The "Biblical Diseases" and U.S. Vaccine Diplomacy

PETER J. HOTEZ
Professor of Microbiology, Immunology, and Tropical Medicine
George Washington University

"It is a trite saying that one-half the world knows not how the other lives. Who can say what sores might be healed, what hurts solved, were the doings of each half of the world's inhabitants understood and appreciated by the other?"
–Mahatma Gandhi

IN 2000, 147 HEADS OF state met at the United Nations headquarters in New York City to adopt a landmark set of eight Millennium Development Goals (MDGs) to achieve sustainable development for the world's poorest people.[1] Together with a set of 18 targets,[2] the MDGs established a framework for combating poverty, disease, and environmental pollution by creating global partnerships between wealthy nations (especially the G8) and impoverished ones.[3]

MDG 6 specifically targets HIV/AIDS and malaria, among other diseases. Together, HIV/AIDS and malaria account for an estimated 4 million deaths annually, with 3.2 million of those deaths occurring in sub-Saharan Africa.[4] Because HIV/AIDS in Africa is also often complicated by tuberculosis,[5] many public health experts consider HIV/AIDS, tuberculosis, and malaria together as "the big three" diseases, causing an estimated 5.6 million deaths annually.[6] This article considers the "other diseases" by focusing on a group of lesser-known tropical infections. New analyses of these neglected tropical diseases (NTDs), also known as the "biblical diseases" because descriptions of them are found in the Bible and other ancient texts, suggest that they may be just as destructive as HIV/AIDS, tuberculosis, or malaria. There is a strong rationale for integrating NTD control into U.S. for-

PETER J. HOTEZ M.D., PH.D is a professor and chair of Microbiology, Immunology, and Tropical Medicine, as well as a professor of International Affairs at George Washington University and the Sabin Vaccine Institute.

eign policy and international development initiatives, especially in concert with the current U.S. focus on promoting relief through faith-based initiatives. As put forth by the UN, the Millennium Development Goals (MDGs) are as follows:

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

THE BIG THREE: HIV/AIDS, TUBERCULOSIS, AND MALARIA

Since the 2000 Millennium Declaration, the devastation wrought by HIV/AIDS, tuberculosis, and malaria in the developing world has attained a high profile in the industrialized world as well as urgently needed humanitarian funds.[7] Indeed, because of their commitment to the big three diseases, Bill and Melinda Gates together with pop singer Bono were lauded as *TIME Magazine* Persons of the Year for 2005. Under President Bush's leadership, the U.S. Congress has pumped hundreds of millions of dollars into the President's Emergency Plan for AIDS Relief (PEPFAR), a component of the $15 billion U.S. Leadership Against HIV/AIDS, Tuberculosis, and Malaria Act of 2003, while the global community has launched The Global Fund to Fight AIDS, Tuberculosis, and Malaria, a partnership among G8 governments, civil society, the private sector, and the affected communities.[8] Since 2001, the Global Fund has committed $1.5 billion in funding in 93 countries.[9]

Because of their effects on the growth and development of children, birth outcome among pregnant women, and worker productivity, the NTDs also exacerbate and promote poverty.

Major global health partnerships have been established to combat HIV/AIDS (the Joint United Nations Programme on HIV/AIDS),[10] tuberculosis (the Stop TB Partnership),[11] and malaria (Roll Back Malaria).[12] In November 2005, a Paris Declaration from the High-Level Forum on the Health MDGs called on these global health partnerships to harmonize and coordinate their activities.[13]

