1 Why research infectious diseases of poverty?
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• Infectious disease – the true burden on communities
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Research is the key to making things happen for poor populations. This introductory chapter of the Global Report examines the need for research into the infectious diseases that disproportionately affect poor and marginalized communities – the so-called “infectious diseases of poverty”. It examines the link between poverty and disease and outlines ten reasons to support research for such diseases. Such research represents unfinished business of global relevance, work that the world can no longer afford to neglect.

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According to the latest published data in 2012, infectious (including parasitic) diseases were together responsible for the death of more than 8.7 million people worldwide in 2008 (1). The majority of these deaths were of poor people living in low and middle-income countries, with many of the deaths occurring in children under five years of age. Given the sketchy data, misdiagnosis and under-detection that are typical of health systems in impoverished areas, these numbers are almost certainly underestimated.

Infectious diseases have shaped societies, driven conflict and spawned the marginalization of infected individuals and communities throughout history. Today they are significant agents in the appalling poverty afflicting so much of the world. Their impact is felt not only in massive loss of life but also in high-levels of morbidity and the accompanying impact on families, communities and weak and under-resourced health systems in low and middle-income countries. Stepping up research into the causes of infectious diseases and how to treat them effectively and prevent them from spreading would, if acted on, have an enormous impact on efforts to lift people out of poverty and would help build a better world for future generations.

Poverty and infectious disease – a problematic relationship

According to The World Bank, the global rate of extreme poverty (less than US$ 1.25 a day) has been falling over the past two decades and will likely meet the Millennium Development Goal (MDG) for 2015 (2–5). Much of this improvement reflects rapid economic growth in China and India, yet many African countries with a high burden of infectious diseases are lagging behind. For example, almost 50% of African countries are far from halving extreme poverty.

However, from a global health perspective, often there are criteria broader than income with which to determine who is actually “living in poverty”. Social and economic conditions underpin poverty and can directly and indirectly affect health status and health outcomes. Major epidemics emerge and chronic conditions cluster and persist wherever poverty is widespread. Lack of food, shelter, security and social protection make people more vulnerable to infections, while affected populations are often unable to obtain even the most basic means of prevention and care. Poverty creates conditions that favour the spread of infectious diseases and prevents affected populations from obtaining adequate access to prevention and care. Ultimately, these diseases – infectious diseases of poverty (see Box 1.1) – disproportionately affect people living in poor or marginalized communities. Social, economic and biological factors interact to drive a vicious cycle of poverty and disease from which, for many people, there is "no escape". As stated in the report of the Commission on Social Determinants of Health (6): "Poverty is not only lack of income. The implication, both of the social gradient in health and the poor health of the poorest of the poor, is that health inequity is caused by the unequal distribution of income, goods, and services and of the consequent chance of leading a flourishing life. This … is not in any sense a ‘natural’ phenomenon.”
**Infectious diseases**

Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi. The diseases can be spread, directly or indirectly, from one person to another.

"Infectious diseases of poverty" is an umbrella term used to describe a number of diseases which are known to be more prevalent among poorer populations, rather than a definitive group of diseases. It is an overarching concept, recognizing the need to focus on the poor and vulnerable, who have less power to intervene. Many such diseases are also considered “neglected tropical diseases”, as defined by WHO (see list below). Infectious diseases of poverty are not restricted to low and middle-income countries, but manifest in poor populations globally. Apart from TB, malaria and HIV/AIDS, many other infectious diseases have not been high on the global agenda. However, an increasing number of organizations and partnerships are now engaged in their control.

Main neglected tropical diseases (6) as identified by WHO are listed below:

- dengue
- rabies
- trachoma
- Buruli ulcer
- endemic treponematoses (including yaws)
- leprosy
- chagas disease (American trypanosomiasis)
- human African trypanosomiasis (sleeping sickness)
- leishmaniasis
- cysticercosis
- dracunculiasis (Guinea-worm disease)
- echinococcosis
- foodborne trematode infections
- lymphatic filariasis (elephantiasis)
- onchocerciasis (river blindness)
- schistosomiasis (bilharziasis)
- soil-transmitted helminthiases (intestinal parasitic worms)

Infectious diseases do not respect socio-economic status. Biologically, we are all at risk – but the risk is not evenly distributed. People already living in social and economic deprivation have a greater exposure to the risk factors for disease, and the economic consequences of living with chronic infectious conditions are often more serious. Investment in controlling the spread of infectious and parasitic diseases will have a powerful impact on global human, social and economic development.

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**Infectious disease – the true burden on communities**

For the working poor, the economic impact of infectious diseases can be catastrophic. Not only are infectious diseases causally linked to conditions of poverty; they can actually make people poor. For example, a study in Orissa, India showed that people with chronic lymphatic filariasis lost 68 working days per year and that their families spent more on treatment than the average government per capita expenditure on health (21). Thus, families that experience such a disease not only have death to fear but also the cost of illness in terms of treatment and lost working days. This easily perpetuates the vicious cycle of poverty and infection.

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### TABLE 1.1. RELATIONSHIP BETWEEN INFECTIOUS DISEASES AND POVERTY

<table>
<thead>
<tr>
<th>Infectious diseases</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>...are a proxy for poverty and disadvantage (7)</td>
<td>Risk factors are shaped by the conditions in which people live and work, particularly poverty, conflict, gender and education levels (8, 9). Infectious diseases contribute to lifelong disadvantage in already disadvantaged groups. For example, the often-devastating effects on learning ability of worm infections and schistosomiasis acquired at an early age have lifelong detrimental consequences (20, 21).</td>
</tr>
<tr>
<td>...affect populations with low visibility and little political voice (7)</td>
<td>Infectious diseases are prevalent among populations living in conflict and war zones, internally displaced populations, refugees and those affected by the consequences of natural disasters.</td>
</tr>
<tr>
<td>...cause stigma and discrimination (7)</td>
<td>People suffering from infectious diseases (such as Buruli ulcer) often experience stigma and ostracization from society. Reasons for this can include fear of the disease or the belief that it is self-inflicted. This stigmatization can have broad economic consequences for an affected individual, particularly if that person is unable to get work as a result.</td>
</tr>
<tr>
<td>...impose a heavy health and economic burden</td>
<td>Infectious diseases place a substantial health and economic burden on poor populations in Africa, Asia and Latin America (12, 13). For example, malaria is the leading cause of mortality in children under five years of age in Africa, constituting one tenth of the continent’s overall disease burden. In areas with high malaria transmission it accounts for 40% of public health expenditure, 30–50% of inpatient admissions and up to 50% of outpatient visits (14). Diarrhoeal diseases, respiratory infections and malaria are all closely associated with childhood mortality (11, 15, 16, 17). Each year, rotavirus, a common cause of childhood diarrhoea, kills over half a million children under the age of five. Most of these deaths occur in the world’s poorest countries (15).</td>
</tr>
<tr>
<td>...are low on many research funders’ agendas</td>
<td>While there is an urgent need for innovative new tools and technologies to combat infectious diseases, the perceived absence of a market means that limited funding has been available to develop them. Of 1393 new chemical entities introduced between 1975 and 1999, only 16 targeted “tropical diseases” or tuberculosis (28). An updated study in 2010 found that while there had been progress for some diseases (such as malaria), not a single new product had been approved in the previous nine years in disease categories that include Buruli ulcer, dengue, trachoma, rheumatic fever and typhoid and paratyphoid fevers (19).</td>
</tr>
<tr>
<td>...have greater impact where health systems are weak</td>
<td>Health systems in many disease endemic countries are noticeably weak. Patients either cannot afford or do not have access to adequate drugs, while human and other resources are overburdened by the volume of needs.</td>
</tr>
<tr>
<td>...burden caregivers and families</td>
<td>Lost labour time due to illness often means a reduction in household capacity to earn income, particularly at a time when the household needs additional money to pay for treatment (20). As a result, money to pay for treatments is often diverted from other expenses, such as school fees.</td>
</tr>
</tbody>
</table>

Source: adapted from reference (7), with selected examples summarized from the multiple references cited above.
The consequences of infectious diseases are not limited to the families whose members become infected. They also have a broader societal and economic impact, much of which could be averted by effective interventions. For example, in 2001, the Commission on Macroeconomics and Health (22) predicted that reducing the number of deaths from infectious diseases and maternal conditions by 8 million per year by 2015 could result in an estimated reduction of 330 million disability-adjusted life-years (DALYs)\(^3\). Conservative estimates of the economic impact of this reduction suggest that it would yield a monetary gain of between US$ 186 billion and US$ 500 billion to the global economy (23).

