Chapter 3
Charting the future

Disease trends

Some infectious diseases once believed to be all but conquered have returned with a vengeance. Others have developed stubborn resistance to antibiotic drugs. New or previously unknown diseases continue to emerge. Together, these trends amount to a world crisis for today, and a global challenge for the future.

They are occurring in an increasingly grey and rapidly urbanizing world. While the proportion of the population under 15 years is declining, the proportion over 70 years is increasing (Fig 7). The annual birth rate is on a downward trend, as is the percentage of children under 5 years of age. By 2025, many more people globally will live in urban rather than rural areas (Fig. 8). Urbanization in developing countries tends to lead to the growth of “mega-cities” with overcrowded and underserved slums, an environment that favours the increasing incidence of infectious diseases.

It is being increasingly recognized that many chronic diseases previously considered non-infectious are associated with infection. Pockets of poverty exist in all parts of the world and have become potential breeding grounds for many infectious diseases. Mass movements of population within and between counties are increasing rapidly, raising fears that potentially explosive outbreaks may occur and that diseases may

Table 6. Selected foodborne infectious diseases

<table>
<thead>
<tr>
<th>Diseases/infections</th>
<th>Important reservoir/carryer</th>
<th>Transmission</th>
<th>Examples of some inculminated foods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Person to person</td>
<td>Waterborne</td>
</tr>
<tr>
<td>Ascariasis</td>
<td>Man</td>
<td>−</td>
<td>+</td>
</tr>
<tr>
<td>Brucellosis</td>
<td>Cattle, goats, sheep</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Cholera</td>
<td>Man, marine life</td>
<td>+ 1</td>
<td>+</td>
</tr>
<tr>
<td>E. coli infections</td>
<td>Man, cattle, poultry, sheep</td>
<td>+ 1</td>
<td>+</td>
</tr>
<tr>
<td>Giardiasis</td>
<td>Man, animals</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Hepatitis A, viral</td>
<td>Man</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Listeriosis</td>
<td>Environment</td>
<td>− 1</td>
<td>−</td>
</tr>
<tr>
<td>Salmonellosis (other than typhoid)</td>
<td>Man, animals</td>
<td>+ 1</td>
<td>+</td>
</tr>
<tr>
<td>Shigellosis</td>
<td>Man</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Trematode infections</td>
<td>Freshwater fish and crabs,</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Trichomoniasis</td>
<td>Man</td>
<td>−</td>
<td>−</td>
</tr>
<tr>
<td>Typhoid and paratyphoid</td>
<td>Man</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

+ = Yes; −/− = Rare; − = No; 0 = No information.
1: Transmission from pregnant woman to infant occurs frequently.
2: +/− for foodborne trematode infections due to Fasciola hepatica.
become established in new areas. Epidemics have been occurring repeatedly in several countries, reflecting fundamental deficiencies in environmental, infrastructural and behavioural patterns.

Of all infectious diseases, many can be controlled and even eliminated or eradicated, given existing advances in medical knowledge and public health practices. For example, cost-effective immunization strategies have protected most children in the world against diseases such as polio, measles, tetanus, pertussis and diphtheria. The incidence of many other diseases such as cholera, typhoid, dysentery, giardiasis and worm infections such as ascariasis and trichuriasis can be reduced dramatically by personal hygiene, public health and sanitation practices such as treating and protecting drinking-water from human and other wastes. Proper storage, cleaning and safe preparation of foods can reduce cases of bacterial food poisoning. Correct application of food processing, including fermentation and preservation, can contribute to preventing some of the foodborne diseases (Table 6).

With the application of new scientific knowledge and proper use of antimicrobial drugs, a number of diseases such as tuberculosis, malaria, schistosomiasis and filariasis can be controlled. Vector control methods such as spraying of chemical pesticides, the application of biological control agents, the destruction and treatment of larval development sites and personal protection measures such as applying repellents or sleeping under insecticide-treated bednets can help control malaria, yellow fever, dengue, leishmaniasis and other diseases by interrupting transmission. Effective application of these measures in cost-effective and sustainable programmes can rapidly reduce the current levels of morbidity and mortality from infectious diseases and make substantial contributions to social and economic development.