THE NEGLECTED TROPICAL DISEASES: ANCIENT BIBLICAL AFFLICTIONS

As the major global health partnerships and international advocacy efforts coalesce into an anti-HIV/AIDS, tuberculosis, and malaria juggernaut, it is possible to conclude mistakenly that the big three account for the entire developing world's burden of infectious diseases, perhaps with some added concern about the threat from emerging viruses such as avian influenza, the West Nile virus, and Ebola. However, a re-analysis of global disease statistics reveals the important, yet previously unrecognized impact of a group of 13–15 NTDs. These NTDs comprise, predominantly, parasitic infections caused by worms (lymphatic filariasis, commonly known as elephantiasis, onchocerciasis, commonly known as river blindness, ascariasis, hookworm, whipworm, guinea worm, schistosomiasis, oriental liver fluke, and cysticercosis) and protozoa (African sleeping sickness, kala-azar, Chagas disease), as well as three bacterial infections—trachoma, leprosy, and Buruli ulcer.[14] Each is a disease that almost exclusively affects impoverished people living in the rural areas (and a few poor urban slums) of low-income countries. With the exceptions of oriental liver fluke (East Asia) and Chagas disease (Central and South America), NTDs are most prevalent in sub-Saharan Africa.[15]

Despite the fact that many NTDs are caused by a menagerie of parasitic worms, bacteria, and protozoa, they exhibit a surprising number of common features. As mentioned above, each occurs mostly in the setting of rural poverty. However, because of their effects on the growth and development of children, birth outcome among pregnant women, and worker productivity, the NTDs also exacerbate and promote poverty. For example, chronic hookworm infection in childhood was shown to have a substantial impact on future wage earning potential,[16] while chronic infectious diseases are a major reason for inability to work in Ethiopia.[17] In India, lymphatic filariasis results in losses of $1 billion annually,[18] and worldwide losses from trachoma total $5 billion.[19] Overall, the NTDs impede progress on at least five MDGs, including those focused on poverty (MDG 1), education (MDG 2), child mortality (MDG 4), maternal health (MDG 5), and the other diseases (MDG 6).

Because of their link to poverty, the NTDs stigmatize those afflicted. Futhermore, several NTDs such as leprosy, Buruli ulcer, trachoma, lymphatic filariasis, schistosomiasis, and guinea worm are disfiguring and cause afflicted individuals to be either shunned or ostracized by their families and communities.[20] This latter feature is prominently described in the Bible and other ancient texts, particularly for leprosy, guinea worm, and schistosomiasis.[21] Therefore, unlike avian

influenza, HIV/AIDS, and other emerging infections, the NTDs are considered ancient conditions. Another common feature is that their link with poverty rules out any meaningful commercial market for treatments; major pharmaceutical companies do not undertake initiatives to develop new drugs or vaccines for the NTDs.[22]

Today, these ancient biblical afflictions still have a huge impact on global health. Approximately 500,000 people die annually from the NTDs.[23] Using a metric of disease burden known as the disability-adjusted life year (DALY—the years of life lost from premature death or disability) the NTDs cause a burden of disease equivalent to either HIV/AIDS, tuberculosis, or malaria.[24] Compared directly and using the revised DALY estimates of Hotez et al.,[25] the NTDs would be the sixth most destructive disease condition of humans behind lower respiratory infections, HIV/AIDS, unipolar depression, diarrheal diseases, and ischemic heart disease. As a result, it has been proposed that the NTDs should form a new fourth leg for the three-legged table composed of HIV/AIDS, tuberculosis, and malaria. According to the World Health Organization, the rankings of the world's 10 Major Diseases by DALYs are:

Rank	Condition	DALYs
1.	Lower respiratory infections	91.4
2.	HIV/AIDS	84.5
3.	Unipolar depression	67.3
4.	Diarrheal diseases	62.0
5.	Ischemic heart disease	58.6
6.	Neglected tropical diseases	56.6
7.	Cerebrovascular diseases	49.2
8.	Malaria	46.5
9.	Road traffic accidents	38.7
10.	Tuberculosis	34.7

POLYPARASITISM AND ITS IMPACT ON THE BIG THREE

The NTDs are among the most common infections in the developing world. Four of the NTDs—the three major intestinal worm infections (ascariasis, trichuriasis, and hookworm infection) together with schistosomiasis (an infection caused by schistosome flukes that live in the veins draining the bladder or the intestines)—occur in an estimated two billion people.[26] Sub-Saharan Africa has the highest prevalence of these worm infections, with 198 million, 173 million, 162 million, and 166 million cases of each disease, respectively.[27] Africa's high endemicity of the

