHO. The disease occurs particularly in rodents. It spreads from rat to rat and from rats to humans mainly by rat fleas biting first a sick rat and then a person, thus transmitting Yersinia pestis, the bacterium of the disease.

Plague most commonly has two forms: bubonic and pneumonic. The more frequent form is bubonic, in which there is a sudden onset of severe malaise, headache, shaking chills, fever and pain in the affected regional lymph nodes. Large and painful lumps appear under the skin, called buboes. The more dangerous form of the disease is pneumonic or pulmonary plague, which affects the lungs and can be transmitted from person to person by droplets in the air from sputum discharged by the infected individual.

Some countries in Africa, the Americas and Asia report cases almost
every year: Madagascar, United Republic of Tanzania and Zaire in Africa; Bolivia, Brazil, Peru and the United States in the Americas; and China, Kazakhstan, Mongolia, Myanmar and Viet Nam in Asia. However, cases occur in areas that had apparently been free from the disease for many decades. For example, it has reappeared in Botswana, India and Malawi in recent years after “calm” periods of up to 30 years. Peru experienced a large outbreak of plague in 1984, followed by another in 1990 and again in 1992. These outbreaks are linked to cyclical epidemics of plague in rodents.

Over the last 20 years, the mean annual global plague case fatality rate has been 9%, ranging from just over 14% in Africa to just under 6% in the Americas. These high rates persist despite the availability of highly effective drugs against the disease.

Other factors are involved in the apparent increase in plague. In the United States, for example, rapid urbanization has resulted in increasing numbers of people living in or near areas where plague exists in nature. The number of states that report plague cases increased from three during 1944-1953 to 13 during 1984-1994. Surveillance of plague in rodents indicates that the disease has spread eastwards in the United States to areas believed to have been free of plague during the previous 50 years.

*Chagas disease* (American trypanosomiasis) is a severe, disabling and potentially fatal disease caused by the parasite *T. cruzi*, which is harboured by both domesticated and wild animals. The parasites are mainly transmitted to humans by a blood-sucking triatomine bug, usually found in poor housing and living conditions. It is also transmitted at birth from infected mothers to their babies, and through transfusions of blood infected with the parasites. It occurs only in the Americas and is widespread in rural zones from Mexico to Argentina, with heavy concentrations in Argentina, Brazil, Chile and Venezuela. Cases are also reported in Mexico, Peru and most other Central and South American countries as well as in the Caribbean Islands and the United States. Some 100 million people are at risk of contracting the disease, and at least 18 million people are infected.

More than a third of those infected develop chronic Chagas disease, and about 30% of these become incapacitated due to cardiac damage which may also lead to sudden death. Others suffer digestive damage and peripheral nerve impairments. More than 2 million people already have complications, and 45,000 people a year die. Chagas disease is the leading cause of cardiac death among young adults in parts of South America.

No treatment is available for the chronic forms of the disease. Oral drugs such as nifurtimox and benznidazole are used in acute cases but their efficacy varies considerably from place to place, probably due to variations in parasite strains. The infection can be effectively eliminated through interruption of transmission via triatomine bugs through regular spraying with residual action insecticides and the systematic screening of blood donors.

**Preventing and controlling insect-borne diseases**

The five main diseases spread by mosquitoes—malaria, dengue, yellow fever, Japanese encephalitis and filariasis—do not lend themselves to a simple, comprehensive approach. Each has to be tackled in its own right. At the same time, however, some methods of prevention or control are common to all of them.

Vaccines against yellow fever and Japanese encephalitis already exist, and others are being developed against malaria and dengue, although it will be several years at least before they become available. There is an effective drug against filariasis.

The two key measures to prevent the spread of these five diseases are the elimination of mosquito breeding places, and the prevention of mosquito bites. The first involves community action, such as covering water storage containers and removing discarded containers from inside and around houses; house-
to-house inspection; and control programmes using insecticide sprays.

