

GLOBAL PUBLIC GOODS
FOR HEALTH

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FOR HEALTH

THE REPORT OF WORKING GROUP 2 OF THE COMMISSION ON
MACROECONOMICS AND HEALTH

Chaired by

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Presented to

DR GRO HARLEM BRUNDTLAND,
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He who receives an idea from me,
receives instruction himself without
lessening mine; as he who lights his
taper at mine, receives light without
darkening me.

—*Thomas Jefferson*

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FOREWORD

The Commission on Macroeconomics and Health (CMH) was launched in January 2000 by Gro Harlem Brundtland, Director-General of the World Health Organization. Its mission was to analyse the impact of health on development and to examine ways in which health-related investments could spur economic development. The Commission worked to develop specific recommendations that would save lives, reduce poverty, and spur economic growth through a scaling up of investments in the health sector of developing countries. The final report of the Commission, *Macroeconomics and Health: Investing in Health for Economic Development*, was released in December 2001.

The Commission focused its work on the world's poorest people, in the world's poorest countries. Millions of impoverished people die every year of conditions that are readily preventable or treatable. Technologies exist to avert millions of deaths due to malaria, TB, HIV/AIDS, diarrhoeal disease, respiratory infection, and other killers. These tragic deaths—and the enormous economic and social costs associated with them—reflect the basic fact that essential life-saving health services are out of reach of hundreds of millions of the world's poor. And yet, without extending these life-saving interventions, poverty is likely to be exacerbated and to be passed to the next generation. The economic costs of ill health, the Commission documented, are enormous and pervasive.

The findings of the Commission are both stark and also encouraging. It will take a lot of money and much more political and organizational effort than has been seen in the past generation to accomplish the tasks at hand. Curbing the HIV/AIDS pandemic, or the resurgence of tuberculosis and malaria, or major killers of children such as diarrhoeal disease and vaccine-preventable diseases, will not happen by itself. Yet the task is feasible, with breathtaking achievements possible. The Commission calculates that if the donor countries contribute around 0.1% of their GNP—one penny for every \$10 of income—and if that effort is matched by a suitable increase in effort within the low-income countries themselves, it should prove possible to avert 8 million deaths per year by the end of this decade. As of 2007, the donor contribution would be around US\$ 27 billion per year, or roughly four times the current US\$ 6 billion in official development assistance for health. The reduction in human suffer-

ing would be enormous. The economic gains would also be striking, around the order of US\$ 360 billion per year during the period 2015–2020, several times the costs of scaling up the health interventions themselves, counting both the donor and recipient country efforts.

To arrive at its conclusions, the Commission organized its research and intensive analysis mainly within six working groups, which in turn engaged the energies of a worldwide network of experts in public health, finance, and economics. Each working group held several meetings around the world, commissioned papers, debated alternative approaches, circulated drafts to the policy and scholarly community, and made detailed recommendations to the full Commission in the form of a Working Group Report. Working group members included CMH members, staff of various international agencies, and experts from governments, academic institutions, NGOs, and the private sector. The Working Group Reports, prepared by the working group co-chairs in consultation with the entire working group membership, are a synthesis of the commissioned background papers and the culmination of each working group's detailed review of the literature and intensive deliberations.

The Commission's findings are therefore based heavily on the crucial work of the six working groups, each of which was responsible for taking stock of the existing knowledge base on a particular topic in order to identify implications for policy and for extending that knowledge base as appropriate. The working groups, with their titles, topics, and chairs, are:

- Working Group 1, Health, Economic Growth, and Poverty Reduction, addressed the impact of health investments on poverty reduction and economic growth. Co-Chairs are Sir George Alleyne (Pan American Health Organization, USA) and Professor Daniel Cohen (Ecole normale supérieure, Paris, France).
- Working Group 2, Global Public Goods for Health, studied multi-country policies, programmes, and initiatives having a positive impact on health that extends beyond the borders of any specific country. Co-Chairs are Professor Richard G. A. Feachem (Global Fund to Fight AIDS, Tuberculosis, and Malaria, Geneva, Switzerland) and Professor Jeffrey D. Sachs (The Earth Institute at Columbia University, New York, USA).
- Working Group 3, Mobilization of Domestic Resources for Health, assessed the economic consequences of alternative approaches to resource mobilizations for health systems and interventions from domestic resources. Co-Chairs are Dr Alan Tait (former senior IMF

official) and Professor Kwesi Botchwey (The Earth Institute at Columbia University, New York, USA).

- Working Group 4, Health and the International Economy, examined trade in health services, health commodities, and health insurance; patents for medicines and trade-related intellectual property rights; international movements of risk factors; international migration of health workers; health conditions and health finance policies as rationales for protection; and other ways that trade may be affecting the health sector. The Chair of this working group is Dr Isher Judge Ahluwalia (School of Public Affairs, University of Maryland, College Park, USA).
- Working Group 5, Improving Health Outcomes of the Poor, examined the technical options, constraints, and costs for mounting a major global effort to improve the health of the poor dramatically by 2015. Co-Chairs for this working group are Dr Prabhat Jha (University of Toronto, Canada) and Professor Anne Mills (London School of Hygiene and Tropical Medicine, UK).
- Working Group 6, International Development Assistance and Health, reviewed health implications of development assistance policies including modalities relating to economic crisis and debt relief. It focused on the policies and approaches of international developmental agencies. One emphasis was on the appropriate balance between country-specific work and support for activities that address international externalities or provision of international public goods. The Co-Chairs are Mr Zephirin Diabre (United Nations Development Programme, USA), Mr Christopher Lovelace (World Bank, USA), and Ms Carin Norberg (Transparency International, Germany).

I am honoured to introduce *Global Public Goods for Health: The Report of Working Group 2 of the Commission on Macroeconomics and Health*, on which I was also pleased to serve as Co-Chair. This Report starts from the concept of public goods, which are types of goods that markets under-supply because market-based incentives are not adequate. Perhaps the most critical public good in the area of health is the creation of new knowledge, especially in basic scientific research. Surveillance of infectious disease epidemics is another classic example. Working Group 2 started from the proposition that many such critical public goods must be provided by an international effort, since national governments acting individually lack the incentive to provide such efforts at a sufficient level for global well being. The evidence presented by the Report is stark: there has

been a critical underinvestment in basic science, product development, and operational research regarding diseases that mainly hit the world's poor, especially tropical diseases such as malaria. The Working Group therefore describes, in an approach adopted by the overall Commission, a new Global Health Research Fund with an annual funding of US\$ 1.5 billion by the year 2007 to spur scientific knowledge vital for control of these diseases. The Report additionally advocates increased public-private partnerships for targeted opportunities such as vaccines for HIV/AIDS, TB, and malaria. Other global public goods requiring increased international efforts include control of communicable diseases that cross national boundaries, including elimination and eradication efforts where appropriate; standardized data collection; and containment of anti-microbial resistance. In all of these efforts, international organizations such as the World Health Organization have a major role to play.

Jeffrey D. Sachs

Chair of the Commission on Macroeconomics and Health

August 2002

PREFACE

If there were such a thing as a world government, what activities might it undertake to promote global health?

This is the question that guided Working Group 2's exploration into global public goods for health. To our knowledge, this work provided the first attempt to apply the basic conceptual lessons of the economic theory of public goods to international health policy. Our goal was to identify a crucial set of institutions and policies that will be needed to promote global health in an era of rapid globalization, to ensure that countries capture the full benefits of openness, and to minimize any associated risks.

Between January 2000 and December 2001, Working Group 2 commissioned over 20 papers to examine global public goods for health in the context of a variety of different subject matters, such as basic and applied research (including targeted research and development, or R&D), the control and prevention of communicable disease transmission, and standardized data collection for analysis and evaluation. What emerged collectively from these studies and related discussions was a clarion call to establish a new framework for international collective action that would respond to the challenges and opportunities presented by an increasingly interconnected world.

More remains to be done. Working Group 2's discussions marked the beginning of a process of identifying key areas where collective action is needed to promote global health goals, and developing a list of priorities within these selected areas of focus. However, the test of our progress lies ultimately with results, not with the strategic framework itself. We must demonstrate that support for global public goods for health can have a real impact "on the ground", where it matters, improving the health and livelihood of all people, and the poor in particular.

Numerous individuals contributed to the development of this Report. In addition to the Working Group 2 members (listed in the Report Team) and authors of the commissioned papers (see Annex 2), several stand out for their very substantial input to the ideas presented here. They include Cristian Baeza, John Barton, Andrew Cassels, James Hughes, Billy Jack, Dean Jamison, Inge Kaul, Jerry Keusch, Richard Lane, Adetokunbo O. Lucas, Michael McAtee, Richard Mahoney, Ariel Pablos-Mendez, Adrian Otten, Tikki Pang, Sally Stansfield, Susan Stout, Jayashree Watal, David

Webber, Diana Weil, Roy Widdus, and Richard Wilder. Thanks also to Miriam Polon and Hope Steele, who provided excellent editorial assistance at various stages in the drafting of the Report.

Several key meetings marked turning points in the development of ideas for this Report. The meetings convened by Working Group 2 were hosted by an impressive range of institutions in various locations around the world, and included the Center for International Development, Harvard University (Cambridge, Massachusetts, 16–17 May 2000); the Fogarty International Center, National Institutes of Health (NIH Stone House, 19–20 July 2001); the Institute for Global Health, University of California, UCSF and Berkeley (Berkeley, California, 11 August 2000); The Wellcome Trust (Hinxton Hall, Wellcome Trust Genome Campus, 7–9 December 2000); the World Bank (Washington, DC, 13–14 December 2000); and the World Health Organization (Geneva, Switzerland, 11 September 2000). It would be impractical to list all the individuals who participated actively at these meetings, but we are grateful for their enthusiastic support and creative input.

Generous funding to carry out this work was received from the Bill and Melinda Gates Foundation, the Rockefeller Foundation, and the World Health Organization. Additional contributions were made by the Fogarty International Center at the National Institutes for Health and The Wellcome Trust. We are deeply indebted to the particular individuals within each of these agencies who worked to secure both financial and in-kind contributions.

Richard G. A. Feachem, Carol A. Medlin, and Jeffrey D. Sachs
Geneva, San Francisco, and New York
August 2002

EXECUTIVE SUMMARY

This Report represents the culmination of work undertaken by internationally acclaimed scholars and practitioners of international health on topics relating to globalization, health and development. The Report brings a “global public goods” perspective to health, exploring the basis for multicountry collaboration to improve global health and, most especially, the health of the world’s very poor. The concept of global public goods refers to programmes, policies, and services that have a truly global impact on health, although the distribution of benefits may be unevenly experienced or perceived across countries. In the past, humanitarian concerns have been the main basis for international collaboration in health. However, building on existing theories of international collective action, the Report emphasizes the ways in which countries can benefit from working together to resolve the major global health challenges of the day.

Although our knowledge is still incomplete, we do know that the relationship between globalization and health is extremely complex. As the world becomes increasingly interdependent, countries are becoming far more vulnerable to health problems originating beyond their borders. For example, tuberculosis has become a major problem in many industrialized countries, where the foreign-born account for nearly one-half of all cases.

However, despite their increasing vulnerability, countries can build on the new opportunities presented by globalization to promote global health objectives. They can expand the frontiers of knowledge by building international research networks for health, and by supporting international public-private partnerships to create a new generation of product lines in drugs, vaccines, and diagnostics. They can band together to reduce the burden of the world’s major diseases through eradication campaigns, elimination programmes, surveillance activities, and other means. They can also take part in establishing new international treaties that govern the movement of people, animals, and foodstuffs across their borders, thereby minimizing the health risks of increased interconnectedness resulting from globalization.

This Report analyses these and other examples (both potential and realized) of international collective action to achieve common health

goals. A central objective is to identify what types of policies and institutions are needed to elicit the cooperative behaviour of countries in promoting global health. An important insight of the global public goods perspective is that truly “public” goods (that is, goods that will benefit the collective community) will be undersupplied at the global level because countries have no incentive to produce them on their own accord without guarantees that other countries will also contribute their fair share. The Report explores reasons why countries may fail to cooperate even when it is clearly in their best interest to do so, and proposes a set of policy recommendations to enlist and sustain the cooperation of countries in areas critical to global health.

I. GLOBAL PUBLIC GOODS FOR HEALTH

I.1 INTRODUCTION

The pace of global economic integration has accelerated over the past decade, dramatically transforming the world's economic and political landscape. The remarkable changes that have ensued have led to a lively debate about the perceived impact of globalization on the growth of nations and the well-being of their citizenry. Recent studies have claimed that technological change and financial liberalization have resulted in a widening income gap between rich and poor over the past quarter century (Wade, 2001). Other studies present an opposing view, arguing that income inequality within countries has remained largely stable over the last few decades, and that, on the whole, the higher growth rates that accompany globalization in developing countries are good for the poor (Dollar, 2001).

A similar debate is taking place within the international health community as it seeks to understand the channels through which the macro-trends of domestic deregulation and external liberalization have an impact on important health outcomes. One well-established (and positive) channel from globalization to health is through income: rising income of the poor leads to better nutrition, lower child mortality, and better maternal health (Dollar, 2001; Thomas, 2001). But other evidence suggests that globalization may also have adverse effects, even if the precise channels are not always clearly understood (Cornia, 2001).

Irrespective of viewpoint, there is a growing consensus among development economists that new supporting institutions and policies are needed in order for countries to capture the full benefits of globalization and minimize the associated risks. The specific mandate of Working Group 2 was to investigate what policies and institutions would be needed at the global level to help countries achieve better health outcomes through international cooperation in ways that might differ from conventional development assistance. In carrying out its mandate, Working Group 2 often found it instructive to pose the following question: If there were such a thing as a world government, what activities would it undertake to improve health?

Over the course of a 2-year period, Working Group 2 commissioned more than 20 papers to examine this question in relation to a variety of different subject matters. Together, these studies present a clear demand for a new structure and basis for international collaborative action that can respond to the challenges and opportunities presented by a world that is increasingly interconnected.

1.2 DEFINITIONS AND CONCEPTS

One effect of globalization is to increase the number of potential channels through which the behaviour of an individual nation-state can affect others beyond its borders. The impact can be positive or negative. If the impact in a substantive area is sufficiently large, it should inspire governments to work together to achieve common goals that may not be easily attained in the absence of cooperation. This is the logic behind a global public goods agenda for health, although—as we shall see—achieving the levels of cooperation needed may be difficult.

1.2.1 *Definitions*

The economic foundations of the concept of public goods, explored in this section, provide the basis for understanding when international collective action in health may be justified.¹

The term *global public goods* is derived from the economic theory of public goods. *Public* goods differ from *private* goods in several important respects, but a very central difference is the degree to which they generate spillover effects, or *externalities*, when consumed. (*Goods*, whether public or private, can be colloquially but accurately described as products, programmes, activities, or services). The presence of externalities may lead to government intervention either to encourage the potential for positive spillover effects or to discourage the negative.

Public goods have two unique properties: they are nonrivalrous and nonexclusive. A good is *nonrivalrous* if, for any given level of production, the marginal cost of providing it to an additional consumer is zero. For most private goods, the marginal cost of producing more of a particular item is positive. But for some goods, the costs of production do not increase with each additional consumer, making it difficult to set an efficient price for each unit. This also means that the ability of any additional individual to enjoy the product or service is not diminished by the use of it by others. A common example is a lighthouse. Once a lighthouse has been built and is operational, its use by each additional ship adds nothing to its maintenance costs and does not reduce the ability of any other ship

in the vicinity to make use of it. A less “pure” example is a freeway. During periods of low traffic, the impact of each additional car on the freeway is minimal in terms of highway maintenance and the ability of each individual car to easily reach its destination. However, as frustrated morning commuters in major urban areas can attest, there is a limit to the carrying capacity of the freeway.