intestinal worms reflects soil and climate conditions suitable to ensure the transmission of these parasites together with the poor sanitary conditions of the region, while schistosomiasis is a water-borne infection reflecting the region's lack of access to clean water. Epidemiological studies have shown that school-age children typically harbor the largest numbers of intestinal worms and schistosomes.[28] Therefore, in impoverished regions of developing countries, a significant proportion of schoolchildren have large numbers of three different types of worms in their intestines and schistosomes in their bloodstream. Such children are said to be *polyparasitized*. Women of reproductive age, including pregnant women, are also frequently polyparasitized with hookworms and schistosomes. Adding to the high rates of polyparasitism in Africa is endemic transmission of arthropod-borne parasitic infections including lymphatic filariasis (46 million infected) and river blindness (18 million infected).

Polyparasitism has a number of consequences for children and pregnant women in the developing world.[29] Chronically infected children suffer from deficits in physical growth, physical fitness, intelligence, cognition, school attendance and performance, and iron status; pregnant women are at risk for higher maternal and neonatal mortality.[30]

An understanding of the population biology of children with chronic polyparasitism, together with observations that deworming with antihelmintic chemotherapeutic agents could reverse many of these delays,[31] led to a resolution adopted at the 54th World Health Assembly in 2001 urging its member states to deworm at least 75 percent of school-age children at risk for chronic intestinal worm infections and schistosomiasis. The UN Millennium Project lists deworming under its "quick wins" category, referring to a simple intervention that could make a profound impact on the MDGs.[32] More recently, there has been an interest in integrating deworming with chemotherapy-based control efforts for other NTDs, including lymphatic filariasis, onchocerciasis, and trachoma.[33] Global initiatives are planned to simultaneously treat seven NTDs using a combination of antihelmintic and antibacterial drugs donated by Merck & Company, Pfizer Inc., GlaxoSmithKline, and Johnson & Johnson.[34] Because the most critical NTD drugs are donated, some estimates indicate that integrated NTD control is highly cost effective, possibly as low as $0.40 per person.[35] This figure is a fraction of the cost of antiretrovirals for HIV/AIDS, direct observed therapies for tuberculosis, or bednets and antimalarial drugs.

There is an additional dimension to deworming and NTD control. In Africa it is believed that a large percentage of individuals with HIV/AIDS, tuberculosis, and malaria are also polyparasitized, that is, they are co-infected with intestinal

worms, schistosomes, and filariae. New data suggest that such polyparasitism can exacerbate the mortality caused by the big three (especially malaria), increase the susceptibility to the big three infections (especially malaria and HIV/AIDS), and accelerate the progression of disease caused by HIV. Therefore, controlling Africa's polyparasitism through deworming and integrated NTD control could have a substantial impact on HIV/AIDS, tuberculosis, and malaria,[35] so that in the near future, U.S. (including PEPFAR) and international (including the Global Fund) efforts currently directed at the big three may need to be realigned to include the NTDs.

U.S. POLICY AND THE BIBLICAL DISEASES

Former national security advisor Zbigniew Brzezinski once described global turmoil as "the basic challenge of our time." He further warned of the importance of confronting the complexity of global turmoil through an understanding of the causes of mass poverty and social injustice. Not to focus on this, he said, is "to ignore a central reality of our times: the massive worldwide political awakenings of mankind and its intensifying awareness of intolerable disparities in the human condition."

The United States must therefore "place a higher premium on a truly shared global cause"; if it is to "derive any political benefit from the cultural revolution it is unleashing worldwide....The United States should treat globalization less as a gospel and more as an opportunity for the betterment of the human condition"; and "if [U.S.] policymakers do not deliberately infuse it with politically evident moral content, focused on the alleviation of the human condition, their uncritical embrace of it could backfire." "In the final analysis," Brzezinski believes, "a globalization that indifferently favors the rich…in a manner that benefits the already privileged will be a globalization that justifies its critics, mobilizes its enemies, and further divides the world."[36]

"A globalization that indifferently favors the rich will be a globalization that justifies its critics, mobilizes its enemies, and further divides the world."