The second involves people protecting themselves with insecticide-impregnated materials such as curtains and nets, repellents and screens.

Vector and disease surveillance are extremely important, as are rapid intervention and control when an outbreak occurs. Other important measures are health education campaigns and preparations to guard against outbreaks.

Following high-level political commitment for a Global Malaria Control Strategy made in 1992 at a Ministerial Conference in Amsterdam, a target was set for achieving a reduction in malaria mortality of at least 20% by the year 2000 in at least 75% of affected countries. In 1994, the United Nations General Assembly called upon WHO, as the lead agency for health, to promote the international mobilization of technical, medical and financial assistance to intensify the struggle against malaria.

Drugs such as mefloquine and halofantrine have been developed and registered, and artemisin derivatives developed and brought close to registration.

In Africa, large-scale multicentre trials of the effectiveness of insecticide-treated bednets have demonstrated a dramatic reduction in mortality of children under the age of 4. These research-based results are now being translated into operational recommendations for national control programmes.

Worldwide efforts in basic research in malaria vaccines are at last beginning to bear fruit. In the United Republic of Tanzania in 1994 a double-blind phase III trial of the Colombian SP/66 peptide vaccine demonstrated that it reduced the numbers of first malaria fevers in children by around a third. Continuing studies with this and other vaccines are yielding additional data that will form the basis for recommendations for their use. In the meantime, emphasis is being placed on strengthening national capacity to diagnose and treat malaria; epidemic preparedness and control; and mobilizing sustainable international commitment for long-term malaria control.

In the countries of Africa south of the Sahara, special attention is being given to strengthening general health services and enabling health care providers from other sectors and the communities themselves to provide early diagnosis and prompt treatment, i.e. disease management. In the rest of the world, the emphasis is on improving the provision of basic curative services at all levels of health care and the promotion of rational drug use; and implementing selective measures for disease prevention, including selective vector control.

A dengue vaccine is being developed in Thailand with WHO’s help. The results of clinical trials in adult volunteers show that it is safe, and its immunological response is encouraging. Trials of the vaccine in children have also begun.

A live, attenuated, highly efficacious vaccine for yellow fever is available and widely used, including in the Expanded Programme on Immunization in many countries. Protective antibodies appear 7–10 days after immunization and probably persist for life, although reimmunization is currently recommended every 10 years. Other interventions centre around prevention of bites from infected mosquitoes. Thus mosquito control activities, especially targeted to Ae. aegypti, are critical in the prevention of urban transmission.

Urban transmission of yellow fever is essentially identical to that of dengue fever, a rapidly increasing public health problem in many countries of the tropics. Control of breeding of Ae. aegypti mosquitoes around houses should lessen the risk of urban yellow fever transmission as well as that of dengue fever.

Vaccines are available for Japanese encephalitis. They require an initial series of two injections, followed by a booster. Immunization is the most effective means of disease prevention. Efforts are under way to develop a live, attenuated vaccine that will be an improvement on the existing inactivated vaccine. Although promising results have been obtained, it will be several years before such a product is available for widespread use.
In *filariasis* four major breakthroughs have occurred, offering the prospect that — given sufficient political commitment and resources — the disease might eventually be well controlled or even eliminated.

The first of these breakthroughs is the development of safe, single-dose, annual drug treatments. Trials have proved that a single dose of diethylcarbamazine (DEC) is very effective even two years after treatment. A single dose of ivermectin has proved to be equally effective. A combination of single doses of both drugs reduced microfilaraemia more than 95% two years after treatment.

Secondly, intensive local hygiene on an affected limb, with or without the use of antibiotic and antifungal creams, has been shown to have dramatic effects by halting the progression of, or even reversing, elephantiasis and lymphoedema.