A good is *nonexclusive* if people cannot be prevented from consuming it. This makes it difficult or sometimes impossible to charge individuals directly for the consumption of a product or service. Again, a common example is the lighthouse. It would be difficult if not impossible to charge ships at sea for the benefits they derive from it. In some cases, however, the property of nonexcludability can be explicitly enforced by the service provider. A freeway can be transformed into a toll road, for example.

As may be clear from these examples, very few public goods are “pure”. It is also the case that many private goods display some degree of externalities, so the distinction between public and private goods is best understood in terms of a continuum rather than a dichotomy. Smoking, an ostensibly private activity, is now known to harm the health of others in the smoker’s vicinity through “second-hand smoke”, giving rise to a series of public policy responses to curb this negative side effect. Thus, the nature of the externality and the relative strength of a good’s “public” characteristics help determine when governments will intervene to achieve a desired collective outcome.

Common pool goods and *club goods* are two obvious examples of impure public goods that can be derived from relaxing one of the two technical criteria of a pure public good while holding the other constant. *Common pool goods* are nonexcludable but rivalrous in their consumption (meaning that they may be subject to congestion or depletion). *Club goods*, conversely, are excludable but nonrivalrous (within the group). Although pure public goods are inherently public, owing to their intrinsic properties, impure public goods can be made more or less public through the manipulation of policy. For example, club goods are often excludable by choice, sometimes in response to the degree of rivalry the good displays, but often for other reasons, as well. Table 1.1 provides a graphic representation of these types of public goods and their respective properties.

Other examples of impure public goods are not derived from a well-defined set, but rather serve as useful heuristic devices for contemplating the impact of government intervention to supply them. *Joint products* occur when a single activity yields two or more outputs that may vary in

Table 1.1 GLOBAL PUBLIC GOODS AND THEIR PROPERTIES

		Excludability	
		Low	High
Rivalry	Low	Public goods	Club goods
	High	Common pool goods	Private goods

their degree of publicness (Sandler and Arce, 2001). The term *merit goods* has been used in a normative sense by economists to describe goods to which people should have access, regardless of their ability or willingness to pay, because the goods display important externalities of public concern. More recently, World Bank staff coined the term *feel goods* to describe lending requests to pay for goods that, if provided, would not be able to generate the revenue needed to amortize their costs (Stout, cited in Candler, 2000).

1.2.2 *The geography of public goods*

Public goods can be local, national, regional, international, or global, depending on the “reach” of their externalities.

When economists refer generically to *public goods*, they typically mean *national public goods*—public goods that benefit the citizenry of a specific country. They may also refer to *local public goods* to indicate that the reach of the externality is confined to a specific community or municipal region (Stiglitz, 1977, 1983; Tiebout, 1956).

Kaul, Grunberg, and Stern (1999); Sandler (1997); Stiglitz (1995); and others have also contributed to a growing awareness that the benefits (or harm) of some public policies, programmes, and services extend beyond the boundaries of independent nation-states. In these cases, the properties of nonrivalry and nonexcludability are likely to apply to countries rather than individuals or firms. Public goods produced nationally by many countries are not necessarily global public goods. They are only global, international, or regional public goods if they exhibit significant cross-border externalities. Thus strong national public health systems are not, in themselves, a global public good. Some elements of national public health systems can, however, generate important, positive global spillover effects—for example, a strong national surveillance system is an important component of global surveillance. National public health systems may also generate important, negative global spillover effects, such as the export of antibiotic-resistant tuberculosis. However, it is the export

of resistant strains, not the national public health system itself, that is the global “bad”.

The terms *global* and *international* have often been used interchangeably in the literature, but some consensus on a precise use of terms is slowly forming (Lele et al., 2001). Generally speaking,

- *Global public goods* refer to programmes, policies, and services that have a truly global reach (although the distribution of benefits may be unevenly experienced or perceived across countries);
- *International public goods* refer to programmes, policies, and services that benefit countries in more than one region (Sandler and Arce [2001] refer to these as “transnational” public goods); and
- *Regional public goods* refer to programmes, policies, and services whose benefits extend exclusively to countries in a single region.

Nevertheless, for simplicity, this report refers to *global public goods* to encompass any public good whose externalities transcend the boundaries of any individual country. Some scholars have also used the term in reference to cross-generational spillovers.

1.2.3 *The collective action challenge*

The attractiveness of the public goods framework for the study of international collective action lies in its ability to explain the underlying structure of incentives that promote or discourage collaboration among individuals, groups, or nation-states. The problem with supplying public goods at the global level is aggravated by the absence of a governing authority that can assign property rights and exact punishment for non-compliant behaviour. That is, in the absence of world government, global public goods must instead be supplied through the “anarchic and horizontal system of international governance” (Barrett, 2000), and this complicates matters considerably.

Economists and social scientists often work with simplified models to study why cooperation among multiple partners to achieve common goals may be difficult. One well-developed theory proposed that rational, self-interested individuals would never act voluntarily to achieve their common or group interests. The reason for this is that when interests are commonly shared, “rational” actors should prefer to “free-ride”—that is, to let others pay for the cost of the good that will benefit everyone. However, if we nevertheless see groups acting to further the collective interest, it will probably be due to the structure of incentives that rewards contributors and punishes noncontributors.

Table 1.2 PAYOFF MATRIX FOR PRISONER'S DILEMMA

		Prisoner B	
		Confesses	Doesn't Confess
Prisoner A	Confesses	-5, -5	-1, -10
	Doesn't Confess	-10, -1	-2, -2

Another favourite “game” (or model) that examines the conditions that prevent cooperation even when it is in everyone’s interest to do so is the infamous “Prisoner’s Dilemma”. It goes as follows: Two prisoners have been accused of collaborating in a crime. They are in separate jail cells and cannot communicate with one another. Each has been asked to confess to the crime. If both prisoners confess, each will receive a prison term of 5 years. If neither confesses, the prosecution’s case will be difficult to make, so the prisoners can expect to plea bargain and each receive a term of 2 years. On the other hand, if one prisoner confesses and the other does not, the one who confesses will receive a 1-year jail term, while the other will go to prison for 10 years. The game predicts that both prisoners will confess, and each serve a jail term of 5 years. Although this is not the optimal outcome for either, they each avoid the worst possible outcome (a jail sentence of 10 years) by refusing to trust blindly their former accomplice in crime. The impediment to a cooperative outcome in this game is lack of trust, fueled by the prisoners’ inability to speak with each other to negotiate the outcome. The payoff matrix for the game of Prisoner’s Dilemma is presented in Table 1.2.

The “game” of Prisoner’s Dilemma, and others like it, form the basis of more complex theoretical models that attempt to pinpoint the conditions under which cooperation for mutual gain among sovereign states can be achieved. It has been demonstrated, for example, that repeated interactions (as opposed to “one-shot” games) build trust among collaborating partners. The number of partners is also a factor—smaller groups are apparently better able than larger ones to elicit the desired response (because of a heightened sense of community, shared values, and/or greater ability to punish noncompliant members).

At the global level, we often observe that when countries do cooperate, they often do so at a level inferior to what is in their own self-interest, and even more inferior to what would be in their collective self-interest. This is due to the familiar problem of free-riding, but it is greatly exacerbated at the global level because the international community has few tools available to reward countries for good behaviour and

to punish them for bad. To deter any country from failing to cooperate in the provision and financing of a global public good, countries must threaten to “punish” deviant behaviour by also refusing to cooperate. However, if they punish the deviant country by refusing to provide the public good themselves, they also suffer (in addition to the rest of the group). Thus, the countries that have the most to gain from supplying the good will do so, regardless of the free-riding behaviour of others. Although the public good will be supplied, it will be undersupplied relative to the optimal levels that could obtain if countries could be induced to cooperate fully.

This is the most common scenario we face in international health. The problem is less about countries failing to cooperate at all than about countries failing to cooperate actively enough to ensure generous funding levels for priority goods, and to ensure that these goods are made widely available. The challenge is to find ways to induce countries and the global community to do what it is in their own interest to do within any particular area of concern to health. “Within any particular area of concern” is important because the incentive structures differ within each area—basic research, applied research, eradication campaigns, surveillance, and so on. Each is characterized by a different set of potential partnerships, different strengths and weaknesses of the various partners, and differences in partners’ relative interest in the ultimate outcome. In game theoretic terms, the challenge is to structure the “game” so that the selective incentives induce the desired cooperative behaviour of the key players. Typically, rather than striving to reach an agreement that expresses the lowest common denominator for each player’s contribution, the idea would be to maximize the contribution of those players who stand to benefit the most from a successful outcome (Barrett, 2000). However, as we shall see, the intuitive solution runs counter to the cherished value of equity in health. Those countries that stand to benefit the most from international collaboration in health (that is, the poorest countries) are often the least able to push the agenda forward.

1.3 PRACTICAL APPLICATIONS TO HEALTH

Structuring incentives to induce the desired levels of cooperation is a lofty goal, but it leaves a more basic question unresolved: Cooperation for what purpose, and for whom? How do we reach agreement on which global public health goods should have priority? The 1978 International Conference on Primary Health Care held at Alma-Ata generated momentum behind a “Health for All” movement that characterized international health policy for over two decades—but is good health itself a global pub-

lic good? Most economists think it is not. Although there are some positive externalities to good health (and negative externalities to bad), personal health is generally considered by economists to be a private good.

“Public” health is a different matter. Governments will occasionally intervene to modify the behaviour of private individuals in order to maximize the public health impact. They may do so with a focus on:

1. Activities that have a positive impact on health that exceeds the ability of individuals, acting independently, to accomplish on their own (e.g. supporting health research to advance knowledge; vaccination campaigns to prevent or slow the spread of communicable diseases within a population).
2. Activities that regulate personal health behaviours because they have an impact (usually negative) on the health of others (e.g. health codes for restaurants; restrictions on smoking in public places).
3. Activities that promote or support personal health because they have an impact that goes beyond health (e.g. nutrition programmes for children in school that improve learning; health intervention programmes that improve labor productivity).
4. Non-health-related activities outside the sphere of any single individual that improve health (e.g. restrictions on industrial pollutants; efforts to slow global warming).

Each of these types of activities has an analogy at the global level. A global public goods perspective focuses on those types of public health programmes and policies that have a global reach. Because the unit of analysis for global public goods is typically the country rather than the individual or firm, the main focus of Working Group 2 was on activities that can only be achieved through multicountry collaboration. This led to a narrowing down of the options to three areas of great importance to international health: (1) research, including targeted R&D; (2) the control and prevention of cross-border spread of communicable disease; and (3) standardized data collection efforts. Chapters 2, 3, and 4 discuss these areas in detail. Here, we provide a brief overview of each.

1.3.1 Research and targeted R&D

Activities supporting basic and applied research are the engine of knowledge generation, which has been widely recognized as one of the most valuable global public goods for development (Stiglitz, 1999). Knowledge is nonrivalrous—there is no marginal cost from an additional individual enjoying the benefits of the knowledge. Knowledge is also nonexcludable, meaning that no one can be excluded from these benefits,

Box 1.1 SOME FORMS OF KNOWLEDGE CAN BE MADE EXCLUDABLE

If firms cannot appropriate the returns to producing knowledge, they will have limited incentive to produce it: in deciding how much to invest, they will look only at the return they acquire, not the benefits that also accrue to others. Governments may choose to provide an exclusive right to inventors to enjoy the fruits of their innovative activity over a limited period by issuing patents and copyright protection. In doing so, governments are engaged in a careful balancing act. The gain in dynamic efficiency from the greater innovative activity is intended to balance out the losses from the static inefficiency that ensues from the underutilization of the knowledge or from the underproduction of the good protected by the patent.

One part of the balancing act is to limit the duration of the patent. But other aspects of the patent system play an important role in how dynamic efficiencies are balanced against static inefficiencies—that is, the breadth and scope of a patent claim can have profound implications.

Source: Adapted from Stiglitz (1999).

once they have been generated. Yet to acquire knowledge requires a substantial investment of resources into research and development (and there may be significant costs associated with the diffusion of knowledge). In health, Working Group 2 examined the importance of research, both basic and applied, and also the importance of investments in targeted R&D that focus specifically on diseases of the poor. Finally, Working Group 2 also reviewed current debates about access, intellectual property rights, and patents. (See Box 1.1 on how patents make some forms of knowledge excludable.)

1.3.2 *Cross-border spread of communicable disease*

Increased awareness of the impact of globalization on cross-border disease transmission has made this one of the most easily recognizable global public goods for health among laypersons. Working Group 2 examined three areas in which countries have organized collectively to respond to health risks that emanate beyond their borders (due in part to the increased mobility of people, animals, and foodstuffs, globally): (1) disease eradication and elimination programmes; (2) global surveillance activities; and (3) the containment of antimicrobial resistance (AMR). The global architecture required to support collective action in the first two of these areas is already in place, although in some cases it is chronically underfunded. A global strategy for collective action in the third area, AMR, is only just beginning to emerge.

1.3.3 *Standardized data collection for analysis and evaluation*

Information is a classic public good that is nonrivalrous and largely nonexcludable. It can be made excludable, by design, if there is a charge associated with obtaining a specific data set or publication, for example. Nevertheless, it qualifies as a public good since the cost of making it available to each additional user is zero, or nearly so, and since each additional user does not lessen the availability of the information to others.

Working Group 2 examined the need for international collaboration in the production of standardized data for analysis and evaluation. It is in no single country's interest to adopt a standardized protocol for data collection or dissemination, but all countries can benefit from the ability to compare their own progress in terms of critical health measures with that of other countries. Thus, the collection of standardized data is a mutually beneficial goal that requires international coordination and collaboration to achieve.

1.4 MODES OF PROVISION AND FINANCE

Government intervention to supply public goods at the local and national levels may take a variety of forms, such as direct provision, taxation, subsidies, and/or regulation. Taxation or subsidies may be helpful if the goal is to change marginal levels of consumption or production. Regulation may be required if the goal is to enforce by legal means a minimum level of activity (e.g. the purchase of compulsory individual health insurance) or to restrict it below some maximum level (e.g. mandatory pollution controls), or where measurement problems prevent the assessment of an appropriate tax or subsidy (Barr, 1993). In cases where no market exists at all and cannot be created or manipulated by other forms of market intervention, direct government provision—often funded through tax revenues—may be necessary.

In the absence of a supranational entity with taxing and spending authority, other forms of equivalence to these known forms of government intervention must be found. One possibility is for a dominant country, motivated by its own self-interest but also by broader global objectives, to assume primary responsibility for providing global public goods (Kindleberger, 1986). Another is that several lead nations, acting in concert with one another, will undertake the same. However, this type of behaviour seems more likely in areas of greater geopolitical importance than is typically the case for global health issues.

A more practical solution would be to create an institutional and organizational framework capable of responding flexibly and effectively

to global challenges. A diverse array of international agencies, both bilateral and multilateral, has been created for this purpose. These agencies provide a variety of services that may be considered global public goods, including resource transfers; knowledge generation; harmonized norms and standards; and fora for global negotiations, regulation, and rule of law (Jamison, Frenk, and Knaul, 1998; Kapur, 2000). Some have even argued that these international agencies are themselves global public goods.²

It is probably more helpful, however, to consider these agencies as lead producers and financiers of global public goods rather than as goods themselves. Our main focus is on how the international agencies can best design efficient and effective platforms and programmes for the production and delivery of global public goods. Much remains to be learned about how to advance our knowledge of this area, and it is clearly a critical avenue for future study (Stiglitz, 1999).

1.4.1 *Production technologies for collective action*

Even within the organizing framework of the international agencies, countries must identify ways to combine their individual contributions to achieve any given collective outcome that they choose. Three principle modes of organization govern these “production technologies” (Sandler and Arce, 2001). Generally speaking, the best form of combining individual contributions will be given by the nature of the good to be produced (see Table 1.3).