**The value of research: new ways to end old diseases**

Poverty begets poverty. Problems such as misdiagnosis, polyparasitism, fragile health services to which populations have limited access, poor transport, lack of drug availability, treatment delays, treatment costs and the social and economic consequences of inadequate management of illness all interact against a backdrop of ecological stress, migration and civil unrest.

Research has played a huge role in efforts to understand, control and prevent the spread of infectious diseases. For some diseases, such as smallpox and dracunculiasis, research has led to eradication. For others, we now have a much better understanding of pathogenesis, treatment and control.

In Box 1.2 below we outline a fictional case study, based on real issues, that illustrates the problems of the poor and highlights the essential role that research plays in helping to tackle the interrelationship between infectious diseases and poverty.

Research findings, put into practice, can do much to prevent situations like Christophe’s from arising. Research can help to improve diagnosis, enable the development of new drugs and treatment regimes, monitor progress, identify how best to deliver interventions and thus lead to the strengthening of weak health systems. The whole spectrum of research – from laboratory bench to field-based, from basic science to social science – with multiple disciplines working together is needed. Some progress has already been made in disease control but there is still much more to do. New technologies, innovative ways of working and a better understanding of pathogenesis, diagnostics, clinical management, transmission prevention and vector control will all improve our future ability to respond to the challenges posed by infectious disease.

**Poverty, infectious disease and policy: moving beyond the Millennium Development Goals**

The MDGs are eight time-bound targets (see Box 1.3) set “to free our fellow men, women and children from the abject and dehumanizing conditions of extreme poverty” (23). If all of the MDG targets are reached by 2015, world poverty will have been halved, tens of millions of lives will have been saved and billions more people will have been able to participate in, and benefit from, the global economy (24).

While progress toward fulfilment of a number of the MDGs has been reported, the latest reports from the United Nations show that considerable challenges remain, particularly in areas related to health. Infectious diseases – clustering in impoverished communities and ignored, undertreated and under-researched – remain a substantial hurdle to MDG attainment.

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2 The true burden of malaria is currently under discussion.

3 Disability-adjusted life-year (DALY) – a measure of disease burden which provides an indication of time lost due to early mortality or morbidity. Calculations of cost per DALY calculate the cost of the intervention in relation to the years of the given symptom or health condition which have been prevented.
Box 1.2. Christophe’s Story: The Need for Research on Infectious Diseases of Poverty

A fictionalized compilation of real issues faced by millions of people

Bolebole is a region rich in alluvial diamonds, attracting migrant workers from surrounding areas. It has few functioning government services, there is chronic civil unrest and the region has a poor transport infrastructure. This situation is compounded by extensive environmental degradation – in particular, deforestation as a result of mineral exploitation. The traditional communities that previously used to live in the area have been displaced by the mining activities and the threat of violence from itinerant rebels, while traditional ways of livelihood – such as hunting for bush meat and small scale farming in the forest – have died out.

The mining community is a largely male, transitory community dependent on imported services of private traders and providers. Christophe, in his thirties, has been working as a miner for several years. Living in the mining camps, he is separated from his family who live far away in one of the largest towns in the region (where he was unable to find work). The mining work is hard and hazardous but the pay allows him to support his wife, elderly mother and young daughter.

Recently, Christophe began to develop recurrent fevers. Believing that they were caused by malaria, Christophe bought antimalarial products from the local “shop” that services the miners. However, despite taking the medicine (which may have been past its sell-by-date or even counterfeit), his fevers continued. Eventually, Christophe’s fevers drove him to seek help at the health clinic in the nearest small town, some 30 km away. He spent most of his money sharing a trip on a motorcycle, but when he reached the clinic it was closed.

The following day, staff at the clinic gave him paracetamol for his fever, which he paid for with his remaining money. However, his fevers persisted, he became increasingly weak and soon he was no longer able to work. Eventually he had no option but to go back to his family home. There, his wife borrowed money to send him to a private doctor, who thought that although Christophe was most likely to have contracted malaria, further investigations were needed as Christophe’s working environment put him at risk of contracting a range of other infections, including HIV. The doctor also noticed that Christophe had some neurological symptoms and swollen lymph glands. Because the hospital had a working laboratory, Christophe was given a lumbar puncture and the sample fluid confirmed that Christophe had late stage sleeping sickness (trypanosomiasis), requiring expensive drugs and hospitalization. Other tests (blood films and stool analysis) performed at the same time revealed that Christophe also had tropical eye worm, hookworm and ascariasis.

Christophe’s wife attempted to raise the money that would be necessary to pay for his treatment by selling some of the family’s precious assets – a radio and a bicycle. She was also obliged to stop paying their daughter’s school fees. Raising the money for treatment took the family three weeks, during which time Christophe’s condition deteriorated further. During that time his wife, who was his sole caregiver and was also providing care for his mother and daughter, became progressively isolated, tired and depressed. Their daughter was unable to go to school and further her education, money became increasingly tight, and Christophe began to feel that he was a burden to his family...

Source: courtesy of David Molyneux
Consider MDG4 – reduce childhood mortality – as an example. According to 2010 figures, approximately 7.6 million children die each year before reaching the age of five (25). Infectious diseases such as pneumonia, diarrhoea and malaria are among the leading causes of those early deaths (25). Malnutrition is a factor in more than one third of all child deaths and the links between lack of nutrition and infectious diseases are already well established.

Infectious diseases also prevent attainment of MDG5 – improve maternal health. Malaria, schistosomiasis and hookworm all cause anaemia, which is responsible for 20% of maternal deaths in Africa and is a key risk factor for poor pregnancy outcomes and low fetal birth weight (26). Moreover, though not conclusive (more research is needed), there is some evidence that other diseases such as dengue and Trypanosoma cruzi infections may also adversely impact maternal and fetal outcomes (27–29).

After a longer period of neglect, the impact of infectious diseases on attainment of MDGs is only just beginning to be truly appreciated. Their low visibility in the “other” infectious diseases category within MDG6 has no doubt delayed progress towards achieving MDGs. Fortunately, there is now explicit recognition of neglected tropical diseases within the United Nations’ “Keeping the promise” resolution (30), signalling greater emphasis on infectious diseases in general and wider recognition of the need to address these diseases across all of the MDGs. We trust this recognition results in an enhanced commitment to using research to address the significant knowledge gaps that impede progress in reducing the incidence, prevalence and impact of infectious diseases on poor and vulnerable populations. Such commitment is critical to delivering on the MDG promise and sustaining achievements beyond 2015.

In recent years there has been an increased focus on the “epidemiological transition” – the shift from infectious diseases to non-communicable diseases (NCDs) as the major

**BOX 1.3. THE MILLENNIUM DEVELOPMENT GOALS (MDGs)**

There are 8 MDGs:

1. **Eradicate extreme poverty and hunger**
2. **Achieve universal primary education**
3. **Promote gender equality and empower women**
4. **Reduce child mortality**
5. **Improve maternal health**
6. **Combat HIV/AIDS, malaria and other diseases**
7. **Ensure environmental sustainability**
8. **Develop a global partnership for development**

These eight MDGs break down into 21 quantifiable targets that are measured by 60 indicators.