Thirdly, DEC-medicated table salt or cooking salt has been introduced in India. The carefully controlled addition of very low concentrations of DEC has long been recognized as an effective means of eliminating lymphatic filariasis infections in communities. However, the addition increases the price of the salt. During 1994, the first commercially prepared DEC salt went on sale in India, at about twice the price of ordinary salt. It remains to be seen whether the product will be a commercial success.

Finally, there has been the development of insecticide sprays and polystyrene beads to seal larrines and roof-top water-storage tanks, to eliminate or reduce populations of urban Cáoex mosquitos.

*Leishmaniasis* can be controlled through prompt diagnosis and treatment together with sandfly vector control. Relatively simple prevention methods are effective. They include vector control through insecticide spraying, personal protection with insect repellents, the use of insecticide-impregnated bednets or curtains, and the destruction of sandfly breeding sites. The tools to establish control exist, but there is a need for political commitment in order to apply them, and additional resources should be made available to all the countries in need.

Control measures extend to animals such as dogs and rodents that act as reservoirs for the parasite. Simple blood tests can identify infected dogs, which can be either treated or put down. Deep ploughing of rodents' burrows and the destruction of certain plants that the rodents eat can sharply reduce the rodent population and the incidence of the disease.

**Sleeping sickness** surveillance and control are hampered by a lack of skilled personnel at all levels, and the high costs of surveillance and tsetse control operations. Field research has shown the dramatic effectiveness of traps and screens to attract and destroy the tsetse flies. For the West African disease, there is a new and simpler field diagnostic test. A major breakthrough has been the development of a new drug — DFMO or eflornithine — the first against sleeping sickness in 40 years, so effective that it has been dubbed the "resurrection drug".

The ideal control strategy is to identify and treat all cases, and keep vector densities down with screens and traps. There should be mobile medical surveillance by specialised staff using the most effective diagnostic tools available. As the disease affects impoverished rural populations, additional support from the international community is required in order to implement these measures.

The control of *onchocerciasis* has for the last 20 years been the story of dramatic successes of the Onchocerciasis Control Programme which has eliminated the disease as a public health problem from 11 countries in West Africa through extensive insecticide spraying of the exposed vector breeding sites in the region, mostly from helicopters.

The recent availability of a safe, effective drug — ivermectin, capable of causing clinical improvement and decreasing the transmission of infection — has led to a new global strategy for controlling onchocerciasis in areas where vector control through spraying is not feasible, based on yearly administration of ivermectin to affected populations.

The anticipated duration for establishing sustainable programmes for the
elimination of onchocerciasis as a public health problem is 10-15 years.

WHO has launched an ambitious new programme – the African Programme for Onchocerciasis Control (APOC) – in close cooperation with the World Bank, the governments of 16 participating countries where the disease exists but which were not covered by the earlier programme, and a consortium of bilateral donors and nongovernmental development organizations (NGDOs). This new programme (which became operational in January 1996) aims to control and eventually eliminate the disease as a public health hazard from the entire African continent by the year 2002. APOC will directly benefit more than 15 million people infected with onchocerciasis and nearly 100 million people estimated to be at risk in these 16 participating countries.

The programme will include community-based annual administration of ivermectin (donated by Merck & Co., Inc.) and selective aerial spraying of insecticide, the cost of implementation being borne by the various partners.

A programme to eliminate onchocerciasis as a public health problem in the Americas is being coordinated by the Pan American Health Organization with the support of NGDOs and the Inter-American Development Bank.

In general, the control of bubonic plague involves breaking the rodent flea-human transmission chain by the use of insecticides, fleas and rodent control and sanitation. Control of pneumonic plague aims at interrupting the respiratory route of person-to-person transmission. Antibiotics are effective in treating the disease.

Flea control involves the use of insecticides blown into rat burrows or distributed around houses frequented by rats. Insecticides should be used before any rats are killed or a rodent control campaign is carried out, because otherwise fleas leave dead rats in search of another living host such as humans.

Plague vaccines exist but are not recommended for immediate protection in outbreaks. Vaccination is only recommended for high-risk groups such as health workers and laboratory personnel who are more intensely exposed to risk of contamination.