Robert McNamara and James Blight recently argued for a similar moral imperative as a major goal of twenty-first century U.S. foreign policy.[37] Thus, aggressively combating these easily curable diseases should be the first priority of governments that promote globalization, especially the United States. Such an effort would reemphasize the moral benefits of globalization, refocusing attention toward its

potential to alleviate the worst afflictions of the human condition.

Combating the NTDs thus represents a unique opportunity for U.S. foreign policymakers to assert U.S. hegemony in a way that will determine whether or not we become a "Superpower Plus or a Superpower Minus."[38] The polyparasitized child with physical and mental delays is a potent icon of the root causes of global turmoil, and he or she could be an important new focus for U.S. outreach. Because of the benefits of deworming and its potential impact on the big three diseases, it would make sense for the Bush administration to expand PEPFAR by embracing NTD control. At the same time, an expanded focus on the biblical diseases would buttress the current administration's efforts to work with faith-based organizations, such as the recently established Center for Faith Based Initiatives at the United States Agency for International Development (USAID). It would not be lost on the U.S. public that hundreds of millions of Christians living in developing regions of sub-Saharan Africa, Southeast Asia, and Latin America are at risk for NTDs.[39]

A U.S.-based initiative on NTD or biblical disease control would also afford an opportunity for the country to take a leading role in the international enterprise of improving global health. The Global Fund to Fight HIV/AIDS, Tuberculosis, and Malaria has not yet committed to incorporating NTDs, even though new reports from the European Parliament and the Commission for Africa have already embraced the concept of tackling parasitic diseases as a component of larger global health programs.[40] In 2005, the United States took an important first step in leading the fight against the biblical diseases by allocating $15 million from the Foreign Operations fiscal 2006 appropriation to promote an initiative to integrate the control of NTDs.[41] It is anticipated that the appropriation will be managed by USAID. This propitious start needs to be followed by initiatives to link biblical disease control with PEPFAR and other U.S. leadership initiatives for HIV/AIDS, tuberculosis, and malaria.

The Larger Framework of Vaccine Diplomacy

Previous articles have discussed the theoretical and practical bases of incorporating vaccine research and infectious disease control as a component of U.S. foreign policy.[42] The modern era of vaccine diplomacy began when the U.S. virologist Dr. Albert Sabin collaborated with his counterparts in the Soviet Union to develop and test the live oral polio vaccine (OPV). After OPV was developed in the United States in the mid-1950s, it was tested in millions of Soviet schoolchildren before being licensed in the United States. Therefore, the development and testing of

OPV was a joint U.S.-Soviet venture occurring at the height of the cold war, shortly after the Sputnik launch in 1956.[43] Conquering polio was followed by additional U.S.-Soviet cooperation that led to improved formulations of the smallpox vaccine and eventually to the global eradication of smallpox in 1977. Some of our greatest medical and public health achievements were brought about because of back-channel scientific collaborations between cold war adversaries. McNamara and Blight calculate that 160 million people died in twentieth century wars.[44] Ironically, this figure approximates the number of people whose lives have been saved by vaccines since the start of the global Expanded Program on Immunization in 1980.[45]

Incorporating tropical disease diplomacy into a larger U.S. foreign policy framework is both a moral imperative and an effective, low-cost means to better the human condition worldwide.

Could similar bilateral and multilateral biomedical research efforts apply to new U.S.- and European-based product development public private partnerships (PD-PPPs) focused on developing improved control tools for NTDs? PD-PPPs such as the Institute of One World Health[46] and the Drugs for Neglected Diseases Initiative[47] are pioneering the development and financing of new chemotherapeutic drugs for NTDs, while the Leishmaniasis Vaccine Initiative[48] and the Human Hookworm Vaccine Initiative[49] are developing first-generation NTD vaccines.[50] As they are researched, new generation NTD vaccines will be incorporated into existing chemotherapy-based strategies. An important component of these drug and vaccine development efforts includes cooperation with "innovative developing countries" (IDCs), i.e. middle-income countries such as China, India, Indonesia, and Iran, which have the curious combination of having achieved a high level of innovation and yet have great pockets of poverty and endemic tropical diseases.[51] Product development partnerships with these IDCs may represent a new theme of tropical disease diplomacy.