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causes of morbidity and mortality in low and middle-income countries. It is now recognized that, by 2020, NCDs will be responsible for 60% of illnesses worldwide and seven out of every ten deaths (31). In impoverished communities, NCDs are becoming a development challenge of epidemic proportions (32). In many cases, infectious and parasitic diseases often contribute to the chronic NCD burden (33). For example: 28% of bladder cancer in Bulawayo, Zimbabwe was accounted for by urinary schistosomiasis (34); Chagas disease is a leading cause of chronic cardiovascular disease in Latin America (35); and toxocariasis is emerging as a leading cause of asthma (36). NCDs add to the burden of disease for individuals, communities and countries that are already struggling to cope with the infectious disease. Therefore, understanding the links between NCDs and infectious diseases through research is crucial, if progress is to be made in improving global health.

The emergence of infections such as severe acute respiratory syndrome (SARS) and H1N1 influenza have vividly demonstrated global vulnerability to infectious diseases and the need for robust health care systems to respond to such threats. In 2002/2003, SARS spread to 28 countries, affected around 8500 people worldwide, and claimed 800 lives (39). The numbers themselves were relatively small compared with the 1.8 million people, most of them children, who die of diarrhoeal diseases each year (40). However, the economic impact of SARS on the global economy was enormous – an estimated US$ 50–140 billion (41, 42) – and thus its impact went well beyond those who were actually infected with the virus.

In 2009, the H1N1 influenza pandemic in Mexico also had a profound economic impact. The outbreak directly affected tourism, the service sector, retail trade, transport, entertainment, the agricultural industry (particularly pig farmers) and depressed international investment. The outbreak is estimated to have reduced economic activity by 0.3% to 0.5% of gross domestic product (i.e. between US$ 2.7 and US$ 4.5 billion) (43).

It is therefore clear that, as well as saving and improving lives in disease endemic countries, tackling infectious diseases is also essential for sustaining the global economy.

The cost of inaction – social and economic consequences

WHO data show that 1 billion people worldwide are directly affected by one or more infectious diseases (6). Such diseases are often wrongly characterized as a developing world problem – but in fact their contribution to the global disease burden has the potential to affect us all. Take tuberculosis (TB) as an example. TB is known to cause more than 10% of paediatric hospital admissions and deaths, particularly in countries where the HIV burden is high (37). In 2009, 9.4 million new cases of TB were reported and 1.7 million people died of the disease, with the highest number of deaths occurring in Africa. Meanwhile the number of cases of multidrug-resistant TB (MDR-TB) is rising steadily: 440 000 cases of MDR-TB and 150 000 deaths were reported in 2008 (38). Given the increased ease of travel due to globalization and the development of modern technology, there is increasing concern that TB and, more ominously, MDR-TB could spread into new areas and ultimately lead to a global epidemic of these diseases.
Tackling disease – a need for investment

There is a sound economic case for investment in research to tackle infectious diseases. Studies have shown that scaling up of previously developed, evidence-based interventions can be highly cost effective, resulting in both direct savings (such as reduced medical costs) and indirect savings (through increased productivity and reduced losses in work time). Examples are shown below.

- Ivermectin and albendazole4 cost US$ 0.05–0.10 per person as part of mass drug administration for lymphatic filariasis, with a cost per DALY averted of US$ 5.90 (7).
- Oral rehydration salts (ORS) for diarrhoeal diseases cost approximately US$ 5.50 per child per episode, with a cost effectiveness ratio of US$ 1062 per DALY (44).
- Immunization against rotavirus and cholera deliver a cost effectiveness ratio5 of US$ 2712 per DALY (44).

These examples show that the return on investment can be considerable. An analysis of more than 100 countries showed that a 1% increase in adult survival rates increases labour productivity by about 2.8%, thus strengthening economic growth (45). When the human costs of diseases are factored in, the return on investment is increased substantially.

A key strength of research is that it can provide evidence on how effectively interventions work and thus can support investment decisions and scale-up. Sometimes research can show that an intervention is unlikely to result in an effective outcome, or that the cost of intervention is not matched by the potential benefit.

At other times research can show where investments could be of most use. As well as providing evidence for what will work, research also provides a robust foundation for terminating studies and interventions, or for changing strategies. Precious resources can then be released for redistribution towards other, better and more cost-effective interventions.

Ten reasons to research infectious diseases of poverty

Research underpins and drives progress in controlling infections and improving health on a global scale. However, for many infectious diseases of poverty, progress has been too slow. For many diseases there is a paucity of effective and affordable treatments. In other cases, although effective interventions exist, often they are not readily available or accessible in communities where the need is greatest. Research has a key role to play in both scenarios – developing new products and interventions where required, and supporting health systems to implement existing interventions effectively. Research is critical to the development of a functional, innovative and sustainable health and disease control system. In Box 1.4 we outline ten compelling reasons why research is vital to break the hold of infectious diseases on populations living in poverty.

On the next page, we expand on the contexts and ideas underpinning each of these ten vital activities.

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4 Donated by Merck & Co. Inc. and GlaxoSmithKline.
5 Cost effectiveness ratio is a term used by health economists to describe the results of a calculation which is undertaken to investigate whether an intervention will provide value for money. At its simplest, a cost effectiveness ratio divides the costs of the intervention by the health effects. For further information see http://www.medicine.ox.ac.uk/bandolier/painres/download/whats/Cost-effect.pdf.
BOX 1.4. TEN COMPELLING REASONS FOR RESEARCH

To meet the global health challenges of eliminating infectious diseases of poverty, it is vital that we find ways to do the following:

1. **Break the vicious cycle of poverty and infectious disease.** The interrelationships between health, infectious diseases and poverty are dynamic and complex. Timely, targeted research will prevent infectious diseases from driving more people into poverty.

2. **Forge an escape for the poor and vulnerable.** Poor people living in the areas most affected by environmental factors are least able to respond to the challenges of environmental and climate change. Interactive, interdisciplinary research can identify ways to mitigate risk factors, establish the potential impact of interventions on the environment and direct future interventions to minimize risk.

3. **Tackle multiple problems.** Research will help understand both causes and consequences of poly parasitism, coinfection and comorbidities with non-communicable diseases on people, societies and systems. An integrated understanding of the complex relationships underpins effective integrated health system delivery and effective disease control programmes.

4. **Commute the life sentence.** Many people must live with the long-term debilitating effects of past or current infection. Research can find ways to mitigate the consequences of chronic and persistent lifelong infection and its secondary complications and associated stigma.

5. **Be prepared – forewarned is forearmed.** Surveillance is essential at all levels to understand patterns of emergence, including the spread of drug and insecticide resistance. Mapping, monitoring and evaluation of these trends are critical. Access to such surveillance data allows us to anticipate and respond to emergent, re-emergent and drug-resistant diseases.
6. **Reach the hardest to reach.** By identifying ways to strengthen health infrastructure and better deliver services in impoverished areas, we can reach disenfranchised populations who continue to struggle with the burden of poverty and disease. Health systems research can create positive synergies between disease control and wider health systems in poor regions.

7. **Prevent loss in translation.** Progress along the route from basic research to clinical and public health practice is slow and patchy. Integrated multidisciplinary research programmes should aim to anticipate and avoid potholes along the route to the introduction of more effective interventions.

8. **Identify small changes that can make a big difference.** Relatively low levels of investment in evidence-based interventions can have a big impact. Small modifications in where and how we deliver treatments and care can achieve dramatic improvements. Effective research that demonstrates positive effects from small modifications should be rapidly scaled up in poor communities.