Because it is transmitted in the wild, plague cannot be eradicated in the foreseeable future. Surveillance at local, national and international levels is crucial in the prevention and control of the disease.

Chagas disease is essentially untreatable. The available control measures are twofold. One is to interrupt transmission by systematic attack on the vectors which infest poorly constructed houses, spraying effective insecticides with residual action or using insecticide paints or fumigant canisters, and by improving housing and health education as part of rural and periurban development initiatives. The other is to systematically screen blood donors from endemic countries for T. cruzi, and to strengthen health infrastructures for multiple blood screening (HIV, hepatitis B and T. cruzi). Many countries such as Argentina, Bolivia, Brazil and Colombia have also enacted laws on methods to screen for or treat infected blood in blood banks.

In 1991, Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay (which accounted for some 60% of the total cases on the continent) launched the Southern Cone Initiative aimed at eliminating the disease as a public health problem, through vector control and blood screening. An intergovernmental commission on Chagas disease, set up under this Initiative, concluded in March 1995 that impressive progress was being made towards elimination of Trypanosoma infecta, the main vector of T. cruzi and that elimination of Chagas disease as a public health problem in the Americas by the year 2000 was achievable.

Diseases from animals

People have always depended on animals as sources of food, transport, labour and companionship. But countless species of animals are also sources of viral, bacterial and parasitic diseases transmitted in many ways, including direct contact, consumption of food derived from them, or water contaminated by them.
Infectious diseases that are transmitted from animals to humans are called zoonoses. Worldwide, rabies and brucellosis are the most serious of these, involving both wild and domestic carnivores in rabbits, and cattle, sheep and goats in brucellosis. Many species of rodents are reservoirs of diseases that may endanger human health. Monkeys may be involved in the transmission of agents that have only recently emerged. And there are diseases – such as Ebola haemorrhagic fever – whose animal host remains unknown.

Rabies is a viral disease transmitted by domestic and wild animals to other animals and to humans through close contact with their saliva (for example through bites, scratches or licks on broken skin). Once symptoms of the disease develop, rabies is fatal to animals as well as humans and there is no cure for it.

The most frequent way in which humans become infected with rabies is through the bite of infected dogs, cats or wild carnivorous species such as foxes, raccoons, skunks, jackals, wolves, and vampire bats. Cattle, horses and deer can become infected with rabies, but rarely transmit the virus to other animals, although they may transmit the disease to humans.

In developed countries, rabies is now found mainly in wild animals, from which the disease can be spread to domestic animals and humans. By contrast, in Africa, Asia and Latin America, dogs continue to be the main hosts and are responsible for most of the rabies deaths that occur worldwide. Dog rabies still presents a deadly threat in at least 87 countries, with a total population at risk of 2.4 billion people.

Reliable data on rabies are scarce in many areas of the globe, making it difficult to assess its full impact on human and animal health. The number of deaths caused each year by rabies is estimated to be at least 40 000 worldwide, and may be as high as 70 000. An estimated 10 million receive treatment each year after being exposed to animals suspected of having rabies. Most cases occur in Asia.

Human brucellosis is a bacterial disease caught from farm animals such as cattle, sheep, goats and pigs. WHO regards it as one of the world’s most widespread of all zoonoses. It is reported in at least 86 countries, and there has been a big increase in cases in Eastern Mediterranean countries in the last 10 years. Apart from its human burden, it has an important impact on the animal industry in many countries.

The bacteria are transmitted mainly through consumption of unpasteurized milk and cheese, and the disease also occurs in workers on farms or in slaughterhouses, and in veterinary surgeons, as a result of a cut or inhalation during close contact with animals. Symptoms include high fever, headache and depression, and other complications can occur in severe cases. Recovery from severe disease is usual but disability is often pronounced.