For *best shot technologies*, the collective outcome equals that of the best individualized effort; small additional efforts have little impact on the overall outcome. Because these highly focused activities benefit from economies of scale, they may empower a single, dominant partner and crowd out the collective effort in production. Critics of this approach caution that excessively centralized provision may generate inefficiencies from an economic standpoint, or less than optimal outcomes for the collective, if a dominant provider is not sufficiently attuned to the interests of the collective (Kaul, Grunberg, and Stern, 1999).

Since these activities tend also to be very costly, the pooling of resources may be desirable. This may help tip the balance away from excessive centralization and towards well-orchestrated collective agreements among multiple partners. In health, the development of an HIV vaccine is often cited as a key example of this type of approach.

For *summation technologies*, the collective outcome equals the sum (or a weighted sum) of the individual contributions. In this most common

Table 1.3 PRODUCTION TECHNOLOGIES OF GLOBAL PUBLIC GOODS AND THEIR INSTITUTIONAL IMPLICATIONS

Technology	Examples	Institutional implications
Best shot	Finding a cure for AIDS Neutralizing an insect pest	Complex partnerships may be required to avoid excessive centralization of provision
Summation	Creating a standardized data set Reducing global warming	Reliance on international treaties, agreements on regulatory, protocol or other standards
Weakest link	Containing river blindness Eradication Outbreak surveillance	Capacity building in poor countries is essential

Source: Adapted from World Bank (2000a) and Sandler and Arce (2001).

form of international collaboration, the cumulative contributions of individual countries generate the collective outcome. A key implication for this type of production technology is that, although the independent contributions of each partner to the collective effort is important, the whole of the collective effort will be diminished—but not debilitated—by the failure of any single partner to contribute. An example would be the creation of a global database containing useful information on vital statistics and other key health indicators. The database can exist and can serve a useful function without the independent contributions of all countries, but its usefulness is lessened if a large number of countries fail to participate.

A variation on the summation technology is the *weighted sum*, whereby the individual contributions of countries are strategically weighted to reflect their relative importance to the collective outcome. Reducing cross-border air pollution may require a weighted sum solution if downwind deposits depend on an emitter's size and position with respect to the prevailing winds. Similarly, controlling the global incidence of AIDS will require the disproportionate contribution of those countries that contribute proportionally more to the total of new global infections.

With *weakest link technologies*, the collective outcome equals the level of the smallest contribution. This type of production technology is typically used to organize efforts to reduce or prevent the emergence of a global public bad. Examples may include eradication and surveillance networks for new and reemerging diseases. In these cases, the collective has an interest in supporting the weakest contributor, since any breakdown in its ability to achieve the desired outcome will occur at the lowest level—at the weakest link in the chain.

These production modes refer primarily to the alternative organizational arrangements that are needed to produce public goods for health. They provide little insight into how countries agree to share the financial burden among them. Yet how the burden is shared is clearly an important factor in determining the level at which the global public goods will be supplied. From an efficiency standpoint, beneficiaries should contribute up to their “marginal willingness to pay” or up to the value of their “marginal benefit from consumption”. However, from a normative standpoint, beneficiaries should pay based on their ability to pay (Sandler and Arce, 2001). Particularly in areas of health, these two perspectives often compete with one another. More attention must be paid to understanding the most effective means of managing the tension between these competing imperatives, at the global level.

1.4.2 Sources of finance

The World Bank’s Annual Report on Global Development Finance (GDF) (World Bank, 2000a) suggests that private charitable foundations and official donors are the main sources of finance for global public goods overall (i.e. not specific to health). (See Box 1.2 for a brief account of the history of charitable giving and global public goods for health.) Other significant sources include allocations of net income by multilateral development banks and programme spending by UN agencies.

Despite a rapid increase in spending on global public goods for health, the largest share of overseas development assistance (ODA) continues to support country-based activities in the health sector within the framework of conventional aid. Working Group 6 of the Commission on Macroeconomics and Health estimates that spending on global public goods for health is approximately US\$ 1 billion³ annually, or 13.3% of total estimated resource flows in development assistance for health. According to these calculations, annual contributions by the World Bank and the World Health Organization total US\$ 460 million, a sum that is closely matched by contributions from the Bill and Melinda Gates Foundation at US\$ 461 million annually. The bilateral and UN agencies contribute an additional US\$ 53 million on an annual basis (WHO, 2001d).⁴

The number of programmes, policies, and services falling under the heading of global public goods for health continue to proliferate. In fact, the multilateral development banks are coming under increasing pressure to finance multicountry initiatives directly, rather than through conventional country-based loans or grants. However, there are limits to how

Box 1.2 PRIVATE PHILANTHROPY AND THE PROVISION OF GLOBAL PUBLIC GOODS FOR HEALTH

Until the end of World War II, private foundations were the major independent source of funds for medical research. The Rockefeller Foundation, established in 1913, sponsored schools of medicine and public health worldwide, establishing the concept of institutional support for research and medical education. To fight yellow fever, for example, the foundation sent scientists throughout Africa and Latin America to conduct research and test new approaches. After 3 years, its New York laboratories developed the first yellow fever vaccine.

Traditional foundation endowments from the Old Economy are today being complemented by those of the New Economy. Businessman and philanthropist Ted Turner donated US\$ 1 billion to support UN efforts on global issues. The Bill and Melinda Gates Foundation has pledged substantial resources to eradicate polio, immunize children, and place computers in schools. It has committed US\$ 750 million to the Global Alliance for Vaccines and Immunization (GAVI). It has also granted US\$ 25 million to the International AIDS Vaccine Initiative and set up a US\$ 75 million Malaria Vaccine Initiative (MVI).

Private corporations and nongovernmental organizations also make charitable contributions. The Merck Corporation, for example, donated supplies of its drug ivermectin to the River Blindness control programme in Africa. The Novartis Foundation is playing a key role in the Global Alliance for Leprosy Elimination. Rotary International has been instrumental in both the financing and implementation of polio eradication, raising over US\$ 450 million and mobilizing volunteers to deliver vaccines in isolated regions.

Source: Adapted from Global development finance (World Bank, 2000a).

quickly the World Bank and other multidevelopment banks can respond to the increased pressure. The World Bank's GDF cites two recurring problems in the financing of multicountry initiatives: obtaining sufficient grant funding for shared project components and technical assistance, and determining the appropriate lending arrangements. The conventional instrument of finance for the development banks—a government-guaranteed loan—cannot be easily applied when countries' financial interests are pooled (e.g. it can be difficult to determine which countries should pay what proportion of the costs of borrowing). Over time, the World Bank has developed means of getting around this problem, including making loans to multinational entities such as subregional development banks and special-purpose companies created for the project; individual coordinated loans to participating sovereign borrowers; and single-country loans with a regional objective (Ferroni and Hassberger, 2000, cited in World Bank, 2000a). However, the absence of more direct procedures is a serious limitation.

The World Bank is also under increased pressure to expand its grant financing in poor countries. The purpose of such spending would be to

encourage poor countries to undertake activities that yield some global benefit, in addition to serving the needs of the countries themselves. From a global public goods perspective, the justification is that the financial obligation for supplying the good should be shouldered by all potential beneficiaries and not only the country that is directly responsible for producing the good.

Stansfield (2001) has identified the International Development Association (IDA) funds managed by the Bank as a potential source for funding health-related global public goods. The World Bank itself has been “cautiously exploring a possible role for IDA grants” to support global public goods, but there is considerable debate both within and outside the Bank regarding the long-term implications of an increased role in grant making rather than lending (Piercy, 2000). The World Bank has already made considerable progress in the area of communicable disease control, however. It recently pledged to triple the availability of IDA lending for this purpose, and it has committed more than US\$ 1 billion for AIDS-related projects in over 50 countries through IDA’s Multicountry HIV/AIDS Program for Africa (MAP). Progress has also recently been made in the area of “softening” lending terms in cases where the global public goods component of a country-level activity is particularly compelling (see Box 1.3).

Finally, trust funds represent a new and growing mechanism for financing global public goods for health. These funds are set up by private charitable foundations and official donors for a specific purpose, but they are administered by multilateral agencies. Among the agencies, the World Bank manages the largest trust fund portfolio, with global and regional programmes capturing approximately US\$ 700 million out of US\$ 1.3 billion in cash contributions in 2000 (World Bank, 2000a). However, although health spending is on the rise, environmental programmes have tended to dominate the trust fund portfolios.

1.5 CURRENT AND FUTURE CAPACITY OF INTERNATIONAL ARRANGEMENTS

Some of the most significant agencies involved in international health—and therefore the most likely financers or suppliers of global public goods for health—are the World Bank, the World Health Organization, bilateral government organizations, nongovernmental organizations (NGOs), and, increasingly, the World Trade Organization (WTO). These agencies must typically balance an assortment of other mandates in addition to the

Box 1.3 SOFTENING THE LENDING TERMS FOR GLOBAL PUBLIC GOODS FOR HEALTH

In partnership with several bilateral donors and the Bill and Melinda Gates Foundation, the World Bank recently designed an innovative new programme to finance global public goods for health. Modelled on a tuberculosis control project funded by the United Kingdom's Department for International Development in China, this initiative:

- Rewards improvement in health outcomes by using pooled donor funds to “pay down” the interest rates on loans for projects if they achieve mutually agreed-upon performance targets;
- Supports special assistance to improve the technical quality of projects using the new financing mechanism; and
- Encourages “ownership” through developing country and other donor participation in the approval and governance of new projects.

Source: Adapted from Stansfield et al. (2001).

increasingly high-profile mandate of financing or supplying global public goods for health.

Jamison, Frenk, and Knaul (1998) distinguish between two essential functions of the international health organizations, and particularly the World Health Organization (WHO): core functions and supportive functions. *Core functions*⁵ “transcend the sovereignty of any one nation state”, addressing problems of the global commons, “in which individual decisions based on property rights are made ineffective by the fact that use of resources cannot be contained within boundaries”. In contrast, *supportive functions* “deal with problems within individual countries that may warrant collective action at an international level owing to the shortcomings of national health systems”. By and large, these are typically the domain of traditional development assistance for health.

The core functions of the international agencies provide the most obvious means through which to organize and support the supply of global public goods for health at the international level. The modes of provision and service delivery may differ depending on the characteristics of the desired good being produced and the incentive structures needed to induce effective collaboration among multiple parties. The strategies adopted by the international agencies may be roughly described in terms of:

Indirect provision. The international agencies enforce treaties and support cooperative agreements that encourage countries to contribute to the overall supply of global public goods (or decrease their contribution to the supply of global public “bads”). These are essentially common strategic plans to which countries sign up. In health, the adoption of such plans often produces a non-event—that is, the

avoidance of an increase of a global public bad. The incentives may be legal or financial.

- *Legal incentives* attempt to modify the behaviour of independent sovereign states through contractual agreement. Important examples in health include the International Health Regulations (IHR), the WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), and the Codex Alimentarius Commission (Codex).
- *Financial incentives* to induce cooperative behaviour have not been widely used in health, although they have been more widely used by the international environment community. In health, a rare recent example was the World Bank's unusual insistence on making its loans to Russia conditional on the country's pledge to bring its tuberculosis epidemic under control. One justification for applying this novel form of conditionality to an area of typically national concern alone is the potential for cross-border transmission of drug-resistant tuberculosis. Collective action (in the form of World Bank lending policy) is needed to curb a negative externality (having a global reach) that stems from the government's negligence in controlling an epidemic.

Direct provision. International agencies undertake activities that contribute to the creation of new programmes, products, or services. There is value-added to these activities, since they contribute to the overall supply of global public goods, above and beyond contributions made by individual nation-states. In other words, these activities may “by-pass” sovereign states in favour of the direct provision of goods and services by the international agencies themselves, or by the international agencies in coordination with other partners. This has been a rapid area of growth for the overall supply of global public goods for health. A noteworthy feature of direct provision is that the initiative for many of these activities has come from outside the international agencies. Philanthropy is an important source of funding for these activities.

- *Products, programmes, and services.* Examples include the multiple and coordinated efforts to develop new drugs and vaccines for diseases of the poor; global eradication and elimination campaigns; GAVI; and the new Global Fund to Fight AIDS, Tuberculosis, and Malaria (GFATM).

- *Contributions to knowledge.* These include standardized data collection efforts, analysis, the development of new methodologies for research, and the dissemination of findings. Although these activities do not by-pass sovereign states in the strictest sense, they build substantially on the contributions of countries (e.g. methodologies to standardize data for comparative purposes and analysis of raw data collected from member states), and therefore can be said to generate “new” knowledge.

1.5.1 *Relative capacities of the international agencies in health*

1.5.1.1 World Health Organization

The World Health Organization is clearly one of the premier international agencies with a mandate for supplying global public goods for health, although the World Bank and other UN agencies play important contributing roles. Bumgarner (2001) cites three main contributions of WHO in supplying global public goods for health:

1. WHO facilitates agreements on standards among Member States and organizes collective responses to important global health challenges;
2. WHO contributes to the body of epidemiological knowledge that is based on WHO’s collection and analysis of routine reports from countries; and
3. WHO issues normative directives that provide guidance to countries about disease control or health care practices, thus enabling Member States to strengthen their national health capacities. (An important potential consequence of increased capacity at national levels is an increase in positive, global externalities.)

In addition to these supply functions, Bumgarner emphasizes the importance of WHO’s convening power to lead the debate over priorities within global public goods for health, and to encourage cooperation among the international agencies to provide them. To perform this function, however, WHO must be a willing partner with other agencies. Although sometimes WHO will be asked to take a lead role in setting up and directing these partnerships, this will not always be the case, and WHO must respond flexibly and cooperatively in these instances.

1.5.1.2 The World Bank

By comparison, the World Bank is largely confined to an “indirect” role in providing global public goods for health, due to its primary role as lender to individual governments. The purpose of Bank lending is to support the ability of individual governments to produce national public

goods. In carrying out this function it may also support activities that generate important global spillover effects (as above, in the case of normative directives issued by WHO). For example, to the extent that the Bank's lending accelerates the pace at which national TB control is achieved, potential sources of TB infection are reduced globally.

However, the Bank is also a knowledge bank, and in so being, it is a direct provider of a crucial global public good for development. Its sector work on health has also made major contributions in this regard. For example, the Bank's formative book *Disease control priorities in the developing world* (World Bank, 1993a) was an important knowledge product in the field of health. Similarly, the ideas and methodologies developed in *Investing in health* (World Bank, 1993b) have been influential in increasing the magnitude and impact of health spending in developing countries. To some extent, the World Bank's analytic work in this area also made a positive contribution to WHO's activities in data gathering, analysis, and reporting methodologies. In fact, there is a great potential for the two agencies to build on each others' comparative advantages. WHO has a clear technical advantage in medical and public health knowledge. The Bank has greater expertise in economic and financial analysis, health sector reform, and cross-sector linkages in development.

1.5.1.3 Financial capacities

The financial capacities of the two agencies are significantly different. As is true for all UN agencies, WHO gets its resources from two primary sources: regular budget resources derived from membership dues, which are determined by treaty, and extra-budgetary resources, determined by external donors. A striking, and troubling, feature of WHO's financial health is that it derives as much as of its resources from extra-budgetary sources as it does from membership dues. This dependence on contributions may seriously distract from WHO's ability to focus on its core mandates. It also creates unhealthy competition, both internally and externally. On the positive side, without the extra resources, WHO would clearly not have the ability to expand into important new areas as those areas evolve. For example, it was external funding that helped to revitalize WHO's activities in the area of tuberculosis, malaria, and tobacco-related diseases.

Until recently, the World Bank has not been as vulnerable to financial constraints in the same manner as WHO because its administrative budget has not depended on external grants. However, this situation has been changing. The Bank has had to respond to external pressure and improve

the efficiency of project operations. Its staff now spend a larger amount of their time trying to mobilize resources, just as WHO has had to do for the past several decades. How seriously this will affect the Bank's focus on its primary mandate remains to be seen, although the outlook for the short and medium terms is not promising.