9. **Stay focused on the light at the end of the tunnel.** Much has been achieved to date and even the most difficult situations are not irreversible. Significant progress will continue to be made if investment in coordinated research programmes is expanded and sustained.

10. **Act quickly on what we know.** Policy-makers and global funders need to have access to the right information at the right time to inform decisions that draw on the evidence of what works, and feed “best buys” into health policy, health budgets and the operations of health systems. Research data must therefore be rapidly translated into effective tools for policy-makers.
1. BREAK THE VICTIOUS CYCLE OF POVERTY AND INFECTIOUS DISEASE

The interrelationships between health, infectious diseases and poverty are dynamic and complex. Timely, targeted research will prevent these diseases from driving more people into poverty.

The vicious cycle formed by disease and poverty represents a fundamental public health problem, as poverty both increases vulnerability and exposure to disease and directly affects access to treatment and disease outcomes (46).

There is clear evidence that investments in controlling infectious and parasitic diseases can be highly effective in reducing the poverty of the poorest quintile of the population (47) – the so-called “bottom billion” (11). Medical and technical interventions to treat infectious diseases have made a significant difference in people’s lives. However, many of the determinants of health lie outside the control of the health sector. Social, economic, political and environmental factors all influence risk, exposure and the effects of infectious disease (46). For example, the poorest populations have the least access to safe drinking water, decent sanitation and effective waste disposal. Accordingly, their exposures to associated infectious disease-causing agents are the highest.

The environments in which poor people live are themselves often conducive to the emergence and spread of infectious diseases. Impoverished communities around the world typically live in close proximity to livestock and other animals. Zoonotic diseases (which can be passed between, or shared by, animals and humans) thrive in conditions of poverty. Yet while animals are a crucial link in the chain of infectious disease transmission, with around three quarters of the 1300 known infectious diseases of humans derived from animal sources (48), for many people they are also a critical resource for daily existence.

In many disease endemic countries, the internal political and economic situation is fragile and corruption is rife. External events, such as the global financial downturn, can compound an already difficult situation, affecting and disrupting the continuum of health interventions that may be available (see Chapter 3). Conflict, ecological and environmental challenges add further complexity, complicating longer-term planning (see Chapter 2).

Research can provide solutions to otherwise intractable problems by identifying risk factors for diseases and understanding of the complex interactions between them (see Table 1.2).

A full spectrum of research – looking across the biomedical to the social, cultural, political and environmental spheres – is needed to address the complex challenges of infectious diseases. Moreover, there is a need for researchers to interact and carry out multidisciplinary research so that, while new tools and strategies are developed, ways to deliver these to those in need are also created and improved.
### TABLE 1.2. BREAKING THE LINK BETWEEN INFECTIOUS DISEASE AND POVERTY: SOME EXAMPLES OF THE ROLE OF RESEARCH

<table>
<thead>
<tr>
<th>ISSUE</th>
<th>HOW RESEARCH CAN HELP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infectious diseases are a proxy for poverty and disadvantage</strong></td>
<td>Epidemiological research and analysis of surveillance data provides an insight into the risk factors for disease, enabling the development of targeted interventions and thus more effective use of resources (Chapters 2, 3).</td>
</tr>
<tr>
<td><strong>Infectious diseases affect populations with low visibility and little political voice</strong></td>
<td>Health services research can help to ensure that opportunities to “reach the hardest to reach” are maximized, drawing on the best available data and use of innovative technologies (Chapters 2, 3, 4).</td>
</tr>
<tr>
<td><strong>Infectious diseases cause stigma and discrimination</strong></td>
<td>Social science research can identify practical solutions that address stigmatization and marginalization of already disadvantaged communities, and find interventions which diminish stigma and promote reintegration into the community (Chapters 2, 3).</td>
</tr>
<tr>
<td><strong>Infectious diseases impose a heavy health and economic burden</strong></td>
<td>Bench research and research and development activity can identify, develop and test solutions to previously intractable problems (Chapter 4). Multidisciplinary research that considers the long-term effects of chronic conditions and the social, economic and cultural environment can offer a lifeline to help people and health services manage conditions more effectively (Chapters 2, 3).</td>
</tr>
<tr>
<td><strong>Infectious diseases are low on research funders’ agendas</strong></td>
<td>Research studies can provide an insight into the research priorities of funding agencies, enabling the identification of funding gaps (Chapter 5).</td>
</tr>
<tr>
<td><strong>Infectious diseases have greater impact where health systems are weak</strong></td>
<td>Health systems research, specifically implementation research and research in the social sciences, can identify positive synergies and innovative mechanisms for improving the links between disease control systems and the wider health system (Chapter 3, 4).</td>
</tr>
<tr>
<td><strong>Infectious diseases place a burden on caregivers and families</strong></td>
<td>Social science research, health services research and multidisciplinary research can play a fundamental role in the empowerment of disadvantaged communities, families and individuals (Chapters 2, 3, 4).</td>
</tr>
</tbody>
</table>
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2. FORGE AN ESCAPE FOR THE POOR AND VULNERABLE

Poor people living in the areas most affected by environmental factors are least able to respond to the challenges of environmental and climate change. Interactive, interdisciplinary research can identify ways to mitigate risk factors, establish the potential impact of an intervention and thus direct future interventions.

The environment is constantly changing. Already there have been dramatic changes in our climate, in our use of the physical environment and in the global ecology. Recently, the rate and pace of change has accelerated, magnifying both positive and negative effects of change and amplifying potential threats to human health.

Interrelationships between the environment, industrial and agricultural activities and the risks of infectious diseases are increasingly recognized. Air and water pollution, deforestation, habitat fragmentation, ecological disruption and changing agricultural practices can all have an impact on the incidence, prevalence and spread of infectious diseases. Environmental changes work in concert to increase the overall risk of infectious diseases and, through changes to the physical environment and the impact on animal reservoirs and vector control, further jeopardize the health of poorer populations (49).

Factors that heighten the risk of infectious disease transmission include close contact between humans, animals and insects/pathogens (48); human behaviour (50); weak institutions (51); low community cohesion (50); population growth and urban density (52); politically marginalized settlers (50); migration (53); environmental challenges such as earthquakes and climate change (52), and changing agricultural and land use practices (52). The interaction between these factors is complex. Using focused enquiry techniques, research can explore the dynamics of diseases and increase our understanding of factors that affect the spatial range and incidence of infectious diseases, such as links between the frequency and intensity of contact between humans and animal species. The environment and the associated implications of climate change need to be considered within policy development. Consider the example of the Three Gorges Dam in China (see Box 1.5).

This example vividly demonstrates the contribution that rigorous data modelling can make to large development projects. Risk assessment showed that constructing the dam would disrupt the ecology. Research helped to establish the level of risk associated with the environmental changes. By identifying and determining the social, ecological and health impacts, data modelling can provide a robust evidence base to establish the level of risk associated with a project, support the development of effective targeted risk management strategies and guide future interventions.

Identifying and managing risks such as those illustrated by the Three Gorges Dam project can be particularly important for poorer populations as they are less likely to be able to leave or otherwise alter their living conditions.

As Chapter 2 will describe, climate change may also have disease control consequences, as environmental changes can affect the

Air and water pollution, deforestation, habitat fragmentation, ecological disruption and changing agricultural practices can all have an impact on the incidence, prevalence and spread of infectious diseases.
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Box 1.5. Public Health and the Three Gorges Dam in China

Built between 1994 and 2009, the Three Gorges Dam in China is the world's largest dam. Benefits cited for the dam include its hydroelectric generating capacity, flood protection on the historically dangerous Yangtze River and improved river navigation.