The disease is now rare in most European countries and in North America and Australasia. Twenty-five countries in the Middle East report the disease and six of them report a combined total of about 90 000 cases a year.

Preventing and controlling diseases from animals

The most effective prevention of rabies after animal bites is to wash and flush a wound or point of contact with soap and water, detergent or plain water, and then to apply ethanol or a tincture or a solution of iodine. Although there is no cure, there is a vaccine, which is effective if given before or shortly after exposure.

Post-exposure vaccination today often requires a daily intramuscular injection for 14 days followed by booster injections. Recent studies with human vaccines suggest that more people could be vaccinated at less cost. Research shows that the number of vaccinations and the amount of vaccine used each time can be reduced by employing intradermal injections. Health staff need to be well trained in this technique.

Anti-rabies campaigns involve the wide distribution of oral vaccines contained in specially prepared baits for tar-
get animals. The baits may be scattered by helicopter or light aircraft, or distributed manually on the ground, in rural and periurban areas where infected animals are known to live.

More than 60 million such vaccine baits have been distributed in Canada and 15 countries in Europe since 1978, when the campaign first began in Switzerland. As a result, cases of animal rabies in Europe have dropped by 80% since 1990. Continuation of the campaigns should lead to the elimination of fox rabies in much of Europe within the next few years. Dramatic decreases in human cases of rabies have also been reported in recent years in China, Thailand and Sri Lanka as a result of improved post-exposure treatment programmes and vaccination of dogs.

In the United States in 1995, about 1 million baits were distributed in southern Texas in an attempt to stop the progression of the current coyote rabies outbreak there. Raccoons have supplanted skunks as the major reservoir species of rabies in that country. Cases of the disease in raccoons have risen sharply since the early 1990s. This is due to the spread of raccoon rabies, apparently through the migration of animals from a south-eastern focus to the north-eastern United States, particularly New England. No raccoon-associated human rabies cases have yet been reported, but the spread is expected to continue for years and vaccine baits are being used against raccoon rabies.

WHO, FAO and the International Office of Epizootics have been working closely together for many years to promote applied research on vaccines and diagnosis and also anti-brucellosis campaigns. Control of animal brucellosis is based on comprehensive vaccination programmes that range from cattle to camels and include buffaloes, sheep and goats, thereby steadily reducing the number of human cases.

Disease surveillance, collaboration between health ministries and veterinary services, and education campaigns aimed at animal food producers and the general population are key elements of prevention and control.
**Infectious diseases and cancer**

Recent studies undertaken by the International Agency for Research on Cancer (IARC) have shown that cancer is the second most common cause of death in many parts of the world. An estimated 6.6 million people died of cancer in 1995, and 10 million new cases were diagnosed. It is generally believed that environmental and lifestyle factors as well as common practices such as diagnostic radiographic procedures are largely responsible for this disease. In addition, the link between infectious diseases and cancer is becoming increasingly clear, opening up new possibilities for prevention. Viruses, bacteria and parasites may be the “secret agents” of cancer.

Up to 84% of cases of some cancers are attributable to viruses, parasites or bacteria (see Table on page 61). WHO estimates that over 1.5 million (15%) of the new cases occurring each year could be avoided by preventing the infectious disease associated with them. About 1.2 million (20%) cancer cases in developing countries and 363,000 (9%) in developed countries are attributable to infectious agents. The relative impact of infections on the overall cancer burden is more important in those populations where communicable diseases are the leading causes of morbidity.

**Stomach cancer.** About 550,000 new cases a year of stomach cancer are attributed to the bacterium *Helicobacter pylori*. This represents about 53% of new cases of this cancer worldwide. Isolated in 1982, this bacterium has been shown to cause duodenal ulcers and gastritis. It has now been established that the infection may eventually lead to the development of stomach cancer, although other factors must also be involved (Map A).