Another significant obstacle to the Bank's ability to contribute to the supply of global public goods for health is its focus on bilateral lending. The Bank's ability to increase its role as an important supplier of global public goods for health will require the creation of better mechanisms for making concessionary loans and grants to multiple countries or regions.

1.6 CONCLUSIONS

In sum, global public goods are public goods that exhibit cross-border externalities, and are therefore likely to be undersupplied at the global level by markets and governments alike. They will be undersupplied by markets because the private sector lacks incentives to invest in them. They will be undersupplied by governments, at a global level, because sovereign states will tend to "free-ride" on the contributions of others under conditions of international anarchy. Countries may attempt to overcome the collective action challenge by working through the international agencies to provide global public goods in one of two ways: directly, through involvement in activities that generate new products, programmes, or services; or indirectly, through enforcing agreements among countries to increase (or decrease) their relative contributions to the global supply of public goods.

Despite the world's growing recognition of the importance of investing in global public goods for health, the international agencies in fact face a variety of constraints that affect their capacity to respond effectively to new global challenges. Two significant examples include institutional constraints (e.g. WHO's ability to act in partnership with other groups may be limited by its Constitution; the difficulties faced by the World Bank in lending to multicountry initiatives) and financial constraints (e.g. insufficient funding and support for global programmes).

Several priority areas for health—international health research, targeted R&D, strategies to prevent or reduce the cross-border spread of communicable disease, and standardized data collection for analysis and evaluation—are addressed in the chapters that follow, but there are certainly others as well.⁶ It will be an important undertaking for the international health community to identify these areas, and to prioritize among them. We have taken only the initial steps towards this goal. There remain

other challenging issues, as yet unresolved, that will affect the trajectory of the global public goods agenda for health. Some of the most significant of these include concerns about equity (who benefits and who pays?); implications of increased spending on global public goods for health on spending on conventional development assistance for health; linkages between local, national, and global public goods (where should the focus be?); and the importance of civil society and its impact on the global public goods agenda for health.

2. BASIC AND APPLIED RESEARCH AND TARGETED R&D

2.1 INTRODUCTION

Two features of health research—joint products and economies of scale—go a long way towards explaining why global research infrastructure tends to be concentrated in a few countries of the world and why resources tend to be skewed towards the development of goods, products, and services that benefit the wealthy rather than the poor. First, health research typically yields “joint products”—some combination of public and private goods (see Section 1.2). This means that the overwhelming emphasis of private-sector research will be on capturing private returns to investment rather than the potential public, or social, returns.

Big pharmaceutical and biotechnology firms are focused on illnesses of the rich rather than diseases of the poor. Although the number of potential consumers for treatment of diseases of the poor is high, the potential for profitability is low, either because of the inadequate purchasing power of individual consumers and/or the lack of effective health systems that can purchase and deliver the needed products.

Moreover, public-sector investments in research in the rich countries tend to reflect the health care priorities of their constituencies, rather than those of the poor in developing countries. Kaul (forthcoming) has called this a “double jeopardy” for the world’s poorest, since not only do they have limited access to the most basic basket of private goods, but the already underprovided basket of existing global public goods is skewed against them.

Second, health research—laboratory and medical research, in particular—tends to reflect important economies of scale in production, as given by “best shot” technologies (see Section 1.4). The effect is typically a concentration of resources into a few geographic locations, which further exacerbates the problem of equity in health research. A 1990 report of the Evans Commission on Health Research for Development, entitled *Health research: essential link to equity in development* (WHO, 2001a), portrayed the problem in this way:

An estimated 93% of the world's burden of preventable mortality (measured as years of potential life lost) occurs in the developing world. Yet of the \$30 billion global investments in health research in 1986, only 5% or \$1.6 billion was devoted specifically to the health problems of developing countries. For each year of potential life lost in the industrialized world, more than 200 times as much is spent on health research as is spent for each year lost in the developing world (cited in Freeman and Miller, 2001).

But the best-shot analogy can be taken only so far. Health research can range from a relatively unfocused scientific exploration (basic research) to highly focused ventures with precise objectives. Even for highly focused ventures, if the best-shot approach means that there is room for only one major participant for any given scientific initiative, it raises efficiency concerns (Webber and Kremer, 2001). Competition among interested parties is often the engine for innovation and creativity in research.

It should be possible, therefore, to work around these technical attributes of research to achieve a more equitable and socially profitable outcome. The Evans Commission highlighted the severe capacity constraints of developing countries as a major obstacle. It built a strong case for investing in research at the national level as a way for developing countries to analyse their own problems, make the best use of limited resources, improve health policy and management, foster innovation and experimentation, and have a stronger impact on global health research. The report spawned a variety of other initiatives that focused on the development of standards for setting national and global priorities for health research, including the 1996 Ad Hoc Committee on Health Research for Development (WHO, 1996). The Global Forum for Health Research was established in 1997 to provide an institutional vehicle for carrying forward this agenda, but more must be done (WHO, 2001a).

From a global public goods perspective, international collaboration to address these concerns can make a difference. Such collaboration will probably not happen if no explicit action is taken, however, and it may not happen in response to objections to the status quo on ethical grounds. Solutions will be more likely if win-win strategies can be found. Lucas (2001a), in a background paper for this Report, reminds us that international collaboration can offer opportunities for mutual gain:

- Scientific talent that produces creativity and innovation is widely distributed around the world and international collaboration expands the pool of talent that is available for tackling research problems.
- Research facilities in any given country, particularly developing countries, are limited, so it is often not possible to generate in one country the critical mass of talent and physical resources necessary to tackle a research problem effectively. Cross-border collaboration offers the opportunity of generating this critical mass.
- Unique opportunities for collaborative research occur in some specific locations. For example, the investigation of Kuru in Papua New Guinea by a team of American scientists led by Dr Carlton Gajdusek gave us the first clues about “slow viruses” and opened the way to a better understanding of scrapie in sheep, Creutzfeld-Jacob disease in humans, and bovine spongiform encephalopathy in cattle.
- International collaboration facilitates the exploration of shared features in biological systems, sometimes leading to unexpected discoveries. By revealing similarities and differences, cross-national comparative studies broaden perspectives and concepts beyond the narrow findings in individual countries.
- International collaboration offers the opportunity to strengthen the research capacity of less-developed countries and institutions and facilitate the transfer of technology.

2.2 RESEARCH: BASIC AND APPLIED

Working Group 2 conceives of health research in its broadest sense, as a process for obtaining systematic knowledge and technology that can be used to improve the health of individuals or populations. Such a process may embrace different types of activity, ranging from *basic research*—the primary purpose of which is to advance knowledge—to *applied research*, which is focused on solving specific problems relating to health care systems and delivery (WHO, 1996). Although basic science is strongly rooted in the tradition of the hard sciences, applied research often draws heavily on the multidisciplinary techniques of the social sciences.

2.2.1 *Forms of international collaboration*

Lucas (2001a) and Barton and Heumueller (2001) have identified various modalities for conducting international collaborative research. These modalities are not mutually exclusive, and a sponsoring agency may provide funding and support any number of these modalities at the same time. A modified version of Lucas's original list highlights the following:

Bilateral research programmes involve partnerships between scientists from two institutions located in two different countries. They may be best supported by sponsorship of medical research councils in the developed countries and advanced developing countries. Over time, these may foster the strengthening and development of national centres of excellence in developing countries. These partnerships can take any of the following forms:

- *Scientist to scientist* in the public sector.
- *Scientist to scientist* (involving public and private institutions). Often supported by the public-private partnerships, such as the Medicines for Malaria Venture (MMV) and the Global Alliance for TB Drug Development.
- *Institution to institution*. These may involve twinning programmes that link developing country institutions with more advanced institutions in the developed countries. For example, the Department of Clinical Pharmacology of the University of Ibadan, Nigeria, was linked with a department at the Karolinska Institute in Stockholm, Sweden, to study chemotherapy of malaria. The UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases (TDR) has supported this type of approach.

Multinational research programmes involve partnerships between scientists and/or research institutions and are likely to be supported by international funding sources. These programmes can take the following forms:

- *Interactive networks of scientists* link groups of scientists who have a common interest in a specific research area. They may also facilitate general access to scientific information.
Examples: African Networks for Health Research and Development (AFRO-NETS), the International Clinical Epidemiology Network (INCLIN), and the International Health Policy Program (IHPP).

- *Integrated networks of institutes* coordinate the activities of collaborating centres to achieve specifically defined goals, such as targeted R&D or training programmes. They may provide excellent fora for conducting multicentric studies that standardize research protocols and pool the results of individual studies, thereby increasing the number of eligible cases for study.

Examples: TDR (Special Programme for Research and Training in Tropical Diseases) and HRP (Special Programme of Research, Development and Research Training in Human Reproduction), both at the World Health Organization.

- *Multilateral research institutes* create a network of international research centres that are based in developing countries and are focused on a specific research goal. They recruit globally and typically have well-equipped laboratories and infrastructure.

Examples: Consultative Group on International Agricultural Research (CGIAR); International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B).

2.2.2 *A fragmented system*

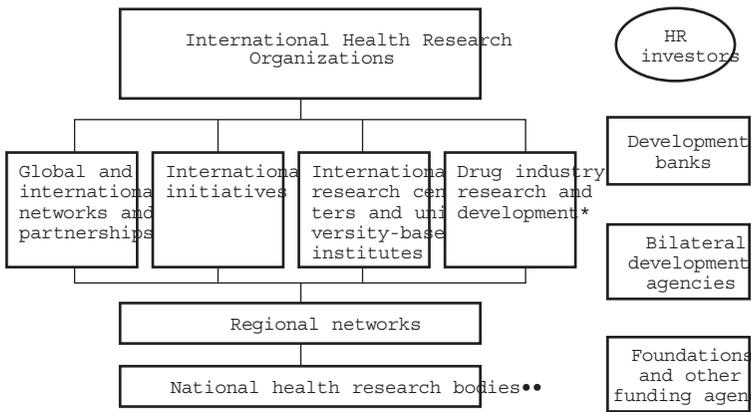
The programmes and corresponding activities associated with international health research do not operate in a vacuum. They take place within an institutional environment that is characterized by a dizzying array of participants and stakeholders. Yet this institutional environment sets the ground rules (often implicitly instead of explicitly) for these programmes, rewarding certain activities and discouraging others.

The Task Force on Health Architecture recently conducted a reassessment of the institutional environment for health research, which followed up on previous work produced by the Ad Hoc Committee (WHO, 1996). It concluded that three new features are increasingly changing the institutional environment for health research: accelerated growth in the number of stakeholders; variations in the number of strategies used to fund and support international health research; and the increased significance of private-sector participation, especially industry and philanthropic organizations. Figure 2.1 shows the map of the global health research system that was generated by the Task Force.

2.2.3 *Where do the incentives lie?*

It would be interesting as part of the mapping exercise undertaken by the Architecture Task Force to include information about resource flows among and between stakeholders identified. This would provide a starting

Figure 2.1 MAP OF THE GLOBAL HEALTH RESEARCH SYSTEM



* The pharmaceutical industry is both a “doer” of research and a provider of research funds.

** Countries have both “doers” of research and government agencies that provide research funds.

Source: WHO, *Task Force on Health Architecture*, 2001.

point for understanding the way in which different forms of international collaboration are encouraged, or discouraged, within the broader framework of international health research.

As is true of global public goods in general, international health research may be strengthened by initiatives undertaken at the national or the supranational level. Recent developments in targeted research have tended to bypass the nation-state in favour of global initiatives such as the public-private partnerships. But Lucas (2001a) warns that global initiatives in international health research must be firmly committed to building national research capacity if they are to succeed. He reiterates the findings of the Evans Commission, which emphasized the importance of national-level research requirements in setting the agenda for global health research.

The Evans Commission called on developing countries to embrace the concept of Essential National Health Research as a mechanism for managing their health research programmes. Several global initiatives have focused on the development of methodologies that would enable developing countries to set research priorities and evaluate their impact (WHO,

1996; World Bank, 1993). Freeman and Miller (2001) argue that further development and refinement of these methodologies is needed in order to promote health research as an area of strategic interest.

2.2.4 *A global public goods agenda for health research*

An important requirement for strengthening international health research involves building national research capacity in developing countries. Lucas (2001a) argues that little can be done if developing countries themselves do not commit to expanding their own research programmes; he notes that few countries have elected to earmark 2% of their national health budgets for research, as recommended by the Evans Commission.

A variety of initiatives can be undertaken at the global level to facilitate health research capacity-building in developing countries, however. These initiatives frequently require changing the incentives governing international health research to increase the opportunities for partnership and collaboration. Discussions have tended to downplay the importance of creating a network of international institutes for health research, such as that of the CGIAR for agriculture research. Lucas's assessment (2001a) is that such a system was successful in Asia and Latin America—in regions that already had a foundation of agricultural science—but was a failure in Africa, where such infrastructure was lacking.

Recent discussion has emphasized the importance of a competitive grant approach to stimulate high-quality health research. The grants could be used to fund individual researchers or to create centres of excellence in selected fields. Thus, at least in theory, such grants could fund any form of international research collaboration described above. Further research into which forms of collaboration are most likely to strengthen research capacity in the developing countries would greatly inform these funding efforts. Two recent proposals for consideration are the following:

1. Creation of an “international” NIH (National Institutes of Health) or Medical Research Council with an emphasis on extramural competition to support research projects. This idea originated at a San Francisco Bay Area meeting of Working Group 2 in August 2000. The CMH Report refers to this institution as the Global Health Research Fund (GHRF), and recommends that it be funded at the level of US\$ 1.5 billion per year by 2007, and US\$ 2.5 billion by 2015.
2. Creation of a Global Public Health Action Trust based on the model of an autonomous development fund. The main aim of the Trust would be to mobilize external support for health research by acting

as an intermediary between donor agencies and recipient institutions. This idea grew out of recent discussions of the Architecture Task Force. The model has recently been applied to INCLIN, which now exists as autonomous trusts in various developing countries.

Current discussions within the international health research community have also emphasized the importance of an enhanced role for medical research councils in developed countries and some advanced developing countries (especially Brazil, China, India, Malaysia, Mexico, and Thailand, all of which have significant capacity and strong institutions) in international health research. One advantage of this approach is that it encourages the use of the most advanced biomedical technologies in the study of problems affecting the poor in developing countries. Special attention should be paid to ensuring that the funding mechanisms encourage mutually beneficial partnerships with scientists in developing countries.

Finally, the international agencies themselves have a role to play in redirecting resources towards collaborative projects in international health research. Lucas (2001a) is a strong supporter of cross-national research studies, and recommends that the World Health Organization expand its activities in this area. The World Bank is similarly suited for facilitating cross-national research with an emphasis on policy (e.g. comparisons of health sector reform).

2.2.5 The role of ethics in a fragmented system

If there is such a thing as an agenda for global health research, is there a need for global standards surrounding the ethical regulation of research? Bhutta (2001) and Lavery (2001) suggest that current discussions regarding this topic, though useful in important ways, have tended to focus inordinately on questions relating to study design, ethical review, and standards of care. The missing piece is an emphasis on community participation in debates about research and its responsiveness to community needs and national priorities. Such an approach favours greater attention and sensitivity to context in all aspects and stages of research.

2.3 TARGETED RESEARCH

In the area of health research dedicated to the development of new pharmaceutical products—including drugs, vaccines, and diagnostics—inequities are even more striking than in basic research. For many of the major killers of the world's poor, no effective treatment exists. Existing treatments are often inadequate or are becoming obsolete due to the ris-

ing rates of drug resistance worldwide. Multi-drug Resistant Tuberculosis (MDR-TB) is spreading rapidly, with “hot spots” in most continents. Malaria is increasingly difficult and expensive to treat, due to growing resistance to existing drugs. No effective vaccine exists for HIV/AIDS, malaria, TB, or several other major killers of the poor.

