PATH/Evelyn Hockstein

Saving lives and creating impact:

Why investing in global health research works

Global Health Technologies Coalition

POLICYCURES

TABLE OF CONTENTS

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ACRONYMS

AACTG	Adult AIDS Clinical Trials Group
ACT	artemisinin-combination therapies
AFRIMS	Armed Forces Research Institute of Medical Services
AFRO	World Health Organization Regional Office for Africa
AMANET	African Malaria Network Trust
ARRA	American Recovery and Reinvestment Act of 2009
ARV	anti-retroviral drug
ATN	Adolescent Trials Network for HIV/AIDS Interventions
AVAREF	African Vaccine Regulatory Forum
CAPRISA	Centre for the AIDS Programme of Research in South Africa
CBER	US Center for Biologics Evaluation and Research
CDC	US Centers for Disease Control and Prevention
CDN	Clinical Directors Network
CPI	Critical Path Initiative
CRADA	Cooperative Research and Development Agreement
DCVRN	Developing Countries' Vaccine Regulators Network
DND*i*	Drugs for Neglected Diseases *initiative*
DOD	US Department of Defense
FDA	US Food and Drug Administration
FIND	Foundation for Innovation New Diagnostics
FWDIRN	Food and Waterborne Diseases Integrated Research Network
GAVI	GAVI Alliance
GDP	Gross Domestic Product
G-FINDER	Global Funding of Innovation for Neglected Diseases
GHI	US Global Health Initiative
GIVS	Global Immunization Vision and Strategy
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immunodeficiency Syndrome
HIVNAT	HIV Netherlands Australia Thailand Research Collaboration
HPTN	HIV Prevention Trials Network
HVTN	HIV Vaccine Trials Network
IAVI	International AIDS Vaccine Initiative
IMPAACT	International Maternal Pediatric Adolescent AIDS Clinical Trials Group
INSIGHT	International Network for Strategic Initiatives in Global HIV Trials
IP	intellectual property
MDR-TB	multidrug-resistant tuberculosis
MHRP	US Military HIV Research Program
MMV	Medicines for Malaria Venture
MTN	Microbicide Trials Network

MVDP	Malaria Vaccine Development Program
MVP	Meningitis Vaccine Project
NCATS	NIH's National Center for Advancing Translational Sciences
NIAID	US National Institute of Allergy and Infectious Diseases
NIH	US National Institutes of Health
PACTG	Pediatric AIDS Clinical Trials Group
PAHO	Pan American Health Organization
PDP	product development partnership
PEPFAR	US President's Emergency Plan for AIDS Relief
PMI	President's Malaria Initiative
PRV	Priority Review Voucher
R&D	research and development
SBIR	Small Business Innovation Research Program
TAVEG	Thailand AIDS Vaccine Evaluation Group
TB	tuberculosis
TB Alliance	Global Alliance for TB Drug Development
TBTC	Tuberculosis Trials Consortium
UNICEF	United Nations Children's Fund
USAID	US Agency for International Development
WHO	World Health Organization
XDR-TB	extensively drug-resistant tuberculosis
WHO	World Health Organization
XDR-TB	extremely drug-resistant tuberculosis

EXECUTIVE SUMMARY

The Government of the United States (US) has long played a role in the development of new global health products that have transformed communities in the poorest countries in the world and saved the lives of millions. However, with increasing political pressure to scale back US Government investment in global health research and development (R&D) and focus instead on programs that further national security and demonstrate quick impacts, a review of evidence on the benefits of global health R&D investments and the cost-effectiveness of US Government funding is critical.

This report aims to assess the impact of past US Government investments in global health R&D and to review the role of ongoing US Government investments in global health R&D.

WHAT HAS THE US GOVERNMENT CONTRIBUTED TO GLOBAL HEALTH R&D?

The US Government is the largest funder of global health R&D in the world

The US Government contributes around 45% of the total investment in global health R&D each year and 70% of all government investment worldwide. In the last decade, the US Government invested $12.7 billion in global health R&D and more than doubled its yearly financial commitment (from $685 million to $1.4 billion). Yet despite the critical role it plays in sustaining research, these investments are a negligible imposition on US taxpayers, at less than 0.01% of GDP.

Five federal agencies make significant contributions to global health R&D

Five federal agencies—the National Institutes of Health (NIH), the US Agency for International Development (USAID), the Department of Defense (DoD), the Centers for Disease Control and Prevention (CDC) and the US Food and Drug Administration (FDA)—contribute funding, infrastructure, and their own unique capabilities and expertise to global health R&D. Financial support is driven by three agencies--NIH, USAID and DoD—who are responsible for 87%, 6% and 6% of US Government global health R&D funding respectively. All of these agencies provide scientific or regulatory expertise, clinical facilities to conduct R&D, intellectual property, and technology transfer.

The US Government is the leading funder of R&D for 26 of the 30 most neglected diseases and conditions affecting the developing world

US Government funding for global health R&D is distributed across many conditions. In the last decade, the largest portion of funds went to HIV/AIDS (57%), while sizeable investments were made in tuberculosis (TB) (12%) and malaria (10%). A handful of diseases and conditions received 2-4% of total funding each, including diarrheal diseases, kinetoplastids (such as sleeping sickness and Chagas' disease), dengue fever, parasitic worms, and contraceptive technologies. For all but four of the diseases considered for this report—bacterial pneumonia and meningitis, dengue fever and Buruli ulcer - the US Government is the leading funder of research worldwide.