**Cervical cancer.** Sexually transmitted infection of the cervix with human papilloma viruses types 16 and 18 involves a very high risk of developing cervical cancer, of which there are 529,000 cases a year. The viruses are responsible for an estimated 436,000 or 83% of these cases; 65% of cervical cancer cases are due to this virus in industrialized countries, and 87% in developing countries. The infection is most prevalent in sexually active young adults and the risk of acquiring it increases with every new sexual partner, although only persistent infections lead to cancer. In addition to cancer of the cervix, these viruses cause 31,000 or 80% of vaginal cancer cases worldwide (Map B).

**Liver cancer.** WHO estimates that globally there are about 527,000 new cases a year of liver cancer, of which 82% are attributable to infection with the hepatitis B and C viruses. The viruses are transmitted in various ways, including sexually and through contaminated blood transfusions. Hepatitis B virus infection causes some 316,000 or 60% of liver cancers a year worldwide, while hepatitis C causes a further 118,000 or 22% of cases a year; some cases are the result of infections with both viruses (Map C).

**AIDS-related cancers.** The relative risk of Kaposi’s sarcoma occurring in patients with HIV infection is so high that it was the first manifestation of the AIDS epidemic to be recognized. It causes distinctive skin tumours and also affects some internal organs. The proportion of patients with AIDS developing Kaposi’s sarcoma is estimated at 15% for North America, Europe, Australia and New Zealand, 10% for Africa and 7.5% elsewhere. In all, about 33,400 cases of Kaposi’s sarcoma developed among new cases of AIDS in 1995 worldwide. Non-Hodgkin’s lymphoma, a cancer of the lymph nodes and spleen, is a relatively late complication of AIDS, occurring in about 6% of new AIDS cases in the developed countries and in about 1% in Africa. Globally the total number of AIDS-related non-Hodgkin’s lymphoma is estimated at 8,600 or about 0.1% of all malignant neoplasms worldwide.

**Burkitt’s lymphoma.** Predominantly a childhood disease, Burkitt’s lymphoma is clearly and strongly linked with the Epstein-Barr virus in Africa. Virtually
### Percentage of new cancer cases attributable to infectious agents, 1995

<table>
<thead>
<tr>
<th>Cancer site</th>
<th>Number of new cases (000)</th>
<th>Percentage attributable to infectious agent</th>
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<tr>
<td>All sites, of which</td>
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<td>Stomach</td>
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<tr>
<td>Liver</td>
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<td>Lymphomas, of which</td>
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<td>Burkitt's</td>
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<td>Cholangiocarcinoma</td>
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</table>

Source: International Agency for Research on Cancer.
all cases in sub-Saharan Africa can be attributed to infection with the virus; the disease is much rarer in North America and Europe. The virus accounts for 8,670 or about 84% of the worldwide total of about 10,400 cases a year.

**Hodgkin’s disease.** The pattern of age-specific incidence of Hodgkin’s disease suggests that the disease has an infectious etiology in young adults – the result of delayed exposure to a common pathogen – analogous to the picture in poliomyelitis. Epstein-Barr virus was implicated in 30,900 (or about 49%) of 63,600 new cases of Hodgkin’s disease worldwide in 1995.

**Bladder cancer.** About 12,600, or 4%, of the 304,000 new cases a year of bladder cancer are attributable to the parasitic disease schistosomiasis, which occurs exclusively in developing countries.

**Viruses** and other infectious conditions can cause cancer through a number of different mechanisms. Effective vaccines are only available against hepatitis B virus, and their use could cut the number of liver cancers by up to 70% in areas such as sub-Saharan Africa and eastern Asia, including China.

There are hopes that with the availability of vaccines in the near future, human papilloma viruses which cause cervical cancer, HIV which causes AIDS, and possible increases in the risk of certain other cancers, can also be effectively tackled.

For the present, however, healthy lifestyles, early diagnosis and appropriate treatment are still the most effective means of reducing incidence and mortality. The potential preventive interventions by immunization, other than for hepatitis B, are still a matter of experimental research for the other viruses.