A review of the potential consequences of the Three Gorges Dam in 2008 highlighted risks of the spread of schistosomiasis to previously non-endemic areas, due to changed ecological conditions and delayed water transit time affecting the habitat of the intermediate host, Oncomelania snails.

A series of studies with rigorous data modelling were undertaken to better understand the factors affecting spatial distribution and seasonal habitat for onchocerciasis-transmitting snails, to identify active transmission sites and to forecast risk. In response to the research, ongoing surveillance using remote sensing data has been instigated to establish geographical distribution maps, analyse the influence of floods, assess the effects of returning wetlands to the reservoir and evaluate and monitor marshland changes due to the Three Gorges project.

Major conclusions to date include the need to deploy monitoring and intervention systems to provide successful prophylaxis of dam-associated schistosomiasis emergence. Further ecological simulations of the effects of the dam are also needed.

Source: references (54, 55, 56)

The Three Gorges Dam created a reservoir that reached its full height in 2010, having submerged 13 cities, 140 towns and 1350 villages. (L) A town and a mountain in the reservoir area of the Three Gorges Dam, with a bridge connecting the two mountain peaks. (R) An image created after modelling the areas that would be submerged following completion of dam construction. It shows most of the old town under water.

Photos: courtesy of Dr JG Guo.

The research portfolio must be broad based. If we are to fully address the new complexities of infectious diseases, we need a new approach that goes beyond animal and human health – and acknowledges the inter-relationships between biology, the environment and the social and cultural context.

Ecology of animals that act as disease reservoirs. Control strategies need to be more complex, with an increasing need for collaboration and interaction between stakeholder groups working on both animal and human health and well-being. Climate change will also demand more interaction, particularly at country level, between researchers, service deliverers and policy-makers from various sectors (including health, environment, natural resources and livestock). This will enable disease control to be based on best possible evidence and also reflect good practice across different fields.
3. TACKLE MULTIPLE PROBLEMS

Research will help understand both causes and consequences of polyparasitism, coinfection and comorbidities with NCDs on people, societies and systems.

An integrated understanding of the complex relationships between infections, and infections and NCDs, underpins effective integrated health systems delivery and effective disease control programmes.

Investigation of the co-clustering of diseases often highlights unexpected biological, social or environmental drivers of disease. Research is needed to explore the complex relationships much more rigorously. Yet single disease control protocols often discourage this and comorbidities are not handled well with our existing research methods.

As an example, polyparasitism, or human infection with more than one parasite, is widespread (12, 57, 58), particularly in environments with predisposing risk factors such as poverty or lack of clean water and sanitation (see Box 1.6 for one example). According to a WHO report published in 2009, more than 70% of the 149 countries endemic for parasitic infections were endemic for two or more diseases; 28 countries were endemic for six or more diseases (59).

While combining disease control programmes can potentially minimize costs and maximize prevention coverage (64), the effectiveness of such an approach is likely to depend on the degree of geographical overlap between diseases at the subnational level (65), and evidence on optimum control packages. Health services research can play a key role in such investigation (see Chapter 3).

The problem of comorbidity is not restricted to polyparasitism and coinfection. As mentioned earlier in relation to the MDGs infectious diseases coexist with, and may be exacerbated by, NCDs.

Infective agents may also predispose to, or trigger, some chronic NCDs including cervical, liver and stomach cancers (see Box 1.7), and possibly some types of diabetes (66).

BOX 1.6. DISEASE CONSEQUENCES – MALARIA AND HELMINTHS

The geographical congruence between malaria and parasitic helminth infections such as hookworm and schistosomiasis is now well recognized (60–62). Each pathogen weakens the health of exposed populations – but these parasites have been shown to interact with each other (63).

Research to better understand the relationship between the malaria and helminth infections could inform:

- the way in which interventions are targeted (recognizing the role of the environment in relation to disease clusters);
- how investment is focused – such as whether combining disease control programmes (where appropriate) could improve the effectiveness of financial investment;
- the development of innovative therapeutic regimes that reflect a more holistic understanding of the consequences of polyparasitism.
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**Box 1.7. Liver Flukes and Cancer**

Fish-borne liver fluke infections (that trigger liver and bile duct cancers) are important emerging public health problems in east and south-eastern Asia, where more than 600 million people are at risk of infection. Exponential growth of aquaculture in Asia (see chapter 2) may be the most important risk factor for the emergence of liver fluke infections.

In Thai males, liver and bile duct cancer ranks fifth among the diseases of the country with the highest number of DALYs. Khon Kaen in north-eastern Thailand (where liver fluke is endemic) has reported the highest incidence of liver and bile duct cancer in the world. This would seem to indicate a link between the two conditions.

Research can unravel such complexities and tell us more about the relationship between liver fluke and bile duct cancer and between the environment, the animal reservoir and the incidence, prevalence and consequences of liver fluke infection.

Broader social factors (e.g. nutritional status and lifestyle factors such as smoking) can also affect how a disease progresses. For instance, studies have also shown that one fifth of the global TB burden may be linked to smoking (67). This is of concern, given that smoking rates are rising in many disease endemic countries. Research can provide more effective evidence of the link between smoking and TB.

The association between diabetes and TB is one example of this complexity (68, 69). It has been suggested that the long duration of diabetes, and associated depressed immunological function and poor glucose control, may increase the risk of TB (70). Insulin dependence, as a marker for severity of diabetes, has been found to predict increased TB risk (71). If the predicted rise in diabetes spurs a rise in TB prevalence, then the potential public health impact could be enormous (66).

Both infectious diseases and NCDs can impose long-term disability (33) and stigmatization. This can have economic consequences both for the individual and (due to the need for health care resources) for the health system. These factors are likely to add to the strain on poorly resourced, fragile health systems.

Investigation of the complex interrelationships of coinfections and comorbidities will increase understanding of the risk factors and consequences of such diseases. This will provide evidence to inform future interventions.

The problem of comorbidity is not restricted to polyparasitism and coinfection. Infectious diseases coexist with, and may be exacerbated by, NCDs.
4. COMMUTE THE LIFE SENTENCE

Many people must live with the long-term debilitating effects of past or current infection. Research can find ways to mitigate the consequences of chronic and persistent lifelong infection and its secondary complications and associated stigma.

Some infectious diseases cause both acute illness and chronic, long-term disability. The effects of chronic infection can be profound – for both the person infected, and his or her family, and the health system as a whole. Box 1.8 gives examples of this.

Chronic infectious diseases may also be a cause of stigmatization. This is particularly true where the individual is associated with some blame or personal responsibility, or in cases where diseases are believed to be untreatable or result in degenerative or disfiguring consequences. Fear of people who are different and the fear of the disease itself may coincide. Infected people become marginalized by such stigma – be it from the behaviour of others or their own perceptions. Levels of stigma may differ according to context (see Box 1.9) and that stigmatization may substantially increase the suffering of patients and their families, as well as making it more difficult to seek or obtain treatment. For example, sufferers from poorer backgrounds often delay seeking help (75) or stop treatment prematurely (72), resulting in disease progression to stages where treatment is more difficult or the symptoms become irreversible.

**BOX 1.8. CONSEQUENCES OF CHRONIC INFECTION: CHAGAS DISEASE AND BURULI ULCER**

Considered to be the parasitic disease with the greatest socioeconomic impact in Latin America (72), Chagas disease is estimated to affect 10 million people in 21 countries (7). More than one in four of those infected will suffer chronic effects, including irreversible cardiovascular, gastrointestinal and neurological problems.

Buruli ulcer is rarely fatal but, if untreated, the disease can cause severe long-term problems. These include functional disability such as restriction of joint movement and deformity. Most infected people live in isolated, poor rural communities and the costs of treatment can be devastating for the household; the disease can also be a major burden on health facilities.