But the rapid expansion of scientific knowledge and the successful control of infectious diseases in most industrialized countries during the past few decades encouraged the widespread belief that infectious diseases were no
longer a threat. Such complacency led to decreased levels of support and to dangerously inadequate systems of disease surveillance and disease prevention and control.

Simultaneously, infectious microbes have demonstrated their remarkable ability to evolve, adapt and develop resistance to drugs. As a consequence of widespread misuse of antimicrobial drugs, many countries face the emergence of drug-resistant pathogens, resulting in prolonged illness, higher mortality rates and higher health care costs. These affect in particular the elderly living in hospitals and nursing homes, the poor, the homeless, migrants, farm workers and others with inadequate access to health care.

More than half of the total production of antimicrobials worldwide is currently used in farm animals, with a large proportion of antibiotics being administered in subtherapeutic doses, not to treat disease but to promote growth. This practice is contributing to the development of multiresistant strains of bacteria such as salmonellae and E.coli in animal production that get transferred to humans through meat or other food of animal origin or through direct contact. The prevalence and implications of antimicrobial resistance connected with food from animals are, however, inadequately understood.

The magnitude and spread of infectious diseases are further accentuated by changes in human behaviour, changes in ecology and climate, in land use patterns and economic development. Modern travel and international migration also contribute; and above all else, so do inadequate or failing public health infrastructures for monitoring and responding to outbreaks of disease.

Together, these factors have created perhaps the richest opportunities ever for the spread of infections, many of which become global problems that make the first line of defence – early recognition and adequate and timely response – essential.

Fortunately, we also have some of the richest opportunities ever to prevent and control these diseases. Cost-effective interventions exist for diseases
which may be described as "old diseases — old problems".

1. Immunization of children against six vaccine-preventable diseases — diphtheria, pertussis, tetanus, poliomyelitis, measles and tuberculosis — with the addition of hepatitis B and yellow fever vaccine for selected countries (and vitamin A and iodine supplements in regions where deficiencies of these micronutrients are highly prevalent) costs about $14.6 per child or $0.5 per capita in low-income countries.

2. The integrated approach to the management of the sick child to prevent premature death among children with acute respiratory infections, diarrhoea, malaria, malnutrition and/or measles costs about $1,60 per capita in low-income countries. Case management based on oral rehydration therapy is the cornerstone of the public health approach to controlling mortality from cholera.

3. Provision of adequate clean drinking-water and of basic sanitation facilities and collection of household garbage, as well as simple personal hygiene measures like washing hands after defecation and before preparing food can prevent viral diseases such as hepatitis A and gastroenteritis; bacterial diseases including cholera, typhoid, paratyphoid and bacillary dysentery; protozoal diseases such as amoebic dysentery and giardiasis; and worm infections such as dracunculiasis, ascariasis and trichuriasis.

4. School health programmes which treat worm infections and micronutrient deficiencies and provide health education cost about $0.5 per capita in low-income countries; periodic deworming of schoolchildren using single-dose anthelmintics such as albendazole or mebendazole is highly effective, cheap and safe. Oral treatment of infected school-age children is also an effective intervention against schistosomiasis.

5. Case management of conventional sexually transmitted diseases using simple algorithms to decide on the appropriate diagnosis and treatment in peripheral health facilities costs $11 per case in low-income countries.

The second category of diseases — "old diseases — new problems" — includes tuberculosis, malaria, dengue and other insect-borne diseases. For many of them, cost-effective interventions also exist, but the development of antimicrobial drug resistance or of pesticide resistance poses a greater threat to public health. Treating resistant infections often requires the use of additional or more expensive and more toxic alternative drugs and can result in longer hospital stays.

The strategy for controlling these diseases is through available cost-effective interventions such as early diagnosis and prompt treatment, vector control measures and the prevention of epidemics, for malaria; and DOTS — directly observed treatment, short-course — for tuberculosis, by launching research initiatives for treatment regimens and improved diagnostics, drugs and vaccines and above all by strengthening epidemiological surveillance and drug-resistance surveillance mechanisms and procedures with appropriate laboratory support for early detection, confirmation and communication.