The shocking imbalance between R&D investments for the rich and poor has been widely documented for over a decade. A 1999 study showed that of the 1223 new chemical entities marketed worldwide between 1975 and 1996, only 13 were developed specifically for tropical diseases (Pecoul et al., 1999).

This disparity is primarily due to a failure of markets. The relative lack of private-sector R&D for diseases specific to the poor in developing countries results from the low expected private returns on investment, which in turn is due to the inadequate purchasing power of affected populations. In the case of malaria, it is estimated that “a new drug that sold well in endemic countries, with a low margin, and achieved an aggressive 30% market share in the travellers market, at a 50% margin, would result at most in \$50m annual returns, not enough for pharmaceutical companies seeking annual sales potential of \$250m–\$300m for a new drug” (MMV Business Plan, cited in Kettler and Collins, 2001). For pharmaceuticals overall, the potential profitability of developing-country markets is small relative to that of developed-country markets. In 2000, developing countries accounted for only 20% of global pharmaceutical sales, and sub-Saharan Africa for less than 1% (Watal, 2000).

Although private returns on investments in diseases of the poor are low, social returns are often large. The potential magnitude of these unrealized social returns can be roughly estimated in terms of aggregate economic loss due to disease. Gallup and Sachs (2001) have calculated, for example, that poor countries with intensive malaria grew 1.3% less per person per year for the period 1965–1990. They also found that a 10% reduction in malaria was associated with 0.3% higher growth. However, a full measure of the economic impact would consider not only how the disease affects the level and growth of per capita GNP, but also its impact on lifespan and reductions in lifetime earnings (WHO, 2001b).

From a global public goods perspective, collective action is required to ensure that R&D activity focuses on areas for which the expected social returns on investment are high. However, each stage of the overall cycle of product research, development, and delivery is characterized by a distinct set of challenges. Thus, a certain amount of fine-tuning is required in formulating an effective policy response.

Working Group 2 examined a combination of push and pull interventions to stimulate overall levels of R&D activity in priority areas. “Push” interventions provide direct funding for research, thereby reducing the upstream costs and risks of R&D. Examples include tax credits on R&D and grants. “Pull” interventions help create a credible market downstream, thereby improving the likelihood of a return on investment. Examples include advanced purchase commitments and tax credits on sales. These interventions were evaluated both by their responsiveness to urgent research priorities and by the likelihood that they would generate a strong private-sector response in light of the market profile of priority diseases.

2.3.1 Identifying research priorities

Recent international attention has been especially focused on three of the major killers of the world’s poor: AIDS, malaria, and tuberculosis. Two other major killers, childhood diarrhoea and acute respiratory infections (ARIs), also require accelerated progress in the development of new drugs and vaccines. These five diseases merit the lion’s share of new resources in light of the global disease burden they collectively impose. However, a broad public policy response directed at the root causes of underinvestment need not arbitrarily be limited to these five diseases alone. There is a finite list of diseases specific to developing countries that can be effectively targeted by a sound set of policies designed to correct the relevant market distortions.

A recent study by the WHO/IFPMA Roundtable on Drug Development provides a useful starting place for discussion. The Roundtable brought together information on disease burden, state of the science, and current levels of public and private R&D for drug treatment of over 40 infectious diseases. The focus was on drugs, not vaccines, so the results must be interpreted with caution. Nonetheless, the Roundtable was able to conclude that there are only 9 disease areas for which additional R&D for new drugs is required: African trypanosomiasis, Chagas’ disease, GI nematode infestations, leishmaniasis, lymphatic filariasis, malaria, onchocerciasis, schistosomiasis, and tuberculosis. The prominent absence of HIV/AIDS from this list can be explained by the Roundtable’s focus on drugs rather than vaccines. Where drugs are concerned, the rich country markets provide sufficient incentive for private-sector R&D activity, but this is not the case for HIV vaccines (and, in particular, for HIV vaccines that target the strains most prevalent in the developing world).

Other obvious additions to the list would include paediatric diarrhoea and ARIs, with an emphasis on drugs and vaccines specifically suited to the epidemiology and biology of these diseases in developing countries. There may well be others, but this list provides a starting point for discussion.

Although Working Group 2 focused exclusively on communicable diseases, future work on identifying the research priorities should also examine the large and growing burden of noncommunicable diseases on the poor (Yach, Fluss, and Bettcher, 2000). In the immediate term, however, the emphasis on communicable diseases also can be justified on pragmatic grounds. The drug and vaccine markets for communicable diseases are highly segmented, making it easier to target the poor through skillfully designed policies.

2.3.2 *Understanding the market context*

Feachem and Medlin (2001) have proposed that a comprehensive policy response to stimulate R&D activity be organized around the market characteristics of three categories of diseases.

Category I diseases are incident in both rich and poor countries, with large numbers of vulnerable people in each. Examples include ARIs, measles, and diarrhoeal diseases. For these diseases, incentives for R&D exist in the rich country markets. However, though the R&D pipeline may be adequate, the resulting new technologies may not be readily applicable in developing country settings. The important causative agents may be different (as with diarrhoea); the strains may be different (as with pneumonia); and the state of health care infrastructure may impose different requirements for delivery (injectable versus oral), dosage, storage, and packaging.

HIV/AIDS is a Category I disease, but the markets for treatment and prevention differ. Whereas the markets for AIDS drugs (antiretroviral therapy) are global, the markets for AIDS vaccines may be segmented. Commercial development is focused on clade B (the strain most common in the United States and Europe) rather than clade C (the strain most common in Africa). The market for a clade C vaccine resembles those for Category II diseases rather than Category I.

A focus on Category I diseases may also be relevant in cases where the safety standards of rich countries are not appropriate for developing country settings. Countries experiencing a severe public health crisis (such as sub-Saharan African countries, at present) may be willing to accept higher levels of risk for any given level of effectiveness for pharmaceutical

products. Early formulations of a new AIDS vaccine are expected to provide only 30% to 40% protection and may produce undesirable side effects. Though unlikely to receive US Food and Drug Administration (FDA) approval (often a proxy for other countries' evaluation of acceptable risk), these early formulations may be appropriate for countries experiencing an extremely high burden of disease.

Category II diseases are incident in both rich and poor countries, but with the majority of the cases in the poor countries. Although R&D incentives exist in the rich-country markets, the level of R&D spending on a global basis is not commensurate with the disease burden. For example, tuberculosis and malaria are present in both rich and poor countries, but the vast majority of cases occur in the latter. Anticipated markets for new products against these diseases are not sufficiently large or profitable to stimulate an appropriate level of R&D investment. The low and decreasing interest shown by the pharmaceutical industry in developing desperately needed new malaria drugs is a good illustration of this phenomenon.

Category III diseases are exclusively incident in the developing countries. They include African sleeping sickness (trypanosomiasis), Chagas disease, and schistosomiasis. These diseases are nearly all caused by tropical parasites with complex life cycles that require warm temperatures for successful transmission. From a market perspective, these diseases are doubly handicapped: their constituencies are smaller than those with the higher-burden diseases of Category II, and are also extremely poor. As a result, such diseases receive extremely little R&D in general, and essentially no commercially based R&D in the rich countries. When new technologies are developed, they are usually serendipitous, as when a veterinary medicine developed by Merck (ivermectin) proved to be effective in control of onchocerciasis in humans.

Working Group 2 focused primarily on public policies that would address the problems of diseases of Categories II and III, although some attention was also given to the "applicability" issues raised for Category I diseases.

2.3.3 *Influencing private-sector decisions*

Various measures have been proposed to help redirect R&D activity towards Categories II and III, in particular. Both push and pull interventions are relevant, but they must be adjusted to reflect the different market characteristics of the three categories. For example, although Category I diseases may not require pull, push is required to ensure applicability of

the products to developing countries. Categories II and III require a different mix of push and pull interventions, but both are needed.

Push interventions have been most commonly used by developed-country governments to support basic research at universities and Medical Research Councils. However, domestic policies may also target specific diseases through tax credits and research grants.

R&D tax credits have the political advantage of not requiring direct budgetary outlays, but they offer no incentive for firms that do not earn an income. Most biotechnology firms have no current profits or tax liabilities. They could benefit if the legislation allows them to pass the benefit of the tax credits along to their investors, but this can be problematic. Legislation proposed in the United States last year addressed this issue by providing for a “refundable” tax credit. Companies would have been eligible for a 30% refund on eligible research expenditures if they could demonstrate a zero income tax liability for 2 concurrent years and gross assets of US\$ 500 million or less.

In the absence of complementary pull measures, R&D tax credits are unlikely to create incentives for commercial research for Category III diseases, since they lack a credible market. If R&D tax credits are not carefully targeted, they may have an unintended impact on research for Category I and II diseases. For example, without proper specification, an R&D tax credit for AIDS vaccine research might stimulate additional research for a vaccine appropriate only for the commercial market in developed countries (e.g. if it was effective for clade B and not clade C). A similar result could arise in the case of a malaria vaccine. A vaccine developed for the commercially important markets for tourists and the military might not be suited for the inhabitants of malaria-endemic countries.

Pull approaches at the national level could include tax credits on sales, extended patent protection, or purchase funds. *Tax credits on sales* would increase revenues on a firm’s sales to poor countries and thus increase the attractiveness of these markets. As with R&D tax credits, tax credits on sales have the political advantage of not requiring direct budgetary outlays. However, the smaller the market, the less actual pull would be afforded by the credit. Such credits would likely have no impact on R&D for Category III diseases and only a moderate impact on Category II diseases. Once again, biotechnology companies that have no tax liabilities would need special arrangements.

Kremer (2001) has proposed the use of *advance purchase commitments* to simulate markets in poor countries by ensuring a buyer for products once they are developed. An advantage of advance purchase

commitments is that the public sector pays nothing until a product is ready for distribution. They could be designed to differentiate among categories of diseases—for example, to contribute proportionally more to the purchasing price of products for Category III diseases than for Categories I and II. They also could be set up to purchase products on behalf of poor countries or to provide matching funds for the purchase of products by middle-income countries. The debate over which is preferable—the use of current financing strategies to create a purchase fund or the offer of advance purchase commitments (through government pledges or promissory notes)—is ongoing. Industry has responded to future commitment proposals with justifiable skepticism, noting insufficient uptake by developing countries and other purchasers of products already on the market.

At the national and/or regional level (as in the case of the European Community), push and pull mechanisms can be combined through *modified orphan drug legislation* (Milne, Kaitin, and Ronchi, 2001). This legislation in both the United States and Europe is designed to stimulate R&D activity for “rare” diseases affecting a small percentage of the population residing in those countries (fewer than 200 000 Americans and not more than 0.05% of Europeans). It creates a package of push and pull incentives to stimulate R&D activity in orphan product research, development, and marketing. The package of incentives may include tax credits on clinical research expenses (push), research grants for conducting clinical trials (push), and patent extensions (pull). Although it is too early to assess its impact in Europe, the US orphan drug legislation has been enormously successful.⁷ Its strong track record in influencing industry behaviour has generated interest in constructing a similar package of incentives for diseases specific to poor countries. The impact of having similar legislation in force on both sides of the Atlantic (in the United States and Europe) could be large. If Australia, Japan, and Singapore were to follow suit,⁸ over 90% of the global research-based pharmaceutical and biotechnology industry would have the incentive to pursue R&D in this area.

Finally, *public-private partnerships* (PPPs) are global networks that build on R&D activities supported at the national level, with a focus on the development of new drugs and vaccines for specific diseases (Kettler and Towse, 2001). The focus of the PPPs has been on the early and mid-stages of R&D. Their success in bringing products to the market is yet to be determined. Existing PPPs have targeted Category II diseases—HIV vaccines (International AIDS Vaccine Initiative, or IAVI), malaria drugs (MMV), and TB drugs (Global Alliance for TB Drug Development). There

Table 2.1 SUMMARY OF PUSH AND PULL POLICY OPTIONS BY LEVEL OF ACTION

Level of action	Push	Pull
National	Funding of basic research R&D tax credits Targeted research grants	Tax credits on sales Extended patent protection
	Modified orphan drug legislation	Modified orphan drug legislation
International	Public-private partnerships	Advance purchase commitments
	Universal adoption of modified orphan drug legislation by rich countries	Universal adoption of modified orphan drug legislation by rich countries

Table 2.2 RELATIVE IMPORTANCE OF PUSH AND PULL INTERVENTIONS BY DISEASE CATEGORY

Disease Category	Push ¹	Pull
I	+	
II	+++	++
III	+++	+++

1 Note, however, that R&D tax credits, an important push device, do not work for biotechnology companies paying no taxes unless special arrangements are made.

is an ongoing debate about whether an additional PPP should be created to address Category III diseases, specifically.⁹

Tables 2.1 and 2.2 summarize push and pull options by level of action and disease category. Ideally, policies at both the national and international levels would be tailored to have a differential impact on industry activity regarding Categories I, II, and III. A focus on more than three diseases, but fewer than twenty, is both realistic and manageable.¹⁰ The types of public-sector interventions needed at the macro-level are similar in most cases, so there is little danger of diluting the impact. On the other hand, the risk of missed opportunities by having a too-narrow focus is significant.

2.3.4 Current debates about intellectual property rights

A global public goods perspective on research must take into account the critical importance of intellectual property rights protection for innovative R&D. It is difficult to balance the public's interest in rewarding innovation against its need to have access to the products generated by the R&D. Achieving the proper balance between these two objectives has

recently been the main cause of tension between the activist community and the pharmaceutical industry.

Although the R&D process is lengthy and risky, most pharmaceutical products are relatively cheap to produce after they have been discovered and developed. This feature is what permits generic firms to launch products at prices well below the cost of a branded product, following expiration of the patent. Without patent protection and a secured period of market exclusivity, generic products would enter the market immediately upon product launch, and force prices down to marginal cost. Since marginal costs do not cover the fixed costs of R&D, the likely result would be a decrease in R&D and hence a decline in the number of new products brought to market. Therefore, intellectual property (IP) protection is needed to encourage risk-taking and innovation in the large research-based pharmaceutical companies and biotechnology firms.

Even for public-sector research on the neglected diseases, IP protection is crucial, since progress on all diseases takes place within a single R&D environment. The public sector must “defensively patent” for its own use to ensure that key data, fundamental to medical research, remain in the public domain. This has been the policy adopted by the SNP Consortium—a collaboration of the Wellcome Trust, 13 pharmaceutical and technology companies, and leading academic centres in the United Kingdom. The Consortium is dedicated to the creation of a high-quality map of genetic markers in the public domain. Patents are filed only for the purpose of establishing a priority date. The mapped SNPs data are released to the public domain on a regular basis at no cost, and no restrictions are placed on researchers (academic or commercial) for their use of the data.

As debate over IP and access has heated up over the past year, the players have become roughly divided into two camps: those who favour shifting the balance of the current global system of intellectual property rights towards less protection, either to promote access or on efficiency grounds, and those who favour working within the current framework but making better use of available tools that would promote access and stimulate R&D activity in priority areas, simultaneously.

2.3.4.1 TRIPS

For those favouring a shift in the balance of the current global system of intellectual property rights, the focus is generally on TRIPS (Trade Related Agreement on Intellectual Property Rights) and its potential impact on the access of developing countries to pharmaceutical products.

TRIPS was one of the agreements reached at the conclusion of the 1986–1994 Uruguay Round of the General Agreement on Tariffs and Trade (GATT) Multilateral Trade Negotiations. It is part of a package of agreements that countries must sign when they join the WTO. TRIPS came into force on 1 January 1995, but the transition periods for its implementation are staggered for countries at different levels of economic development.