- Estimates from Ghana show that the median annual total cost of Buruli ulcer to a household ranges from approximately US$ 76 to US$ 428 per patient (equivalent to as much as 16–89% of the average annual salary in the country) (73).
- A study in Cameroon, where hospital care for Buruli ulcer is free, showed that the true cost of the disease to the patient still exceeded 25% of annual earnings. This surpasses the threshold of 10%, the cost burden threshold generally deemed “catastrophic” to a household economy (74).
Such chronic burdens are often disregarded and underestimated (13). The costs to patients and their families, the impact on quality of life, and the socioeconomic consequences for individuals and the community are not adequately captured by indices that focus on mortality data rather than the consequences of chronic morbidity. Including such impacts into calculations of the cost effectiveness of interventions can make a difference to funding decisions and prioritization processes for health services (see Chapter 3).

Multidisciplinary research that considers the long-term effects of chronic conditions and the social, economic and cultural environment can help people and health services to manage such conditions more effectively, and identify practical solutions that address stigmatization and marginalization of already disadvantaged communities.

**Box 1.9. STIGMA AND LYMPHATIC FILARIASIS: COMPARISON OF THE DOMINICAN REPUBLIC AND GHANA**

Globally, 120 million people suffer the consequences of lymphatic filariasis, including stigmatizing lymphoedema (or elephantiasis) of the leg.

Studies showed differences in how women from the Dominican Republic and from Ghana have experienced stigma associated with this condition (26). Antecedents, consequences, coping strategies and outcomes of the experiences varied between the two cultures, with people from the Dominican Republic faring better. In Ghana, poverty, poor access to health care, limited education and diminished social support challenged the coping strategies of many women and exacerbated negative consequences of lymphoedema related stigma.

Research could:
- identify effective interventions, educational strategies and policy changes that may be used to overcome stigma and enable these groups to access care;
- find interventions that diminish stigma and marginalization and promote rehabilitation and reintegration into the community.

The costs to patients and their families, the impact on quality of life, and the socioeconomic consequences for individuals and the community are not adequately captured by indices that focus on mortality data rather than the consequences of chronic morbidity.
5. BE PREPARED – FOREWARNED IS FOREARMED

Surveillance is essential at all levels to understand patterns of emergence, including the spread of drug and insecticide resistance. Mapping, monitoring and evaluation of these trends are critical. Access to such surveillance data allows us to anticipate and respond to emergent, re-emergent and drug-resistant diseases.

Surveillance is essential for identifying and controlling infectious diseases. It helps to detect emerging problems, identify human-animal disease “hotspots” (see Chapter 2), track any recrudescence after control activity and provide evidence on which to base policy decisions.

A good surveillance system is a cornerstone of an effective and sustainable disease control system. It is dependent on comprehensive health information systems, supported by readily available and appropriate diagnostic tools. Diseases may be undiagnosed or misdiagnosed because making a definitive diagnosis requires diagnostics that are unavailable and/or unaffordable in the settings in which the diseases occur. Clusters of cases and their true etiology therefore might not be recorded, especially if they occur in isolated areas in low and middle-income countries. Some cases may be wrongly attributed to NCDs (e.g. if symptoms are not those normally associated with an infectious agent). Hence the true burden of infectious disease is likely to be much higher than reported. Only system-wide research supported by effective surveillance can gauge the true extent of this problem.

Data for many infectious diseases are, at best, patchy. Despite efforts to improve disease surveillance and response, many countries still have difficulty in accurately identifying, diagnosing and reporting infectious diseases, particularly in remote areas. Lack of transport and communication infrastructures as well as capacity and capability gaps – such as a shortage of skilled healthcare workers and laboratory facilities to ensure accurate diagnosis – all compound the problem (51). However, greater connectivity in rural areas; communities’ increasing involvement in data gathering; and technological improvements such as smartphones and tablets provide a new and affordable mechanism for extending and improving surveillance coverage in resource poor settings. Extending the reach of such new technologies across remote and impoverished communities is essential, if we are to address the current data challenges.

Effective surveillance relies on gathering information from a broad range of information sources including surveys, health service and disease control facilities, laboratories and registries. Studies such as the continuing Global Burden of Disease study6 act as essential building blocks for surveillance, providing baseline information and giving an insight into the prevalence, incidence, mortality ratios and DALYs of several infectious diseases. However, local data-gathering systems are essential to ensure the robustness of country-level health information. Disease endemic countries need to invest in their own comprehensive health information and surveillance systems if they are to ensure that country-relevant data is captured and used to inform health policy and resource allocations.

Surveillance data is needed for baseline mapping of infectious diseases and for measuring the effectiveness of disease control programmes and interventions. Re-emergence of diseases (see Box 1.10 for some examples of emerging and re-emerging infectious diseases) or any development of resistance needs to be identified as early as possible.

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**Why Research Infectious Diseases of Poverty?**

Box 1.10. Examples of Emerging and Re-Emerging Infectious Diseases of Public Health Importance

- Severe acute respiratory syndrome (SARS) due to SARS coronavirus
- Influenza due to H1N1 and H5N1 viruses
- Hepatitis B and C
- Ebola haemorrhagic fever
- Rift Valley fever
- Chikungunya infection due to Chikungunya virus
- Cholera
- Multidrug-resistant TB (MDR-TB)
- Viral encephalitis due to Hendra/Nipah viruses
- Hantavirus haemorrhagic fever and/or cardiopulmonary syndrome
- Lyme disease
- Diarrhoeal disease due to *Escherichia coli*
- Gastroenteritis due to norovirus
- Bubonic plague
- Legionella pneumonia
- Meningococcal meningitis

Source: courtesy of Annette Ives

Box 1.11. Multidrug-Resistant Tuberculosis: Why Good Surveillance is Critical

Each year, more than 400,000 people develop MDR-TB, which can spread from one person to another. MDR-TB emerges when there is mismanagement of drugs, underinvestment in quality TB control and poor patient compliance (many TB patients do not complete their full 6–9 month drug regimen). The TB bacillus develops resistance through incomplete, erratic or inadequate treatment. In some TB hotspots, up to 30% of patients are infected with drug-resistant strains.

Extensively drug-resistant TB (XDR-TB) is resistant to all of the most effective anti-TB drugs, and emerges through mismanagement of MDR-TB treatment. It can also be spread from one person to another. XDR-TB was highlighted as a global threat to public health in 2006, especially in high HIV-prevalence countries. If uncontrolled, it could spark an epidemic of untreatable TB that will jeopardize the major gains made in TB control.

How could research change this scenario?

Weaknesses in health information and surveillance systems are responsible for slow detection of MDR-TB. Technical challenges currently impede the diagnosis, treatment and prevention of TB. Rapid diagnosis and treatment could have a major impact on HIV-associated TB and drug-resistant TB. Key research priorities to address this include the following.

- Identifying feasible and optimal ways to undertake intensified case finding in communities.
- Developing rapid tests for easier diagnosis of MDR-TB and XDR-TB.
- Supporting the development of comprehensive health surveillance systems in communities to enable rapid detection of emergent, re-emergent and drug-resistant disease.
- Finding ways to better control TB in high-risk settings.
- Developing simple standardized treatment regimens for MDR-TB.
- Establishing rational re-treatment regimens for patients who fail or develop recurrent TB after first line treatment.

Source: TB Alliance (http://www.tballiance.org/why/mdr-tb.php, accessed 17 February 2012); Stop TB Partnership (http://www.stoptb.org/, accessed 17 February 2012); TDR Disease-Specific Reference Group on Tuberculosis, Leprosy and Buruli Ulcer
The emergence of drug and insecticide resistance also emphasizes the need to routinely undertake surveillance to identify, isolate and prevent microbial and vector resistance as early as possible. Box 1.11 further outlines why surveillance is so important.