The third category of diseases — "new diseases — new problems" — such as Ebola and other viral haemorrhagic fevers, is probably the most frightening. Their natural history is unknown, and our understanding of the factors responsible for, or contributing to their emergence, and how they interact, is incomplete. The need therefore is for expanding research on infectious disease agents, their evolution, the vectors of disease spread and methods of controlling them, and vaccines and drug development. Much of this already applies to HIV/AIDS, one of the most serious diseases to emerge in recent decades.
The priority requirements for this are:
(1) improving infectious disease surveillance systems at national and international levels;
(2) responding rapidly to urgent threats to public health;
(3) developing appropriate prevention strategies to combat new and re-emerging infectious diseases;
(4) integrating laboratory science and epidemiology to optimize public health practice.

The early warning system for infectious diseases relies on public health laboratories with qualified staff; the timely development, availability and appropriate use of diagnostic tests and agents; and enhanced communication of public health information (Box 19) to help speed prevention measures.

Global surveillance for recognition of and response to emerging diseases is being strengthened in WHO, making maximum use of existing WHO collaborating centres located throughout the world. WHO aims to enhance laboratory capabilities for rapid recognition of new outbreaks as they occur. It will complement this effort with a stronger intervention capacity at WHO headquarters to ensure, in conjunction with the regional offices, a range of prompt, coordinated actions. These include organization and mobilization of international response teams; provision of technical and logistic support; mobilization of resources and management of funds; and communication with the press and other media.

WHO has also developed WHONET, a computer program designed to facilitate management of the results of antibiotic susceptibility tests for use by microbiology laboratories (Box 5, page 21). The network will allow ongoing surveillance of antimicrobial resistance at local, regional and global levels.

**Box 19. PHILIS: An electronic system for reporting public health data from remote sites**

Disease surveillance is conducted in the United States by the Centers for Disease Control and Prevention (CDC) in cooperation with state health departments with the aid of databases that catalogue disease information and data. These systems, while useful, have traditionally addressed the needs only of a single disease-specific programme. A broader, more flexible system that could be installed in any site was essential. The Public Health Laboratory Information System (PHILIS) was therefore developed for local, state or national organizations.

PHILIS is a personal computer-based reporting system that can capture most types of public health data from multiple sources (e.g., hospitals, laboratories, state or county offices) and accommodate electronic transmission of these data between sending and receiving sites. Data entry screens (modules) can be created and distributed to all reporting sites electronically, so that data can be input and reported via these modules within hours, without involving computer programmers. PHILIS also provides the capacity for a hierarchical reporting scheme involving reports to multiple, successively higher reporting levels.

The most recent version of PHILIS (version 3.0), is a menu-driven system based on a relational data model sufficient for the needs outlined earlier. The system requires a patient record to be input only once and links multiple specimens for the patient record. It provides a core set of data to be collected on every patient. Field staff (non-programmers) can rapidly add their own data fields to existing disease modules to customize the data entry for special needs at each data reporting site. In addition, PHILIS allows non-programmers to access disease modules, incorporate them into their system and send them electronically to any other reporting site, which can automatically assimilate them into their PHILIS system. During an outbreak, a new module can be rapidly developed and electronically transmitted to all participating reporting sites.

The system, which includes data communication software, is configured so that data flow in a pyramidal reporting structure: that is, upwards through higher-level reporting sites and ultimately to a single central site. Additional information about a case or specimen may be added at any reporting site.

To meet the need for feedback, PHILIS has provided a menu option to transmit files or messages both up and down the reporting chain. This facility is flexible enough to allow any valid user in the chain to transmit files or messages to any other user.

The public health benefits of PHILIS include reducing data entry due to electronic transmission of reports; reducing paper-based record-keeping; and access to timely summaries offered through feedback, ensuring that data are current and responses to enquiries at each reporting site are timely.