TRIPS will affect each developing country differently, depending in part on the current state of development of its pharmaceutical industry. Countries such as India will be ready to compete in global markets, shifting away from the copycat strategies of producing patented products without authorization towards a research-based strategy of discovering and developing new products (Kettler and Modi, 2001). There is little evidence to suggest that TRIPS will increase the amount of investment directed towards neglected diseases, however. The expectation that it would is based on the assumption that local companies could discover and develop drugs at a fraction of the cost of global players and thus make a “neglected disease” strategy profitable, despite the low purchasing power of consumers. Volume sales of low-priced products could pay off if the R&D costs are sufficiently low.

A Working Group 2 report on “Intellectual Property Rights and Access” found that the basis for this expectation is weak for a number of reasons (Medlin and Kettler, 2000). First, to realize these optimistic cost savings, significant investments in drug discovery and development are needed. Such cost savings also depend on a steep and rapid learning curve for companies that, with few exceptions, have until now done little or no extensive R&D required to discover, develop, and market new products. Second, even if companies were capable of realizing such low costs, money-making opportunities from diseases of the rich would be many times greater than those from neglected diseases. Not surprisingly, Cipla and Ranbaxy, two of the largest research-based pharmaceutical firms in India, have targeted global markets by focusing their research on conditions of the wealthy and aged, including cardiovascular disease, diabetes, and cancer.

Correa (2001) points out that certain flexibilities within TRIPS—including compulsory licensing and parallel importing¹¹—could permit countries to obtain patented pharmaceutical products more cheaply. Under Article 31 of TRIPS, governments may seek to obtain a compulsory licence for domestic production, provided certain conditions are met. Among these is the condition that they first seek to obtain a voluntary

licence and, failing that, that they provide adequate compensation to the patent owner for the compulsory licence. However, TRIPS requires that the use of compulsory licensing be “predominantly” for the supply of the domestic market, raising questions about whether developing countries that lack production capacity can take advantage of this provision.

The proposals for working *within* the current global system of intellectual property rights are highly diverse, but all seek creative solutions to improve the poor’s access to existing products while preserving incentives for R&D activity for priority diseases. Two proposals speak specifically to global diseases, referring to treatments for Category I and II diseases that have potential markets in both the developed and developing countries.

For example, Lanjouw (2001) suggests that an agreement by firms to avail themselves of patent protection in either the high-income countries or the low- to middle-income countries, but not in both, could help reduce the prices that poor countries pay for drugs to treat global diseases. She predicts that the large pharmaceutical firms would naturally relinquish their patent rights in poor countries, allowing local copycat firms to produce the drug in question without fear of retaliation. If adopted, the proposal would represent a *de facto* return to previous practices that were evident prior to TRIPS.

2.3.4.2 Differential pricing

In an ideal world, countries would contribute what they could afford to the total costs of drug production, including R&D, and prices would be inversely related to the consumers’ ability to pay. The “global joint costs”—that is, the fixed costs of pharmaceutical R&D that are the same regardless of the number of purchasers of the final products—benefit all consumers and therefore most optimally will be shared by all. The economic theory of efficient pricing known as *Ramsey pricing* supports the practice of charging different prices to different consumers to cover these costs in addition to the baseline marginal costs (i.e. the baseline cost of production, excluding overhead).

By extrapolation, Danzon (2001) argues that an optimal pricing scheme for pharmaceutical products under patent would be one in which all countries contribute to the joint costs of R&D, but at different levels or tiers, depending on their GDP or some other equivalent measure of ability to pay. This would require that wealthy countries bear a disproportionate amount of the R&D costs of the product in question. Poor countries would contribute only partially or not at all to the cost of R&D. However, payments in these countries would cover the marginal cost of

the products they consume. The sum of the difference between the price paid and the marginal cost to each country (or segment of the population) would have to cover the joint fixed costs of R&D. The result: Cheaper prices can be made available to poor countries without negatively affecting the R&D incentives of firms. This is a simplified description of what is generally known as *differential pricing*.

A form of de facto differential pricing has characterized the vaccine industry for many years (Batson and Glass, 2001). Using different types of purchasing strategies, both the Pan American Health Organization (PAHO) and the United Nations Children's Fund (UNICEF) have been influential in lowering the prices for vaccines paid by their clients in the late stages of product maturity. Whether a similar strategy can now be pursued in the early stages of product maturity, and applied not only to vaccines but also to drugs, remains an open question. In theory, pharmaceutical and biotechnology firms should find a priori differential pricing appealing because it would increase their sales to markets that have been previously closed to them. But three concerns could reduce its appeal:

1. The low, differentiated price to developing-country markets could be used in setting reference prices in the developed markets.
2. The cheaper products made available to developing-country markets could find their way back to markets in the United States, Europe, and Japan.
3. The cheaper products could also benefit the affluent minority within developing-country markets.

2.3.4.3 Creative licensing arrangements

For Categories II and III, creative licensing arrangements may provide incentives for R&D while at the same time helping to improve affordability of the eventual product. Kettler and Towse (2001) point out that a key strategy of public-private partnerships must be to maximize the social value of product and process patents through aggressive management of intellectual property rights. This can be done by:

- acquiring rights over all IP arising from projects directly funded by the PPPs;
- trading rights to rich-country markets and use in other indications in exchange for affordable prices in developing-country markets;
- creating incentives for delivery to developing-country markets, such as requiring simultaneous launch in rich and poor countries;
- providing incentives to supply sufficient volume to developing-country markets; and

- retaining reversion rights, should commercial partners not deliver on their commitments.

In a similar fashion, Keusch and Nugent (2001) discuss ways that similar strategies can be pursued by public-sector funders of research. In the United States, the government transfers technology in accordance with the laws governing federal R&D (primarily, the Stevenson-Wydler Act and the Bayh-Dole Amendments to the Patent and Trademark Act of 1980). These laws define the ownership of rights expressed in patents and licences, and are intended to stimulate both development and commercialization of product activity in the biotechnology and pharmaceutical industries. It is at least technically possible for the US National Institutes of Health (NIH) to structure licensing agreements with private industry and others so that they are responsive in some fashion to the health concerns of the poor in developing countries. There are limits, however. First, extramural research in universities consumes 90% of NIH research funding, which means that the tech transfer offices of the universities have a far greater capacity for making use of innovative IP agreements. Second, there is the question of whether support for policies that benefit the poor in developing countries adequately represents the interests of the US taxpayer. If the interests of taxpayers are viewed too narrowly, there will be little support for such policies. However, if levels of support are to be generous and sustainable, there must be growing recognition of how health destinies in very different regions of the world are intertwined.

2.4 CONCLUSIONS

The need for concerted action to promote targeted R&D to benefit the poor in developing countries requires the international agencies to become involved in direct provision, thereby bypassing or, at least, adding value to the contributions of individual countries to these efforts through their Medical Research Councils, or their equivalent. Efforts to increase global levels of investment in international health through indirect means are less likely to produce the desired effect. Countries are unlikely to reach agreement on spending priorities in this area in the form of treaties or cooperative agreements. The most the international agencies can hope for is to influence domestic policies through informal recommendations in the manner of the Evans Commission (which suggested that developing countries devote at least 2% of their health budgets to research).

Underinvestment in specific disease areas that principally burden the poor is an expected result because of the tendency of research to generate “joint products”—that is, the same activity may produce a basket of

goods, some primarily public in nature and others private. The private sector is enormously capable of bringing private goods to market, so it falls to the public sector to invest in goods displaying significant “public” qualities. However, the vast majority of public-sector funding for health research is provided by the Medical Research Councils of the developed countries, or their equivalent. Thus, the spending priorities of even the public investments in research are likely to reflect the health care concerns of citizens in developed countries. The fact that research (especially laboratory research) displays significant economies of scale levies another serious blow to equity in the research endeavour. Research tools tend to be concentrated in the hands of a few, and many developing countries lack the capacity or the funding to compete.

In economic terms, it makes no difference whether a public good is provided publicly or privately, so long as it is supplied. By extrapolation, it should not “matter” whether targeted R&D is conducted in a handful of laboratories in the United States or on site in Tanzania. However, we know that it does in fact matter. The involvement of developing-country researchers is essential to the process of identifying priority disease targets, applying the benefits of general research findings to specific locations and contexts, and exploring new hypotheses through cross-national comparative studies. Thus, it matters from the standpoint of science, ethics, and pragmatism, even if not from a strictly economic perspective.

It is vitally important that the international agencies and the international research communities uncover ways to support research capacity in developing countries, in addition to supporting the basic principle of increased investments in health research that will benefit the poor. This international community could begin by encouraging the Medical Research Councils of the developed countries to devote, say, 20% of their budgets to research on diseases that primarily affect the poor. However, new funding mechanisms, such as an “international NIH” that would sponsor high-quality research through the competitive vetting of proposals, are needed on a global scale. An international funding mechanism could sponsor individual researchers or multinational research programmes or networks (although further study is needed to understand which among the existing models of collaboration are most cost-effective).

Finally, the international agencies must focus on creating effective partnerships to guide the complex process of targeted research through the various stages of product discovery, development, and delivery. These complex endeavours will build on the comparative strengths of partners from industry, public-sector research, and civil society.

3. CROSS-BORDER SPREAD OF COMMUNICABLE DISEASE

3.1 INTRODUCTION

Preventing the cross-border transmission of communicable disease¹² requires a “weakest link” approach to its provision, since the country contributing the least amount of effort towards the desired outcome tends to set the level that is achievable for the collective as a whole. This is a simplified description of a complex process described by Bradley (2001). Using a simplified general model of migratory activity, Bradley demonstrates that the degree of interrelated vulnerability between any two countries will be conditioned on the ratio of their point prevalences (instead of prevalence rates). In other words, if the disease has similar prevalence rates in Countries A and B (and unless the cross-border migration rate is extremely high), disease control activities in Country A will have little impact on Country B. However, Country B’s risk of importing outbreaks from Country A will rise as it begins to control indigenous infection. As the local prevalence approaches zero, Country B’s entire risk will depend on imported cases, and the global public goods value of control in Country A in terms of its benefit to Country B will reach a very high level. (The model presumes that Country B controls indigenous infection through means other than high-coverage immunization, which of course would reduce the risk of imported outbreaks for the period of immunity given by the vaccine.)

Bradley’s model highlights a crucial feature of preventing cross-border transmission of communicable disease: the benefits of *global* control efforts will be greatest for countries that have already reduced disease prevalence rates within their borders to relatively low levels. This feature raises interesting questions about equity. If one believes that those countries that stand to benefit the most from global control effects should also assume the lion’s share of the cost, one would hope to see resource transfers from endemic-free countries to the highly endemic countries. However, if one believes that countries should be taxed to compensate for the negative consequences of their domestic policies on the rest of the world, one might wish to see instead a transfer of resources from the highly endemic to the endemic-free countries.

In addressing these issues, Working Group 2 focused on three forms of international collective action that have emerged historically in response to threats of cross-border transmission: eradication and elimination programmes, global surveillance activities, and global strategies for the containment of antimicrobial resistance (AMR). The need for AMR containment has been recognized by the international community only recently, and global strategies to support it are still in their infancy.

For varying reasons, these examples of global public goods may appear “impure” in important respects. The principle of nonrivalry is maintained because the marginal cost of each additional user is zero, even if the costs of production are substantial. That is, the *principle of nonrivalry* refers to whether countries must compete for information made available by the network, not whether there are internal costs associated with their ability to contribute to the development of the network itself. However, countries may be excluded from the benefits of collective action, especially in the area of global surveillance. For example, some countries may be unable to benefit from surveillance information received from other countries, either because they are too poor to take the preventive action required or because they lack the expertise to develop a measured and effective response. As Stiglitz (1999) and others have pointed out, however, obstacles to access are not themselves violations of the technical criteria of global public goods for health.

3.2 WHICH DISEASES “COUNT”?

Working Group 2 began with the hypothesis that the control of some diseases is more likely to generate global externalities than others. This assumes, of course, that the externality of cross-border transmission is a central defining feature of global public goods for health in the area of communicable disease control. Others have pointed to non-health-related externalities related to disease control that might define the scope of the global public goods agenda—including the negative impact that a high disease burden has on a country’s economy, and including also the potentially destabilizing impact of a high disease burden on the social and political institutions of the country.

These considerations are clearly important, but it is also instructive to begin first with an assessment of the health-related externalities. Bradley (2001) tells us that the key determinant of whether the control of a disease is a global public good for health is the degree of migration across borders of infected people, vectors, reservoir hosts, or the pathogens themselves or their genes. Table 3.1 sets out a list of criteria that influence these migra-

tory patterns, and applies these to a subset of 24 communicable diseases. Examples of diseases for which their control efforts clearly qualify for global public goods status are malaria, polio, smallpox, and tuberculosis. On the other hand, the control of trachoma does not qualify, according to these criteria.

The ability of malaria to cross borders even under the most unlikely scenarios has been well documented. Bradley (2001) cites a study in rural Yunnan, China, in the Red River Basin, which set out to use satellite remote sensing to predict the location of malaria incidence. Instead, the researchers found that 126 of the 220 falciparum malaria cases found using the gold standard ground survey were imported from elsewhere. Even among the apparently local cases, the relative risk of infection in the 29 cases who had travelled in the previous few months was 9 times higher than those who had not travelled, so they too had probably acquired the disease from elsewhere. In other words, 70% of the cases in rural Yunnan had been contracted outside the area of residence.

By contrast, despite the highly contagious characteristics of the communicable disease trachoma, migratory patterns seem to have little impact on its spread. The infection spreads primarily within families, by contact with fingers that have picked up infection from already-infected eyes or genital tract. The infection may also be carried between people's eyes by the fly *Musca sorbens*, but evidence suggests that the impact of this mode of transmission may be mitigated if there is an ample local water supply available for personal hygiene. Thus, disease transmission appears to be very dependent on *local* environmental conditions.

3.3 DISEASE ERADICATION AND ELIMINATION PROGRAMMES

Eradication is perhaps the purest of global public goods in the area of communicable disease control and transmission. Once eradication has been achieved, all countries benefit (nonexcludability) and they do not have to compete for their share of the benefits (nonrivalry). Elimination programmes are essentially control programmes that bring disease incidence down to levels that are conducive to halting the transmission of an infectious organism from a defined area. These programmes are excludable by definition (and thus assume the characteristics of a club good), but still generate externalities of a nature similar to eradication.

The successful eradication of smallpox is undoubtedly the world's most stunning accomplishment in international health collaboration. Since final eradication in 1979, an estimated 30 million lives have been saved. The total cost of this achievement was US\$ 25 million per year for

Table 3.1 KEY FEATURES OF DISEASE TRANSMISSION FOR SELECTED DISEASES

Diseases	Endemic importance	Drug resistance	Vaccine	Feasibility of eradication	Vector		Animal Reservoir		Temperature dependent	Human Asymptomatic reservoir	Endemic need for Control	Overall Risk
					Needed?	Localized?	Exists?	Essential?				
Diarrhoea overall	++++									+	++++	+
Specific viral diarrhoeas	++	+								+		+
Tuberculosis	++++	+++	+	+						+	++++	+++
Malaria	++++	+++		+	Y	+			Y	++	++++	++
Meningococcal disease	++	++	++							+		+
Pneumococcal disease	++	++	++							+		-
Schistosomiasis	++			+	Y	+++			Y	+		
Dengue fever	++				Y	+			Y			
Viral haemorrhagic fevers	++				+	?+						
Influenza	+++		+++							+	+	
Acute respiratory infections	++++	++									+++	
HIV/AIDS	++++	+++								0	++++	++++
Measles	+++		++++	++						0		++
Tetanus	+		++++							++		
Polio	++		+++	+++								++
Pertussis	+		++									
Diphtheria	++		+++							+		+
Geohelminths	+		++			+			Y			-
Onchocerciasis	++				Y	++			Y	+		-
Guinea worm	++			+++	Y	++			Y			-
CJD	++									Y	Y	++
Salmonellosis	++	++								Y	+	++
Leishmaniasis	++	++			Y	++			Y	+		+
Emergent viruses	-	-	-	+	+	+				+	+	+++

Source: Bradley (2001).