A second component of vaccine and medical diplomacy is an association noted between the prevalence and incidence of endemic infectious diseases, infant mortality rates, under-five childhood mortality rates, and the risk of a nation engaging in armed conflict.[52] Since 1990, approximately 80 percent of all wars have been fought in sub-Saharan Africa, Asia, and the tropical regions of the Americas where multiple NTDs are co-endemic.[53] Since many nations with the worst health indicators are members of the Organization of the Islamic Conference (OIC), it is worth exploring the impact of tropical infectious disease control as a component of foreign policy with OIC countries.[54]

A Chance For Leadership

Former secretary of state Henry Kissinger has pointed out that for a humanitarian intervention to be effective, it must both be sustained by U.S. domestic opinion and, at the same time, resonate with the international community.[55] The biblical legacy of the NTDs, together with their enormous impact on global health and poverty and the relatively low cost of NTD intervention efforts, satisfies these criteria. Joseph Nye, Jr. has emphasized the high probability of success ("good consequences") as an important motivating principle for humanitarian intervention.[56] The identification of deworming and other NTD control measures as possible "quick wins" relative to other global health programs provides additional optimism for their likely success as a form of U.S. humanitarian intervention.[57]

Incorporating NTD control efforts and tropical disease diplomacy into a larger U.S. foreign policy framework is both a moral imperative and an effective, low-cost means to better the human condition worldwide. Through the new $15 million federal appropriation for integrating NTD control, the Bush administration and the U.S. Congress are making a modest first step toward the front lines of combat against a group of forgotten diseases afflicting people in the rural areas of low-income countries. Expansion of this package in order to incorporate NTD control into PEPFAR and other big three global health initiatives offers an opportunity for the United States to assume leadership in this important area of international diplomacy. WA

Notes

1. Jeffrey D. Sachs and John W. McArthur, "The Millennium Project: a plan for meeting the Millennium Development Goals," *Lancet* 365 (2005): 347-53.

2. Targets: 1. Halve, between 1990 and 2015; the proportion of people whose income is less than one dollar a day; 2. Halve, between 1990 and 2015, the proportion of people who suffer from hunger; 3. Ensure that, by 2015, children everywhere, boys and girls alike, will be able to complete a full course of primary schooling; 4. Eliminate gender disparity in primary and secondary education, preferably by 2005, and in all levels of education no later than 2015; 5. Reduce by two thirds, between 1990 and 2015, the under-five mortality rate; 6. Reduce by three quarters, between 1990 and 2015, the maternal mortality ratio; 7. Have halted by 2015 and begun to reverse the spread of HIV/AIDS; 8. Have halted by 2015 and begun to reverse the incidence of malaria and other major diseases; 9. Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources; 10. Halve, by 2015, the proportion of people without sustainable access to safe drinking water and sanitation; 11. By 2020, to have achieved a significant improvement in the lives of at least 100 million slum dwellers;12. Develop further an open, rule-based, predictable, non-discriminatory trading and financial system;13. Address the special needs of the least developed countries;14. Address the special needs of landlocked developing countries and small island developing States (through the Programme of Action for the Sustainable Development of Small Island Developing States and the outcome of the twenty-second special session of the General Assembly); 15. Deal

comprehensively with the debt problems of developing countries through national and international measures in order to make debt sustainable in the long term; 16. In cooperation with developing countries, develop and implement strategies for decent and productive work for youth;17. In cooperation with pharmaceutical companies, provide access to affordable essential drugs in developing countries; 18. In cooperation with the private sector, make available the benefits of new technologies, especially information and communications. (http://unstats.un.org/unsd/mi/mi_goals.asp)

3. Jeffrey D. Sachs and John W. McArthur, "The Millenium Project: a plan for meeting the Millenium Development Goals, *Lancet* 365 (2005): 347-53.

4.World Health Organization, "Annex Table 3, Burden of disease in DALYs by cause, sex and mortality stratum in WHO regions, estimates for 2002," in *Changing History, The World Health Report 2004* (2004).