Drug resistance has been implicated in the spread of infectious diseases. Malaria drug resistance spreads rapidly and poses significant problems for the treatment of patients. Research plays a key role in mapping, measuring and charting the development of resistance to existing drug regimens. Through operational research, interventions can be targeted and proactive management strategies developed.

An effective response to vector-borne infectious diseases requires information on the levels of risk; distributions of parasites, vectors and reservoir species; and understanding of the social context. Surveillance can help provide this information. Box 1.12 illustrates how good surveillance has helped decrease disease incidence.

**Research plays a key role in mapping, measuring and charting the development of resistance to existing drug regimens. Through operational research, interventions can be targeted and proactive management strategies developed.**

Human health, veterinary, environmental and wildlife management expertise should be used jointly to develop a more effective surveillance system. Gathering and sharing data through such a system is vital if strategic responses at global, regional, national and local levels are to be sustained.

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**Box 1.12. Halting River Blindness**

Between 1975 and 2002, 11 west African States, together with the World Bank, the Food and Agriculture Organization of the United Nations (FAO), United Nations Development Programme (UNDP) and the World Health Organization (WHO), embarked on one of the largest and most comprehensive vertical vector control operations against onchocerciasis in west Africa. An area of about 1,300,000 km², with more than 50,000 km of rivers, was covered by the operation.

The success of this intervention was due in large part to the enormous information infrastructure that had been created. This drew on hydrology/seasonal river flows, information on vector habitats, parasite mapping and information on population levels of infection and blindness.

This foundation of multidisciplinary knowledge undoubtedly played a key role in ensuring that an “escape route” was found from river blindness. The operation had a dramatic impact on the prevalence and transmission of infection. More than 40 million people in the areas concerned were freed from risk of infection and onchocer-cal eye lesions, while more than 1.5 million people were no longer infected. Another 600,000 cases were prevented and 16 million children living in the area (and born since the programme began) are free of onchocerciasis.

The socioeconomic impact has also been dramatic. Twenty-five million hectares of fertile land in the river valleys were made available for resettlement and agriculture, with an economic rate of return (ERR) of about 20%, resulting mainly from increased labour due to prevention of blindness and increased land utilization (77).

Maintaining such good surveillance is of utmost importance. While onchocerciasis is no longer a problem in some savannah areas of west Africa, transmission persists in other areas.

Human health, veterinary, environmental and wildlife management expertise should be used jointly to develop a more effective surveillance system. Gathering and sharing data through such a system is vital if strategic responses at global, regional, national and local levels are to be sustained.
6. REACH THE HARDEST TO REACH

By identifying ways to strengthen health infrastructure and better deliver services in impoverished areas, we can reach disenfranchised populations who continue to struggle with the burden of poverty and disease. Health systems research can create positive synergies between disease control and wider health systems in poor regions.

Often, health services and disease control programmes struggle to reach the people who need their help the most. There are many reasons for this. Population coverage is a particular challenge for disease endemic countries, where fragile health systems often coincide with high disease incidence and prevalence rates, as well as with broader social, economic and environmental challenges such as a poor transport infrastructure.

Ideally, infectious disease control activities would be intimately interrelated with the health system (see Chapter 3). But in reality there is a gap (real or perceived) between disease control systems and health care delivery systems. Too often, disease control programmes are dissociated from the core provision of health services. This needs to change if we are to achieve long-term, sustainable control of infectious diseases of poverty: awareness of infectious disease and the programmes for its control must be seen as integral to health systems, particularly at the community level and in primary care. Health systems research can greatly improve the health system/disease control programme interface. It can identify ways to mainstream control programme activity (where appropriate) and to make more effective use of limited human and financial resources, including donor funding (78, 79). There may be a clear role to be played by communities themselves. Research on community-directed interventions shows that success can be substantially improved through community management.

As the story of Christophe (see Box 1.2) illustrated, people in under-resourced settings often experience difficulties in accessing appropriate, timely health care. Since we already know a lot about the factors that undermine access to health care, this information should be used to inform and improve health services. For example, pro-poor and pro-equity strategies need to consider not just income, but also systematic disparities in health status such as gender, health education and health literacy, all of which can be key determinants governing access to health.
7. PREVENT LOSS IN TRANSLATION

Progress along the route from basic research to clinical and public health practice is slow and patchy. Integrated multidisciplinary research programmes should aim to anticipate and avoid potholes along the route to introduction of more effective interventions.

The translation of research in the laboratory to the bedside, and of small-scale bedside research to the wider population, often receives low priority. At present much research is conducted in isolated “silos” and is not directed towards translation into effective interventions, policy and practice. A comprehensive research strategy is needed to maximize the impact of studies.

The example outlined in Box 1.13 shows how research evidence can have a dramatic impact if translated into evidence-based practice and policy. In this case, a coordinat ed and purposeful approach to tackling lymphatic filariasis, supported by intersectoral cooperation, paid a global health dividend. The robust partnerships that developed as a result of this intervention provide a firm foundation for future interventions.

“At present much research is conducted in isolated “silos” and is not directed towards translation into effective interventions, policy and practice.”

Enabling the translation of research into evidence-based practice is critical to the achievement of a more coordinated and purposeful approach to health.

BOX 1.13. TRANSLATING RESEARCH INTO PRACTICE: CHINA’S SUCCESS LEADS TO GLOBAL PROGRAMME

The success of the Chinese lymphatic filariasis control programme during the 1960s and 1970s, using a single drug (diethylcarbamazine) and vector control, resulted in the elimination of transmission in a population of some 350 million people. This success led to the International Task Force for Disease Eradication recommending lymphatic filariasis as one of only six eradicable diseases.

TDR (The Special Programme for Research and Training in Tropical Diseases) supported research on drug combinations which, when given annually, reduced parasite levels in the blood to a level which would arrest transmission by mosquito vectors. These findings led to a World Health Assembly resolution recommending Member States to eliminate the disease as a public health problem.

In turn, these led to the donation of the drugs albendazole and ivermectin (by GlaxoSmithKline [GSK] and Merck & Co., Inc. respectively) and the launch of a global programme supported by an alliance of partners and known as the Global Alliance to Eliminate Lymphatic Filariasis (GAELF).

The strategy was based on two approaches: (i) mass distribution of the two drugs annually for at least five years and (ii) treatment of those with existing symptoms. The programme has expanded substantially since its launch in 2000, when only 2.9 million people were treated. In 2008, more than 500 million people benefited from annual treatments in 53 countries. In 2010, a further commitment to the donation of diethylcarbamazine was also made and the programme has been recognized to be the most rapidly advancing public health programme in history. It has resulted in some US$ 24 billion in savings and the cumulative number of treatments delivered at the end of 2008 was 2.8 billion. Using tools developed through operational research, intense evaluation is demonstrating impact on both prevalence and incidence of the disease.

Source: references (80, 81).
Relatively low levels of investment in evidence-based interventions can have a big impact. Small modifications in where and how we deliver treatments and care can achieve dramatic improvements. Where effective research demonstrates positive effects from small modifications, this should be rapidly scaled-up in poor communities.

Research can make a profound difference to interventions and strategies by identifying and directly addressing the challenges to delivery faced within the field. For example, interventions can be tailored to specific audiences, and products can be modified to ensure that they are culturally acceptable and technologically adaptable to the field conditions within which they are to be used.

By applying these changes systematically, enormous progress can be made against previously intractable conditions.