12 years. Since the annual cost of vaccination and treatment at the start of the eradication effort was over US\$ 300 million, global savings amount to approximately US\$ 275 million per year in direct costs alone, with a cumulative total of over US\$ 168 billion (Nelson 1998, cited in Stansfield et al., 2001). Stansfield et al. (2001) estimates that US taxpayers are thereby repaid for their contributions to the smallpox eradication effort every 26 days.

Current projections suggest that the world will successfully eradicate a second disease from the planet—poliomyelitis—by the year 2005. Key elements of the eradication strategy include high routine infant immunization coverage with the Oral Polio Vaccine (OPV), national and sub-national immunization day programmes, acute flaccid paralysis (AFP) surveillance and laboratory investigation, and mop-up campaigns for containment of disease outbreaks (St. John and Plant, 2001).

The World Health Organization is the lead partner of the polio eradication initiative, ensuring that all components of the strategic plan are technically sound and successfully implemented. However, WHO's coordinating and management role depends heavily on the financial and technical assistance of its partners from civil society (e.g. Rotary Foundation), governments (e.g. US Centers for Disease Control), nongovernmental organizations (e.g. International Red Cross, Médecins Sans Frontières), the multilateral agencies (e.g. the World Bank, UNICEF), and the private sector. This is only a partial listing of partners, which underscores the growing complexity of international collaboration in the field of global public health initiatives of this scope and magnitude.

St. John and Plant (2001) credit WHO's strong leadership and a successful management of a diversity of partners in the impending success of the polio eradication initiative. In enlisting the support and cooperation of countries, WHO often provides direct technical assistance. Here, the global public goods benefit is the spillover effect generated by the polio's containment at the country level. But borders in many countries are increasingly porous, and WHO has also played a central coordinating role in helping countries synchronize their national immunization days in order to target mobile populations. Operation MECACAR, in the Mediterranean, Caucasus, and central Asian republics, provides an important example; and there have emerged important examples of cooperation in the southeast Asian region, as well (Andrus et al., 2001). Thus, through collective action, countries are able to reach major milestones in health that they either could not have attained, or could have attained only at high cost, through independent action.

Table 3.2 WHO SHOULD PAY? APPROPRIATE SHARE CALCULATIONS (US\$ MILLION)

World Bank income bracket	Financial or in-kind contribution	Appropriate share by WHO assessment	Appropriate share by population	Appropriate share by disease burden
High Income	2 533	6 004	1 078	8
Upper Middle	522	924	770	62
Lower Middle	938	616	1 155	354
Low Income	3 704	154	4 695	7 274
TOTAL	7 697	7 698	7 698	7 698

Source: Acharya et al. (2001).

Despite these optimistic findings, global eradication campaigns have had darker moments, also. The realization that only a handful of diseases were true candidates for eradication placed a damper on the enthusiasm of the early years following the world's success with smallpox. There is a danger of misplaced resource allocation, focusing scarce resources and the energy of the public health community on eradication campaigns that are relatively single-minded in their focus. This has led to increased support for strategies linking eradication efforts towards strengthening and capacity-building of health systems (Andrus, 2001).

Finally, the burden of eradication campaigns on the limited resources of health systems in the developing world raises questions about equity. Although all countries benefit, the enormous financial gains that accrued to the United States in the case of smallpox eradication, for example, were not matched by similar gains in most developing countries. The greatest beneficiaries were likely to be the developed countries that needed eradication to consolidate the gains of their national immunization programmes. In the case of polio, Acharya et al. (2001) have determined that developing countries are contributing more than their "fair share" to the polio eradication initiative given their capacity to pay. Table 3.2 compares actual contributions to appropriate share calculations based on need, population, and disease burden.

3.4 GLOBAL SURVEILLANCE: A NETWORK OF NETWORKS

Imagine a fully functioning global surveillance network. Once it is up and running, the property of nonrivalry applies—the cost for each additional country on the network is minimal and does not reduce the ability of the existing participant countries to benefit from the network. Instead, the network is reinforced and strengthened by each additional participant. In

addition, the principle of nonexcludability applies to the functioning network—although a “club” of countries could choose to exclude other countries, it would be costly (and therefore irrational) for them to do so.

In reality, there is no such thing as a fully functioning global surveillance network. A recent study by the US General Accounting Office (GAO, 2001) has concluded that the network could be more aptly described as a “network of networks” that suffers from fragmentation and, in many instances, from chronic underfunding. Developing countries are reportedly the weakest link in the global surveillance network. They bear the greatest burden of communicable disease, and are likely to be ground zero for the emergence of new pathogens, the reemergence of old ones, and the development of new drug-resistant strains.¹³ Surveillance systems have some general weaknesses, which are more pronounced in developing-country settings. These weaknesses include the lack of laboratory technicians, health care workers, and equipment; weaknesses in transportation and communication infrastructure; fragmentation of reporting systems; and poorly integrated linkages between data collection, analysis, and response.

Weaknesses in developing countries constrain the world’s ability to detect and respond globally to the threat of infectious disease. This situation points to an interesting, and unresolved, feature of global public goods: the solution to their adequate provision and supply rests at local, national, and sometimes regional levels. This has prompted many within the international health community to advocate on behalf of capacity-building in developing countries rather than consolidation of the fragmented systems at the global level. It must be strongly emphasized that these capacity-building efforts are not necessarily inconsistent with the global public goods approach to surveillance. In other words, the global public goods approach does not demand (and frequently avoids) overly centralized solutions to international health challenges.

3.5 GLOBAL STRATEGIES FOR ANTIMICROBIAL RESISTANCE CONTAINMENT

The problem of antimicrobial resistance (AMR) must focus on containment rather than eradication, since the goal is to achieve a balance between the use of effective antimicrobials to treat infection—thereby reducing morbidity and mortality caused by disease—and the emergence and spread of resistance to these antimicrobials. The ability of microorganisms to develop resistance to antimicrobials is a natural biological phenomenon, caused by the selection of resistant microorganisms as a

direct consequence of the use of antimicrobial treatments. The critical pathways for the spread of AMR across borders is not fully understood, but some evidence suggests that the transmission of AMR across borders may represent a greater threat than the spread of resistant bacteria within countries.

Smith and Coast (2001) have developed a typology of strategies that can be employed to contain the emergence and transmission of AMR. They note that the vast majority of strategies must be pursued at the national and even local levels. They argue, appropriately, that a “grand strategy” at the global level will not be as effective at containing the spread of AMR as the cumulative impact of changed behaviour at the local and national levels. Thus, we return to the conclusion we reached previously about avoiding overly centralized solutions to enhancing the supply of global public goods for health.

WHO has identified three strategies that may be undertaken at the global level to contain the spread of AMR:

1. Strengthen global surveillance of AMR and track the adoption and use of antimicrobial therapies.
2. Encourage the research and development of new antimicrobial therapies and alternative treatments for infectious diseases where antimicrobial resistance is a problem.
3. Take steps to ensure the rational use of antimicrobial drugs.

The last of these strategies may require changing the incentives faced by countries so that they adopt the appropriate domestic policies to respond to this global crisis.

For the incentive structure to be effective, it must be designed to force countries to behave strategically, so that the “reward” they accrue from their self-interested behaviour also results in the best collective outcome (Hargreaves-Heap et al., 1992, cited in Smith and Coast, 2001). In this case, the goal of international collective action must be to correct an imbalance that seems to exacerbate the spread of AMR worldwide—that is, the tendency towards overuse of antibiotics by rich countries and the tendency towards underuse of antibiotics in developing countries (Smith and Coast, 2001). Overuse in the rich countries may result both from the practice of medical doctors of prescribing antibiotics for situations where they are not justified and from the misuse of antibiotics in agribusiness. Recent studies have demonstrated the ability of resistance to appear in people following the consumption of animal meat containing the resistant strains (Brody, 2001). Underuse in the developing countries may result

from the inappropriate use of pharmaceutical products or the use of counterfeit or generic drugs of low quality.

At present, international agencies have few tools at their disposal to design a structure of incentives that will alter the domestic policies of countries. Heretofore, WHO has opted to address the issue in the same manner it has done historically, by developing recommendations and guidelines for nation-states and relying upon largely ad hoc harmonization of individual national mechanisms, legislation, and strategies rather than formal international legislation (Smith and Coast, 2001). These types of strategies, however, are unlikely to provoke the necessary worldwide response. As we have seen, countries will attempt to free-ride on the contributions of others if the appropriate incentives are not in place to prevent it. Given the gravity of the problem and evidence suggesting that global awareness is growing regarding this and other areas of concern to the cross-border spread of communicable disease, it is possible that conditions now favour a renewed resolve for collective action.

3.6 ADEQUACY OF EXISTING INSTITUTIONS

Since eradication is difficult and most diseases are not even good candidates for eradication, increased efforts to prevent the spread of communicable disease across borders must focus on other forms of collective action such as coordinated immunization and improved surveillance. However, under some circumstances, international law (treaties, standard-setting, etc.) may offer a useful instrument for achieving cooperative outcomes in health.

Fidler (2001) has argued forcefully that the international health community must begin to adopt legal strategies similar to those that have already been employed by the environmental community for many years. The presumption is that the use of *soft law*—principles and agreements between countries that are not binding but carry normative weight—does not have sufficient bite to achieve the necessary results. Much of WHO's work in the area of global communicable disease control has relied on nonbinding recommendations and guidelines to Member Countries. The only international health agreement on communicable disease that is in fact binding on its members—the International Health Regulations (IHR)—is widely recognized to be ineffective¹⁴ and in need of revision. In 1995, WHO initiated an effort to revise and strengthen the legal standing of IHR. These revised IHR are expected to be ready for international review in late 2002.

International trade law may emerge as a powerful vehicle through which to promote international cooperation in controlling the cross-border spread of communicable disease. The potential for this has already increased with the WTO's Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). The SPS Agreement has more bite than the IHR, in part because the Agreement applies to all trade-restricting measures designed to address cross-border transmission (unlike the IHR, which is confined to three specific diseases). More important, disputes under the SPS Agreement must be settled through WTO's Dispute Settlement Board. This provision is far more powerful than any dispute provision contained within the IHR.

3.7 CONCLUSIONS

The form of international collaboration required in preventing the cross-border spread of communicable disease, in contrast to international health research and targeted R&D, resembles indirect provision. The international agencies typically rely on a mixture of carrots and sticks—through treaties, conventions, or informal agreements—to encourage countries to cooperate to prevent or slow the spread of diseases across borders. Rather than by-pass countries to supply a new good, product, programme, or service, the international agencies work with them to stimulate global supply through concerted action at the national level. In contributing to the global good, countries also stand to benefit themselves, often considerably. For example, a country's contribution to the global containment of drug resistant TB is essentially equal to its own contribution towards the controlling the TB epidemic within its own borders. Hence, its contribution to the global good is no more or less than its contribution to the national good (from which it derives full benefit). Nevertheless, the global community will be very concerned with whether or not the country does in fact make this national level investment.

Two observations are relevant. First, for the global community to achieve its goals, it must persuade countries (and some countries more than others) to make investments at the local and national levels—for example, to strengthen the world's surveillance capacity or to control an epidemic. This intense interest by the global community in the domestic affairs of a sovereign state is given by the attribute of the weakest link, which is applicable here. The smallest contribution of the weakest member of the group defines the maximum level of good or product attainable by the group. This has tremendous implications for linking activities at the local, national, and global levels, but it has important equity implications,

as well. This brings us to a second observation. The distribution of benefits from preventing the spread of communicable diseases across borders is not evenly distributed among countries. And since surely countries vary by their relative contributions to the global supply of public goods or “bads”, (and not in the same proportion to the amount that they benefit from global containment), equity concerns loom large. Which country is primarily responsible for making massive investments at the local and national levels to reduce the potential for cross-border spread of disease? The country producing the output (or the global public “bad”, in this case) or the receiving country that benefits from its containment? This is a question that merits great scrutiny by the international health community.

4. STANDARDIZED DATA COLLECTION FOR ANALYSIS

The generation of information in the form of data collection undertaken on a global scale resembles the summation approach described in Section 1.4, in which the contributions of data from individual governments are the basic ingredients that produce the collective outcome. The analogy is only approximate, of course, because the activities of the international agencies—through the standardization of data, analysis, and dissemination of findings—contribute to the accumulation of new health-related knowledge. In other words, the whole is greater than the sum of the individual parts (i.e. discrete contributions of data from individual countries). The knowledge generated by these activities can provide information to local and national governments about best practices to be gleaned from cross-country data, or it can inform policy-making at a global level. In either case, the accumulation of knowledge based on standardized data collection and analysis is a crucial global public good that is absolutely dependent on international cooperation.

From a global public goods perspective, the types of relevant information range from simple descriptive statistics (e.g. vital statistics on births and deaths) and aggregate measures (e.g. disease burden and health systems accounting) to data required for the purposes of monitoring and evaluation (e.g. health systems performance data). Although the international agencies have made some impressive gains in all areas in recent years, much still remains to be done.

4.1 VITAL REGISTRATION DATA AND DEMOGRAPHIC SURVEILLANCE SYSTEMS

For many years, WHO has collected vital registration data. But because these data are based on registered deaths at the country level, the information is far from complete and is often of poor quality (Vos, 2001). Few countries outside of the Organisation for Economic Co-operation and Development (OECD) and former Soviet countries (with the exception of Mauritius) have complete vital registration data. China and rural India rely on sample registration systems. Vital registration in the Latin American countries may reach 80% in the urban areas, but these are not representative of health status in rural areas or of highly marginalized

groups in the population. Only two countries in sub-Saharan Africa have functioning vital registration systems: South Africa (with approximately 60% to 70% coverage) and Zimbabwe (with approximately 50% coverage). In both cases, coverage is far more complete for urban areas than for rural areas.

Demographic surveys and modelling techniques are used to supplement data from countries where routine data collection systems are unreliable. The Demographic and Health Surveys (DHS) of the United States Agency for International Development (USAID), for example, have a 15-year history of collecting data on population health in developing countries. Also, in addition to collecting the routine data reports from Member States, WHO relies on modelling techniques to estimate mortality rates for all countries as part of its project on the Global Burden of Disease (GBD). The goal of these modelling exercises is to assess global morbidity and mortality and to allow comparison between and among countries.

4.2 CAVEATS

The routine data-reporting requirements established by WHO serve an important function, but use of these data must be tempered by an awareness of two concerns. First, governments have been known to withhold or manipulate data deliberately for political purposes, which sometimes makes data sets from official sources vulnerable to misinformation. WHO's reluctance to challenge government misreporting has been subject to criticism from many sources (Bumgarner, 2001; Fidler, 2001). Lucas (2001b), for example, has questioned the extent to which government suppression of information about the spread of HIV/AIDS contributed to today's health crisis in Africa. Second, too many reporting requirements amount to a needless tax on scarce resources in developing countries. Musgrove (2001) asserts that the more information is piped "up the chain" (from local, to national, to global bureaucracies), the less likely it is to be detailed, accurate, or useful for decision-making. In the specific case of official disease surveillance, weaknesses in the official reporting systems have led these systems to be eclipsed by more rapid reporting through informal networks (Fidler, 2001; GAO, 2001).

In order to be useful, the reporting requirements of routine data must be either directly or indirectly linked to information needs for decision-making at the local, national, regional, or global level (Stout and Bos, 2000); the most important of these is usually the local or national level. An important "value-added" provided by the international agencies is the development of methodologies that allow these data to be standardized

and analysed in constructive ways. The list of crucial methodologies that now inform health policy at all levels includes the GBD and assessments of “best buys” in health (Jamison, Frenk, and Knaul, 1993; World Bank, 1993).