5. D. Maher, A. Harries, and H. Getahun, "Tuberculosis and HIV interaction in sub-Saharan Africa: impact on patients and programmes; implications for policies," *Tropical Medicine and International Health* 10 (2005): 734-42.

6. World Health Organization, "Annex Table 3, Burden of disease in DALYs by cause, sex and mortality stratum in WHO regions, estimates for 2002," in: *Changing History, The World Health Report 2004* (2004).

7. Peter J. Hotez et al., "Incorporating a rapid impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis and malaria, a comprehensive pro-poor health policy and strategy for the developing world," *PLoS Medicine* 3 (2006): e102.

8. Ibid.

9. Global Fund website: http://theglobalfund.org

10. United Nations Programme on HIV/AIDS website: http://www.uniads.org

11. Stop TB Partnership website: http://www.stoptb.org

12. Roll Back Malaria website: http://www.rollbackmalaria.org

13. High-Level Forum on the Health MDGs, Best practice principles for global health partnership activity at country level, Paris, 14-15 November 2005.

14. Peter J. Hotez et al., "Incorporating a rapid impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis and malaria, a comprehensive pro-poor health policy and strategy for the developing world," *PLoS Medicine* 3 (2006): e102.; Peter J. Hotez et al., "The neglected tropical diseases: the ancient afflictions of sigma and poverty and the prospects for their control and elminiation," *Advances in Experimental Biology and Medicine* 582 (2006): 23-33.

15. D. H. Molyneux, P. J. Hotez, and A. Fenwick, "'Rapid-impact interventions': how a policy of integrated control for Africa's neglected tropical diseases could benefit the poor," *PLoS Medicine* 2 (2005): e336

16. H. Bleakley, "Disease and development: evidence from hookworm eradication in the American South," *Journal of European Economic Association* 1 (2003): 376-86.

17. D. Narayan with R. Patel et al., *Voices of the Poor, Can Anyone Hear Us?* (Oxford University Press and the World Bank, 2000), p. 118. Statement based on 1998 participatory poverty assessment for Ethiopia.

18. K. D. Ramiah et al., "The Economic Burden of Lymphatic Filariasis in India," *Parasitology Today* 16 (2000): 251-3.

19. K. D. Frick, C. L. Hanson, and G. A. Jacobson, "Global Burden of Trachoma and Economics of the Disease," *American Journal of Tropical Medicine and Hygiene* 69 (2003): 1-10.

20. Peter J. Hotez et al., "The neglected tropical diseases: the ancient afflictions of sigma and poverty and the prospects for their control and elminiation," *Advances in Experimental Biology and Medicine* 582 (2006): 23-33.

21. Peter J. Hotez et al., "The neglected tropical diseases: the ancient afflictions of sigma and poverty and the prospects for their control and elminiation," *Advances in Experimental Biology and Medicine* 582 (2006): 23-33.; P. Hotez and E. Ottesen, "Beating back ancient scourges of the poor," *Fort Worth Star-Telegram* (op-ed), January 1, 2006.

22. ; M. Kremer and R. Glennerster, *Strong Medicine, Creating Incentives for Pharmaceutical Research on Neglected Diseases* (Princeton, New Jersey: Princeton University Press, 2004), 25-6.; PJ Hotez et al., "Incorporating a rapid impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis and malaria, a comprehensive pro-poor health policy and strategy for the developing world,"

PLoS Medicine 3 (2006): e102.

23. P. J. Hotez et al., "The neglected epidemic of chronic diseases (letter)," *Lancet* 367 (2006): 563-4.; P. J. Hotez et al., "Incorporating a rapid impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis and malaria, a comprehensive pro-poor health policy and strategy for the developing world," *PLoS Medicine* 3 (2006): e102.

24. World Health Organization, "Annex Table 3, Burden of disease in DALYs by cause, sex and mortality stratum in WHO regions, estimates for 2002," in *Changing History, The World Health Report 2004* (2004).

25. P. J. Hotez et al., "Incorporating a rapid impact package for neglected tropical diseases with programs for HIV/AIDS, tuberculosis and malaria, a comprehensive pro-poor health policy and strategy for the developing world," *PLoS Medicine* 3 (2006): e102.