PHILIS requires only a personal computer with DOS of 3.1 or higher, a hard disk (at least 10 megabytes free hard disk space are recommended), and 4 megabytes of memory. PHILIS also provides access to EPHINFO and EPIDAT. For further information on PHILIS contact Mr Stan Martyn (404-639-4701) or Dr Nancy Bear (404-639-4703), National Center for Infectious Disease, Centers for Disease Control and Prevention (CDC), 1600 Clifton Road, Mail Stop C07, Atlanta, Georgia 30333, USA, or electronic mail at nbeare@cdc.fed.us.
Box 20. Smallpox: the final chapter

1996 marks the 200th anniversary of an event that led to one of mankind's greatest achievements—the eradication of smallpox. In May 1796, the English physician Edward Jenner (1749-1823) realized that many of his patients who had been exposed to the much milder but related disease, cowpox, were immune to smallpox.

In the first example of immunization, he inoculated an 8-year-old boy with cowpox virus. After observing the reaction, he vaccinated him with smallpox virus—and the boy did not develop the killer disease. Jenner's procedure was soon widely accepted, resulting in sharp falls in smallpox death rates.

However, less than 30 years ago, smallpox was still endemic in 32 countries; 10-15 million people a year were stricken by it, nearly 2 million a year died of it, and millions of survivors were disfigured or blinded for life. Today it affects nobody. The disease has disappeared, and the cost of getting rid of it—approximately $313 million over ten years—has been repaid many times over in savings in human lives and in costs of vaccines, treatment and international surveillance activities.

The smallpox eradication campaign began in 1967 with the systematic vaccination of entire populations in endemic countries—an enormous and complex exercise. The strategy soon became “surveillance and containment”. Every time a new case was discovered, it was followed up and contacts of the patient traced. Where such cases occurred, local immunization was intensified.

The incidence of the disease fell rapidly. By 1972, cases were occurring in only eight of the endemic countries in Africa and southern Asia.

Huge technical and logistic difficulties had to be overcome in many countries, often aggravated by civil wars, political and social upheavals, and refugee movements. Eventually the last naturally acquired case of smallpox was reported in Somalia in 1977; in 1980, WHO's World Health Assembly declared the global eradication of the disease.

The final chapter of the smallpox story remains to be written, however. For the smallpox virus has not been completely destroyed. Stocks are still held at government research centres in the Russian Federation and the United States. A resolution from WHO’s Executive Board to the World Health Assembly in May 1996 recommended that these stocks be destroyed in 1999.

Table 7. Diseases targeted for eradication or elimination

<table>
<thead>
<tr>
<th>Disease</th>
<th>Estimated prevalence (000) 1995</th>
<th>Target for 2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smallpox</td>
<td></td>
<td>Eradication</td>
</tr>
<tr>
<td>Poliomyelitis</td>
<td>82</td>
<td>Eradication</td>
</tr>
<tr>
<td>Leprosy</td>
<td>1,832</td>
<td>Elimination</td>
</tr>
<tr>
<td>Neonatal tetanus</td>
<td>10,000 a</td>
<td>Elimination</td>
</tr>
<tr>
<td>Chagas disease</td>
<td>18,000</td>
<td>Elimination</td>
</tr>
<tr>
<td>Iodine deficiency disorders</td>
<td>655,000 b</td>
<td>Elimination</td>
</tr>
</tbody>
</table>

a 1995 reported value.
b 1990 estimate for goiters.

Priorities for action

In confronting infectious diseases as a whole, the first priority relates to the completion of unfinished business—i.e. to drive on towards the eradication or elimination of diseases such as poliomyelitis, guinea-worm infection, leprosy, neonatal tetanus and Chagas disease (Table 7). Relatively small financial resources are needed for this stage if they cannot be found, eradication or elimination will not be achieved; these diseases will exploit any easing of the campaign against them, and return with a vengeance. The eradication of smallpox (Box 20) shows the way forward. The lessons of malaria and tuberculosis must not be ignored, or the efforts and resources already invested will have been wasted. This must not be allowed to happen.

The second priority relates to tackling old diseases such as tuberculosis and malaria which present new problems of drug resistance. Cost-effective interventions to prevent the spread of the disease in the community by removing the infectious source and to make a major impact on the prevalence of the disease by curing a high proportion of infectious cases exist; the concern is over the emergence of drug resistance. An appropriate epidemiological surveillance and control activity for these diseases should be established and research for the development of better treatment regimens and improved diagnostics, drugs and vaccines should be promoted and supported.