Again, caution is needed. The international agencies have been criticized on occasion for providing countries with inconsistent policy guidelines. Lucas (2001b) has identified significant discrepancies between policies advocated even within units of the World Bank on the importance of investments in water and sanitation to health outcomes (see Box 4.1). Clearly, coordination both among and within the international agencies is needed.

A second, related, concern is that the international agencies may not always have a sufficient understanding of a problem to give clear guidance to countries. For example, WHO was widely criticized for its publication of the *World health report 2000*, which ranked countries on health system performance. The rankings were at best a first cut at evaluating health system performance based on cross-country comparative data. Although the publication and the analysis it contained was an important step forward, it was probably unwise to present the rankings as conclusive findings, rather than as a work in progress.

4.3 CONCLUSION

The international agencies perform critical roles in data collection, standardization, and analysis that give value-added to the raw data that are received from countries. This function serves the international agencies by informing them of global trends, and permitting them to use this information to guide policy on global activities. In addition, the information generated directly benefits the countries that provide the data. The mechanism is circular: the data provided by countries to the international agencies are processed and analysed, and the results are fed back to the countries themselves to inform local and national decision-making.

Box 4.1 THE WORLD BANK'S COMPETING VIEWS ON THE IMPORTANCE OF WATER AND SANITATION TO HEALTH (CITED IN LUCAS, 2001B).

World Development Report:
Investing in Health,
World Bank (1993)

The costs and benefits of investments in water supply and sanitation (box 4.5, p. 93):

If households pay the total cost of water and sanitation services because of the productivity and amenity benefits, substantial health gains are an added bonus at no extra cost per DALY [disability-adjusted life years] gained. When willingness to pay is much less than costs, it is usually a mistake to justify subsidies on health gains alone. First, such subsidies compromise the demand driven approach to services provision (that is provision of services that people want and are willing to pay for); lack of accountability and inefficiency, and the inevitable consequences. And second, if publicly financed investments in these services are being considered for health reasons, it should be noted that such investments generally cost more per DALY gained than other health interventions recommended in this report.

Better Health in Africa:
Experience and Lessons Learnt,
World Bank (1994) Report.

Safe Water and Sanitation (pp. 30–31):

Safe water is an essential pillar of health. Yet large shares of Sub-Saharan Africa are deprived of safe drinking water... A review (Esrey and others 1991) of findings from 144 studies revealed that improved water supply and sanitation often reduces child diarrheal mortality by 50 percent, and sometimes as much as 80 percent, depending on the type of intervention and on the presence of risk factors such as poor feeding practices and maternal illiteracy. Improvements in the rural water supply in Africa have resulted in a remarkable reduction in the number of cases of Guinea-worm.

Esrey, S. A. J., Potash, B., Roberts, L., and Sciff, C. (1991) "Effects of Improved Water Supply and Sanitation (Excreta Disposal) on Ascaris, Diarrhea, Dracunculiasis, Hookworm, Schistosomiasis and Trachoma". *Bulletin of the World Health Organization* 69(5): 602–621.

5. CONCLUSIONS

Increasing the supply of global public goods can be thought of as creating a “virtuous circle” in at least two important respects. First, many global public goods enhance the ability of individual governments to produce local and national public goods. For example, the dissemination of information about best practices allows governments to make informed decisions about crucial health interventions and care delivery. The virtuous circle gains momentum as improved decision-making at the national level generates spillover effects at the global level. Second, increasing the supply of any given global public good for health may have a positive impact on the supply of other global public goods for health. For example, the successful eradication of smallpox owes much to the fact that the initiative was strongly supported by ongoing scientific research.¹⁵ Likewise, ongoing scientific research generates important new discoveries about best practices and controlling the cross-border spread of communicable disease.

Despite these optimistic observations, important challenges remain. The global public goods agenda is still in its infancy, and issues of consequence require our focused attention. Some of the most significant of these are summarized briefly, below.

5.1 EQUITY CONCERNS

Achieving sustainable levels of financing for global public goods for health is a major challenge that is complicated by the differences between who will benefit from the priority global public goods, if provided, and who pays. The most convincing theoretical scenarios for achieving high levels of sustainable cooperative financing depend on the willingness of one or a few countries to shoulder the financial burden for all the rest. For this to work, it generally presupposes that these same countries that shoulder the bulk of the financial burden are also the countries that will benefit the most from the supply of the good—witness the willingness of the industrialized countries to invest in a global trading regime, global financial stability, and global security.¹⁶ However, for many global public goods for health, the reverse is more likely true. That is, in many cases, the countries that stand to benefit the most from the programmes, policies, and services described are also those that are the least able to pay for them. Under

these circumstances, the supply of global public goods will most certainly fall below optimal levels.

In the case of health, the relative benefits enjoyed by countries may differ greatly according to the type of good in question. It may be the case, for example, that the proportionate benefit to rich countries is greatest in the area of preventing cross-border disease transmission. If so, might we witness a greater willingness on the part of the developed countries to invest resources in eradication and elimination programmes rather than in research and targeted R&D?

5.2 IMPLICATIONS OF A GLOBAL PUBLIC GOODS AGENDA AND TRADITIONAL DEVELOPMENT ASSISTANCE

Kanbur (2000) has identified at least two different perspectives on the global public goods debate. One perspective is that the presence of cross-border externalities strengthens the case for traditional development assistance; another is that the global public goods agenda offers a new vehicle for securing resource transfers that goes beyond the conventional bilateral transfers of loans and grants. The first perspective supports the securing of new resources for conventional development assistance. The second perspective is essentially neutral on the question of whether new resources are needed, but favours increased financing of activities that meet the criteria for global public goods.

Certainly, the potential for additional benefits in the form of global externalities would increase donor self-interest in providing traditional development assistance. But if the impact of increased self-interest on the part of donors is to undermine progress in the area of increased ownership by recipient governments, then linking the global public goods agenda to the development agenda could perniciously undermine the latter. (See WHO, 2001d, for an analysis of why increased ownership is a critical component of aid effectiveness.)

A different perspective on global public goods views this agenda as a new approach to conducting world affairs in an era of globalization. International cooperation is encouraged in areas that offer opportunities for mutual benefit and reward. In health, particularly in the areas of research and targeted R&D, poor countries will benefit disproportionately. Thus, global expenditures in these areas are a new means of providing resource transfers between the developed and developing countries. Under the circumstances, this may mean that spending on global public goods for health can be more effectively deployed than traditional aid to benefit the poor (if, as Dollar [1999] has argued, for example, it is the case that devel-

opment assistance in a poor policy environment is ineffective at reaching the poor). Whether global public goods overall provide a more effective mechanism than traditional aid for poverty reduction remains an empirical question that must be tested, especially in light of the equity considerations discussed above.

5.3 LINKAGES BETWEEN THE LOCAL, NATIONAL, AND GLOBAL LEVELS

The global public goods versus traditional aid debate is further complicated by the reality that the successful production of global public goods for health depends critically on activities undertaken at the local, national, and regional levels. This is less the case for research and targeted R&D than for activities in the area of communicable disease control and data collection. (Rightly or wrongly, resources dedicated to research and targeted R&D have often been concentrated in a relatively small number of laboratories or institutions in the developed countries.) Adequate global surveillance, for example, is often seriously constrained by weaknesses—such as the lack of qualified people and equipment, poor communications and transportation infrastructure, and poor coordination among local authorities—in developing countries (GAO, 2001).

5.4 GLOBAL PUBLIC GOODS AND CIVIL SOCIETY

This past decade has witnessed the emergence of important new global players, and the international agencies have been increasingly subject to pressures from interest groups and members of civil society. The challenge of developing the global public goods agenda becomes one of promoting pluralism and diversity in decision-making, on the one hand, and ensuring proper representation and legitimacy, on the other.

NOTES

1. A public goods approach is not the only justification for international collective action, but it is an important one.
2. Local and national governments are not usually termed *public goods*, though they produce many goods and services that qualify as public goods.
3. For the purposes of this Report, the term *billion* refers to 1000 million.
4. Working Group 6's calculations differ sharply from those produced by the World Bank's GDF (World Bank, 2000a). The GDF estimated total spending on global public goods for health at approximately US\$ 3 billion, but included in its calculations the entire amount of ODA dedicated to the health sector. Since

ODA includes spending on local and national public goods and some private goods, these figures substantially overinflate the actual amount of resources dedicated specifically to global public goods for health.

5. The authors identify four “global” public goods (which they refer to as *international public goods*): research and development, information and databases that can facilitate a sustained process of shared learning across countries, harmonized norms and standards for both national and international purposes, and consensus-building on health policy. They identify as a separate core function the prevention of negative externalities, such as surveillance activities. Working Group 2 treats all these core functions collectively as *global public goods for health*.
6. Yach, Fluss, and Bettcher (2000) cite the growing importance of noncommunicable diseases (NCDs) in global mortality and morbidity rates. These diseases do not display cross-border externalities as do many communicable diseases. However, NCDs are an important focus within two of the three priority areas of global public goods that are examined here: research and data collection for analysis and evaluation.
7. In the 10 years prior to the passage of orphan drug legislation in the United States in 1983, only 34 drugs of orphan status had been approved. In the 14 years following, over 990 substances have been granted orphan status, and 217 have received marketing approval.
8. The US orphan drug legislation was introduced in 1983. Other countries followed: Japan in 1995, Singapore in 1997, Australia in 1998, and the European Union in 2000.
9. Several alternatives exist. Some experts support the creation of a not-for-profit pharmaceutical firm. Another option would be to increase the resources available to the research councils (and/or to the TDR programme at WHO) for research on Category III diseases.
10. Any new legislation, European or national, could specify a list of priority diseases. Preferably, it would specify the characteristics of the included diseases and state that the precise list will be determined by periodic administrative review in light of the experience with the incentives, technical advice, and the changing global disease situation.
11. Although not explicitly permitted under TRIPS, parallel imports are permitted de facto. The legal principle is *exhaustion*—that is, patent holders relinquish all rights over how a product may be used (traded or resold) once it has been sold to an initial purchaser. TRIPS clearly states that none of its provisions can be used to address the issue of exhaustion of intellectual property rights in a WTO dispute (Article 6).

12. The term *communicable disease* is used by Working Group 2 in its most general sense to refer to infections as a whole rather than contagious infections only. International regulations and standards governing the transport of food and animals across borders would also have been relevant to this discussion, but these were excluded due to time constraints.
13. Several factors contribute to the increased likelihood that developing countries will contribute disproportionately to the emergence of new pathogens and the reemergence of old ones. These include accelerating urbanization and overcrowding in the context of inadequate water supply and sewage systems, population displacement because of complex emergencies and other disasters, and the increased likelihood of human infection by animals and insects that are carriers of these pathogens (GAO, 2001).
14. IHR's ineffectiveness results from (1) its focus on diseases that no longer represent the infectious disease threats of the day; (2) the failure of WHO Member States to notify WHO of outbreaks as required by regulations (and the informal reporting networks that have emerged globally and have eclipsed the formalized reporting process); (3) the tendency of WHO Member States, in response to outbreaks, to apply excessive and irrational measures affecting the free movement of people, animals, and food products across borders; and (4) the unwillingness on the part of Member States to punish violators (Fidler, 2001).
15. A heat-stable, freeze-dried vaccine; the jet injector; and the bifurcated needle were among the technological advances that contributed to the success of the smallpox eradication campaign (St. John and Plant, 2001).
16. Kaul (2002) has called this "double jeopardy" for the poor—that is, not only do the poor have limited access to the most essential basket of private goods, but the already-underprovided basket of existing global public goods are skewed against their favour.

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ANNEX I LIST OF ACRONYMS

AFP	Acute flaccid paralysis
AFRO-NETS	African Networks for Health Research and Development
AMR	Antimicrobial resistance
ARI	Acute respiratory infection
CGIAR	Consultative Group on International Agricultural Research
Codex	Codex Alimentarius Commission
DHS	Demographic and Health Surveys
FDA	Food and Drug Administration (US)
GAO	Government Accounting Office (US)
GATT	General Agreement on Tariffs and Trade
GAVI	Global Alliance for Vaccines and Immunization
GBD	Global Burden of Disease
GDF	Global Development Finance (World Bank)
GFATM	Global Fund to Fight AIDS, Tuberculosis, and Malaria
HRP	Special Programme of Research, Development and Training in Human Reproduction
IAVI	International AIDS Vaccine Initiative
ICDDR,B	International Centre for Diarrhoeal Disease Research, Bangladesh
IDA	International Development Association
IFPMA	International Federation of Pharmaceutical Manufacturers Association
IHPP	International Health Policy Program
IHR	International Health Regulations
INCLEN	International Clinical Epidemiology Network
IP	Intellectual property
MAP	Multicountry HIV/AIDS Program for Africa
MDR-TB	Multi-drug Resistant Tuberculosis
MMV	Medicines for Malaria Venture
MVI	Malaria Vaccine Initiative
NCDs	Noncommunicable diseases
NGO	Nongovernmental organizations
NIH	National Institutes of Health (US)
ODA	Overseas development assistance

OECD	Organisation for Economic Co-operation and Development
OPV	Oral Polio Vaccine
PAHO	Pan American Health Organization
PPPs	Public-private partnerships
R&D	Research and Development
SNP	Single Nucleotide Polymorphisms
TDR	The Special Programme for Research and Training in Tropical Diseases
TRIPS	Trade Related Agreement on Intellectual Property Rights
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization
WTO	World Trade Organization

ANNEX 2 BACKGROUND PAPERS PREPARED FOR WORKING GROUP 2

- Paper 1:** A Conceptual Framework for Understanding Global and Transnational Goods for Health (Sandler T, Arce D)
- Paper 2:** International Collaboration in Health Research (Lucas AO)
- Paper 3:** Scientific Capacity Building to Improve Population Health: Knowledge as a Global Public Good (Freeman P, Miller M)
- Paper 4:** Ethics in International Health Research: A Perspective from the Developing World (Bhutta ZA)
- Paper 5:** A Culture of Ethical Conduct in Research: The Proper Goal of Capacity Building in International Research Ethics. (Lavery JV)
- Paper 6:** The Role of Intellectual Property and Licensing in Promoting Research in International Health: Perspectives from a Public Sector Biomedical Research Agency (Keusch GT, Nugent RA)
- Paper 7:** Public Policies to Stimulate the Development of Vaccines and Drugs for the Neglected Diseases (Kremer M)
- Paper 8:** Orphan Drug Laws in Europe and the US: Incentives for the Research and Development of Medicines for the Diseases of Poverty (Milne C, Kaiten K, Ronchi E)
- Paper 9:** Differential Pricing for Pharmaceuticals: Reconciling Access, R&D, and Intellectual Property (Danzon P)
- Paper 10:** A Proposal to Use Patent Law to Lower Drug Prices in Developing Countries (Lanjouw JO)
- Paper 11:** Patent Law, TRIPS, and R&D Incentives: A Southern Perspective. (Correa C)
- Paper 12:** Patents in Genomics and Basic Research: Issues for Global Health (Barton J)
- Paper 13:** International Scientific Cooperation: Considerations from Previous Efforts (Barton J, Heumueller D)
- Paper 14:** The Biological and Epidemiological Basis of Global Public Goods for Health. (Bradley D)
- Paper 15:** Preventing the Cross-Border Spread of Communicable Disease. (St. John R, Plant A)
- Paper 16:** Global Responses to the Growing Threat of Antimicrobial Resistance (Smith RD, Coast J)

Paper 17: International Law and Global Infectious Disease Control
(Fidler D)

Paper 18: Global Information Needs for Health (Musgrove P)

Paper 19: The Evolving Role of the International Agencies in Supplying
and Financing Global Public Goods for Health (Bumgarner R)

Paper 20: Public-Private Partnerships to Promote R&D Activity (Kettler
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Paper 21: Innovative Financing of Global Public Goods for Health
(Stansfield S, Harper M, Lamb G, Lob-Levyt J)

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