26. World Health Organization, *Deworming for Development* Report of the third global meeting of the partners for parasite control, Geneva, 29-30 November 2004 (WHO: Geneva, 2005): 3-5.

27. D. H. Molyneux, P. J. Hotez, and A. Fenwick, "'Rapid-impact interventions: how a policy of integrated control for Africa's neglected tropical diseases could benefit the poor," *PLoS Medicine* 2 (2005): e336.; N. R. De Silva et al., "Soil-transmitted helminth infections: updating the global picture," *Trends in Parasitology* 19 (2003): 547-51.; M. F. Van der Werf et al., "Quantification of clinical morbidity associated with schistosome infection in sub-Saharan Africa," *Acta Tropica* 86 (2003): 125-39.

28. R. M. Anderson and R. M. May, "Population dynamics of human helminth infections: control by chemotherapy," *Nature* 297 (1982): 557-63.; DAP Bundy DAP, "Population ecology of intestinal helminth infections in human communities," *Philosophical Transactions of the Royal Society Series B* 321 (1988): 405-20.; D. H. Molyneux, P. J. Hotez,, and A. Fenwick, "'Rapid-impact interventions': how a policy of integrated control for Africa's neglected tropical diseases could benefit the poor," *PLoS Medicine* 2 (2005): e336.; D. A. Bundy et al., "Control of geohelminths by delivery of targeted chemotherapy through schools," *Transactions of the Royal Society of Tropical Medicine and Hygiene* 84 (1990): 115-20.

29. L. Savioli, D. Bundy, and A. Tomkins, "Intestinal parasitic infections: a soluble public health problem," *Transactions of the Royal Society of Tropical Medicine and Hygiene* 86 (1992): 353-4.

30. P. Christian, S. K. Khatry, and K. P. West, "Antenatal anthelmintic treatment, birthweight, and infant survival," *Lancet* 364 (2004): 981-3.; RM Anderson and RM May, "Population dynamics of human helminth infections: control by chemotherapy," *Nature* 297 (1982): 557-63.

31. D. A. P. Bundy, "Population ecology of intestinal helminth infections in human communities," *Philosophical Transactions of the Royal Society Series B* 321 (1988): 405-20.; D. A. Bundy et al., "Control of geohelminths by delivery of targeted chemotherapy through schools," *Transactions of the Royal Society of Tropical Medicine and Hygiene* 84 (1990): 115-20.; L. Savioli, D. Bundy, and A. Tomkins, "Intestinal parasitic infections: a soluble public health problem," *Transactions of the Royal Society of Tropical Medicine and Hygiene* 86 (1992): 353-4.

32. Jeffrey D. Sachs and John W. McArthur, "The Millennium Project: a plan for meeting the millennium development goals," *Lancet* 365 (2005): 347-53.

33. D. H. Molyneux and H. M. Nantulya, "Linking disease control programmes in rural Africa: a pro-poor strategy to reach Abuja targets and Millennium Development Goals," *BMJ* 328 (2004): 1129-32.; D. H. Molyneux , P. J. Hotez, and A. Fenwick, "'Rapid-impact interventions': how a policy of integrated control for Africa's neglected tropical diseases could benefit the poor," *PLoS Medicine* (2005): e336.

34. A. Fenwick, D. Molyneux, and V. Nantulya, "Achieving the Millennium Development Goals," *Lancet* 365 (2005): 1029-30.; D. H. Molyneux , P. J. Hotez, and A. Fenwick, "'Rapid-impact interventions': how a policy of integrated control for Africa's neglected tropical diseases could benefit the poor," *PLoS Medicine* (2005): e336.

35. A. Fenwick, "New initiatives against Africa's worms," *Transactions of the Royal Society of Tropical Medicine and Hygiene* in press (2006).; A. Fenwick, D. Molyneux, and V. Nantulya, "Achieving the Millennium Development Goals," *Lancet* 365 (2005): 1029-30.