To ensure the protection of children against an ever-widening range of diseases, research into and the development of new and improved vaccines against measles, neonatal tetanus, bacterial meningitis, tuberculosis and other diseases must be supported (Box 21).

At the same time there is an urgent need to strengthen the capability for surveillance and control of infectious diseases in several of the countries that have been experiencing repeated out-
breaks of epidemics during the past few years. Such improvements should include the integration of clinical, epidemiological and laboratory components and epidemiological expertise and laboratory resources in national centres which can then join with others in a comprehensive network forming part of an effective global surveillance and response system.

The third priority relates to the category of newly emerging diseases, where there is little knowledge of their natural history or incomplete understanding of the factors responsible for them. They require rapid action on one hand, and a more calculated, longer-term approach on the other. Responding speedily to outbreaks of important new infections, wherever they occur, is of direct benefit not merely to the individual affected but to the global community. At the same time, there is a need for intensive research on new diseases and on the potential for preventing, treating, and controlling them. Such research must be conducted with a global surveillance programme to recognize and respond to emerging diseases. WHO has begun to strengthen its capacity to respond rapidly and more efficiently to calls for help in such emergencies, and aims to have a team of experts at the location of an outbreak anywhere in the world within 24 hours of being officially notified of it. Extra resources are being sought to fund these operations.

The World Health Report 1995 indicated how poverty could be alleviated by enabling the poor to earn their way out of poverty and by enhancing their health potential through measures for prevention of diseases, promotion of positive health, and for protection from health hazards, thereby improving their social and economic productivity. This report has outlined opportunities that exist now for improving the health of the present generation while laying the foundation for better health for future generations.

**Box 21. New and improved vaccines for tomorrow’s children**

Every year, hundreds of millions of people, most of them infants, are protected by vaccines against deadly diseases of childhood and adulthood. As a result poliomyelitis, measles and neonatal tetanus are likely to be eliminated within the next few years. The constant quest for new and improved vaccines offers the prospect of protecting the children and adults of tomorrow against an ever-widening range of diseases.

WHO is actively supporting the research into and development of both improved vaccines and completely new ones for diseases which so far have not been preventable by immunization. This latter category includes acute respiratory viral diseases, diarrhoeal diseases, bacterial meningitis and tuberculosis, which together kill many millions of people, most of them children under 5, every year.

Brief progress reports on some of the new or improved vaccines are given below.

**Measles.** Three candidate vaccines intended for infants under 6 months of age should be studied in primates in 1996, and the target for 1998–2000 is to have at least one of them evaluated in human studies.

**Neonatal tetanus.** The goal is to develop vaccines simpler to deliver than existing ones, with particular emphasis on reducing the number of doses needed to induce long-lasting protection. Goals include having at least one such vaccine ready for clinical trials in 1996–1997, and introducing a single-dose tetanus vaccine into human use by 1998–2000.

**Dengue and Japanese encephalitis.** The aim is to accelerate the final development of attenuated dengue vaccine and genetically engineered dengue and Japanese encephalitis vaccines. Targets for 1998–2000 are to have one dengue vaccine evaluated for effectiveness and plans made to introduce it into immunization programmes in at least one country; and to have evaluated one new Japanese encephalitis vaccine in clinical trials.

**Diarrhoeal diseases.** Priority is being given to the development of vaccines against shigellosis and rotavirus diarrhoea. Research groups are working towards vaccines that are effective against both the recently isolated cholera strain 0139 and the more common 01 strain. Studies related to the potential use of cholera vaccines in refugee camps are being conducted. Vaccines against *E.coli* diarrhoea and typhoid are being developed. Shigellosis vaccines should be available by 1998–2000, and evaluations of typhoid, *E.coli* and cholera vaccines should be completed within the same period.

**Bacterial meningitis.** The intention is to test two new vaccines against the disease in infants in at least two developing countries by 1997.

**Tuberculosis.** Although the existing BCG vaccine prevents severe tuberculosis in children, it has a rather poor impact on the disease in adolescents and adults. Research is ongoing to develop a new and more efficient tuberculosis vaccine. At least one such candidate vaccine should have been evaluated in clinical studies by 1998–2000.