Interventions such as hand washing, water filters and bednets have been shown to have a significant impact on infectious disease control. However, often these interventions are not readily available or accessible to those communities and individuals in greatest need. Identified reasons for this include lack of compatibility with local lifestyles and cultural norms, and a lack of capacity and capability at district and sub-district level to deliver the effective intervention. Investment in research can do much more to ensure this “know–do” gap is bridged. For instance, research can help ensure that tools and strategies are locally relevant, particularly with regard to equity of access, field effectiveness, cost-effectiveness, community acceptance and uptake, sustainability and environmental challenges. Educators, health promoters and decision-makers are more likely to achieve desired behavioural changes if community-based research is used to tailor health messages to specific populations and monitor their impact (50).
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9. STAY FOCUSED ON THE LIGHT AT THE END OF THE TUNNEL

Much has been achieved to date and even the most difficult situations are not irreversible. Significant progress will continue to be made if investment in coordinated research programmes is expanded and sustained.

Research has driven progress in many areas, providing new products to enable identification and control of infections and harnessing the capabilities of health systems and communities to support action and interventions to improve health. By highlighting up-to-date methodologies and new approaches, and drawing across a variety of disciplines, research provides solutions to improve the delivery of interventions and manage illness. Table 1.3 provides an insight into some of the ways in which research has made, and continues to make, a difference to disease identification, control and monitoring. Many other examples of success are cited throughout the rest of this report.

There has been a great deal of progress in combating infectious diseases of poverty. Some diseases such as smallpox have now been eradicated. Several other diseases are already targeted for elimination/eradication. Research has played, and will continue to play, a key role in achieving such goals.

Whilst very effective for some diseases, vaccines are not a panacea and should not be the only focus for research. While a worthy goal, disease eradication is rather easier said than done. New products are difficult to develop and may not provide effective solutions. A commitment to investment in research is about more than empirical scientific discovery and the creation of innovative products – it is about improving health by discovering and advancing whatever methods work best. Our existing evidence base shows that small changes can make a difference. However, implementation gaps need to be addressed as a priority.

Investment in research is about more than empirical scientific discovery and the creation of innovative products – it is about improving global health by discovering and advancing whatever methods work best.
### TABLE 1.3. EXAMPLES OF RESEARCH SUCCESS

<table>
<thead>
<tr>
<th>EXAMPLE</th>
<th>ROLE OF RESEARCH</th>
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<tbody>
<tr>
<td><strong>Surveillance</strong></td>
<td>Real time data and situational awareness, underpinned by broad use of data, are an integral part of the response to emerging threats (82). Systems that are making a difference to the identification, treatment and control of infectious diseases could not have been developed without significant research into developing tools and diagnostics to detect asymptomatic infections, and a rigorous approach to evaluation of the validity of the data produced.</td>
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<tr>
<td><strong>Better use of resources/cross disciplinary work</strong></td>
<td>Geographic information system (GIS) enabled the development of a spatial model of Loa loa risk in Cameroon. This information provided the baseline data for the development of an integrated approach to tackling Loa loa (see Chapter 2).</td>
</tr>
<tr>
<td><strong>Community engagement in disease control programmes</strong></td>
<td>Research has helped promote the use of community-based approaches to drug delivery and targeted use of community volunteers for multiple health intervention delivery. Studies have shown that involving communities in their own care can improve the enrolment of participants, which in turn improves the cost effectiveness of disease control programmes (83) (see Chapter 3).</td>
</tr>
<tr>
<td><strong>Integration of new technologies such as mobile phones into disease control initiatives</strong></td>
<td>Health services research has demonstrated that new, non-medical technologies can offer significant potential to improve disease control and treatment strategies. For example, a study that integrated the use of mobile phones and web-based technology into a routine malaria prevention and control programme on the Thai–Cambodian border showed improvements in the management of malaria cases among an underserved population, with case follow-up rates improving significantly. This study has now been expanded to cover a wider area (84) (see Chapters 2, 3, 4).</td>
</tr>
<tr>
<td><strong>Drug development</strong></td>
<td>Effective and affordable drugs to treat malaria in developing countries are still limited. Improvement has been achieved through the increasing development of artemisinin-based combination therapies (ACTs). Research is currently investigating the potential for the development of drug resistance (85) and will continue to play a key role in developing the next generation of artemisinin derivatives</td>
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10. ACT QUICKLY ON WHAT WE KNOW

Policy-makers and global funders need to have access to the right information at the right time to inform decisions that draw on the evidence of what works, and feed “best buys” into health policy, health budgets and the operations of health systems. Research data must therefore be rapidly translated into an effective tool for policy-makers.

More effective use of available tools and infrastructure will result in progress. But many opportunities to make a serious difference to global health equity in terms of infectious disease incidence, prevalence, morbidity and mortality are missed or only partially realized. One of the critical reasons for this, which we cannot afford to ignore, is the effectiveness of the link between research and policy.

If we are to effectively reduce the burden of the infectious diseases that plague impoverished communities, we need to understand how to ensure that the research and the research community are both informed by, and inform, activity across the broader social, economic and political landscape. A crucial factor to address is the fragility of the link between the research community and those making the policy decisions that translate research into action. At the political level there needs to be consistent reinforcement of the need to take actions, many of them relatively inexpensive, to implement evidence into practice.

Partnerships between the research community and others, including the private sector, have shown increasing interest in research on infectious diseases (86). Research that provides data and evidence needs to be readily available and accessible to support rational decision-making processes across both the political and the funding landscapes. Coordinated policy and planning enables more efficient and effective use of resources and fosters collaboration (87). Ensuring that this is based on the best available evidence, supported by robust cost-effectiveness analysis of available technologies and strategies, is essential to the development of effective health policy.

“Good science is the basis of good public health, but the challenge we face is to translate the best science into public policy.”
Gro Harlem Brundtland, former Director-General, WHO

Research can and should play a key role in informing the decision-making process (the “decision calculus”) of policy-makers and global funders. In 2008 the Bamako Declaration established that all countries should have national research capacity so that they can answer nationally relevant questions. Ministries of health were called upon to dedicate 2% of their budgets to research (reinforcing a World Health Assembly resolution in 2008). Unfortunately, implementation of this has been inconsistent thus far (88). Encouraging and supporting local governments to make a political and financial commitment to the health of their own populations is crucial.

Available and emerging data from across the research spectrum need to feed into the policy arena to support “best buys” within health policy, health budgets and the operations of health and disease control systems. To do this, research to policy linkages are needed to support the decision-making processes of all relevant sectors.
Under the lens...

The burden of infectious diseases falls heavily on those who have the least ability to deal with it. The lens of poverty adopted in this report provides insights into the dynamics and context of infectious diseases and into the interactions between human health, animal health and the broader social, economic and political environment within which we live. Understanding the complex interplay of factors that affect our risk and exposure to these diseases is key to making progress in tackling them.

This chapter has set the scene and makes the case for research. The next chapters turn the lens on the role of the environment, health systems and innovation. Each of these chapters provides an insight into research evidence and the interface between infectious diseases and poverty, suggesting ways in which investment in research can make a difference to millions of lives. The fifth chapter describes the status of research funding, while the final chapter turns the lens to the macro challenges that will need to be addressed, outlining practical “options for action” that will go a long way towards addressing the challenges identified by the rest of the report.

This report provides a firm foundation for changes in the way that the global health community responds to the challenge presented by infectious diseases of poverty. The synthesis and discussion of the evidence it provides underlines the need for a robust and sustained commitment to tackling infectious diseases, and highlights the contribution this would make to social justice.

Infectious diseases are a pressing global problem, costing lives, reducing life expectancy, sapping economic growth, reducing educational opportunities and increasing the pressure on already fragile health systems. The search for solutions to this pressing public health challenge represents unfinished business of global relevance, work that the world can no longer afford to neglect. We need to invest in research, and the time to act is now.
References – Chapter one


78. Atun RAB, Bennett S, Duran A. *When do vertical [stand-alone] programmes have a place in health systems?* WHO Regional Office for Europe, Copenhagen, 2008 (Policy Brief).