36. Zbigniew Brzezinski, *The Choice, Global Domination or Global Leadership* (New York: Basic Books, 2004), 160-217.

37. Robert S. McNamara and James G. Blight, *Wilson's Ghost, Reducing the Risk of Conflict, Killing, and*

Catastrophe in the 21st Century (New York: Public Affairs, 2001), 218.

38. Zbigniew Brzezinski, *The Choice, Global Domination or Global Leadership* (New York: Basic Books, 2004), 160-217.

39. Peter J. Hotez, "Hookworm in the Catholic world," *Sabin Vaccine Report* 4, #2 (2001): 2.

40. Commission for Africa, *Our Common Interest: Report for the Commission for Afric*a (2005). Available http://www.commissionforafrica.org/english/report/thereport/english/11-03-05_cr_report.pdf; European Parliament, Committee on Development,*Report on Major and Neglected Diseases in Developing Countries* (Rapporteur. John Bowis), A6-0215/2005, 19 pages.

41. P. Hotez, E. Ottesen, "Beating back ancient scourges of the poor," *Fort Worth Star-Telegram* (op-ed), 1 January 2006.

42. P. J. Hotez, "Vaccine diplomacy," *Foreign Policy*, May/June (2001) 68-9.; P. J. Hotez, "Vaccines as instruments of foreign policy," *EMBO Reports* 2, #10 (2001): 862-8.; P. Hotez, "Appeasing Wilson's ghost: the expanded role of the new vaccines in international foreign policy," *CBACI Health and Security Series*, Occasional Paper 3 (2002):1-16.

43. Peter J. Hotez, "Vaccine diplomacy," *Foreign Policy*, May/June (2001): 68-9.; Peter J. Hotez, "Vaccines as instruments of foreign policy," *EMBO Reports* 2, #10 (2001): 862-8.

44. Robert S. McNamara and James G. Blight, *Wilson's Ghost, Reducing the Risk of Conflict, Killing, and Catastrophe in the 21st Century* (New York: Public Affairs, 2001), 218.

45. WHO website: (http://www.who.int/countries/eth/areas/immunization/en); Peter J. Hotez, "Appeasing Wilson's ghost: the expanded role of the new vaccines in international foreign policy," *CBACI Health and Security Series*, Occasional Paper 3 (2002):1-16.

46. Institute for OneWorld Health website: http://www.iowh.org

47. Drugs for Neglected Diseases website: http://www.dndi.org

48. Infectious Disease Research Institute website: http://www.idri.org

49. http://www.sabin.org/hookworm.htm

50. Peter J. Hotez et al., "Hookworm: 'The great infection of mankind,'" *PLoS Medicine* 2, #3 (2005): e67.

51. C. M. Morel et al., "Health innovation: the neglected capacity of developing countries to address neglected diseases," *Science* 309 (2005): 401-4.

52. Peter J. Hotez, "Vaccines as instruments of foreign policy," *EMBO Reports* 2, #10 (2001): 862-8.; P. Hotez, "Appeasing Wilson's ghost: the expanded role of the new vaccines in international foreign policy," *CBACI Health and Security Series*, Occasional Paper 3 (2002):1-16.

53. D. Smith, *The Penguin State of the World Atlas, Seventh Edition,* (New York: Penguin Books, 2003), 71. Statement based on data presented that of the 727 wars occurring each year between the years 1990 and 2002, 577 occurred in sub-Saharan Africa, Central and South America, or Asia and the Pacific.

54. P. Hotez, "Appeasing Wilson's ghost: the expanded role of the new vaccines in international foreign policy," *CBACI Health and Security Series*, Occasional Paper 3 (2002):1-16.

55. Henry Kissinger, *Does America Need a Foreign Policy? Toward a Diplomacy for the 21st Century* (New York: Simon & Schuster, 2001), 256.

56. Jospeh S. Nye, Jr., "Redefining the national interest," *Foreign Affairs*, July/August (1999) (www.foreignaffairs.org).

57. Jeffrey D. Sachs and John W. McArthur, "The Millennium Project: a plan for meeting the Millennium Development Goals," *Lancet* 365 (2005): 347-53.; L. Savioli, D. Engels, and H. Endo, "Extending the benefits of deworming for development," *Lancet* 365 (2005): 1520-1.