WHAT NEW GLOBAL HEALTH PRODUCTS HAVE BEEN DELIVERED OR ARE BEING CREATED?

Investment in global health R&D has led to a remarkable increase in global health products, with 45 new products registered between 2000 and 2010.

The US Government was involved in development of half of all new global health products in the last decade

The US Government was involved in the development of 24 (53%) of the 45 products introduced between 2000 and 2010, although their input varied in degree and type.

Ongoing US Government investment is supporting development of the largest pipeline ever of new global health products

US federal agencies are working with others to support development of 200 (55%) of the 365 products in the pipeline that will deliver the next generation of life saving global health products. The pipeline includes what is likely to be the first ever vaccine against malaria, three HIV vaccine candidates, and a new generation of improved TB drugs.

HAS THE US GOVERNMENT INVESTMENT PAID OFF?

The US Government investment in global health R&D has paid off resoundingly. Four global health technologies developed with US Government support, and highlighted in the report—a new meningitis vaccine, a new test to diagnose TB, the next generation of HIV preventives and improved TB drugs—provide a clear cut case for global health R&D investment. These four technologies alone have already saved or are projected to save millions of lives, and often also millions of dollars, just as polio and measles vaccines did for previous generations throughout the world.

WHY THE US GOVERNMENT SHOULD CONTINUE TO INVEST IN GLOBAL HEALTH R&D

Current investments in global health are already on course to save millions of lives and dollars in the developing world

New global health technologies have already delivered substantial health and economic benefits in the developing world.

The next generation of global health products is imminent and promises to deliver even greater health and economic gains

A number of promising global health products have already entered late-stage development and will require continued investment to ensure they reach patients and deliver their projected health benefits and economic gains to the developing world. Among these products are several HIV vaccines, with modeling suggesting that a vaccine with even 50% efficacy provided to just 30% of the population could reduce the number of new HIV infections in the developing world by a quarter over 15 years—preventing 5.6 million new infections.[1]

The US Government's role in global health R&D decreases risk and leverages inputs from the philanthropic sector and the pharmaceutical and biotechnology industries

The partnership between the US Government, industry and the philanthropic sector decreases risk, improves R&D outcomes and enables each partner to bring their complementary skills and capabilities while building on their areas of comparative advantage.

Funding global health R&D benefits the US and the domestic economy

Funding global health R&D creates products and technologies that save lives and money in the developing world, but also protect US citizens, including US troops. The US contribution to global health R&D is an important instrument of foreign policy and diplomacy that highlights the U.S at its best, sharing knowledge in developing countries and creating products that are not only needed but also appreciated. Funding global health R&D also brings significant benefits to the U.S domestic economy. Around 64 cents in every dollar spent by the US Government on global health R&D goes directly to US-based researchers and product developers, creating jobs, building US research and technological capacity, and providing a direct injection of investment into the US economy.

HOW CAN THE US GOVERNMENT GENERATE GREATER IMPACT FROM ITS INVESTMENT?

The US Government can increase consistency across the value chain

US Government investment is not consistent across the R&D value chain with two-thirds of its funding directed to early stages of the R&D process and only around one-fifth to clinical studies in humans. The US Government's investment in early basic research is so great that it now provides nearly two-thirds (62%) of global funding in this area. But when it comes to the final clinical stages of product development, which are the most expensive and the most in need of funding, other groups (in particular the Bill & Melinda Gates Foundation and for-profit industry) are providing around 60% of all funding. This is unlikely to be sustainable as more products move into expensive late-stage clinical trials.

The US Government can increase support for translation mechanisms, including partnerships aimed at converting research into products for patients in the developing world

Despite the US Government's substantial investment, research has not always translated sufficiently into successful products. Current programs—such as NIH's Small Business Innovative Research (SBIR) program and Cooperative Research and Development Agreements (CRADAs)—are poorly suited to global health product development. US Government support for product development partnerships (PDPs)—responsible for over 40% of new global health products registered between 2000 and 2010—has also been slow and limited. The US Government has provided only 11% of PDPs' global funding commitments from 1993 to 2019.

RECOMMENDATIONS

1. The US Government should maintain its funding for global health R&D, and increase this funding where possible.
2. The US Government needs to have a greater focus on translational research, in particular clinical development, to fully leverage their global health R&D investments.
3. The US Government should increase funding to partnering mechanisms that are focused on translation of global health research, including PDPs and other partnering approaches.

METHODOLOGY

This report is centered on global health product development from 2000-2010 for 30 neglected diseases that disproportionately affect developing countries and for which there is insufficient commercial market to attract R&D by private industry. Additionally, R&D of new reproductive health products and platform technologies that address the needs of developing-country users were included. While we recognized the importance of noncommunicable diseases and maternal health in low- and middle- income countries—as well as other R&D-related activities such as operations/implementation research and capacity building—these are outside the scope of this report.

The report uses US Government investment data from the annual G-FINDER surveys from 2007-2010 for the four federal agencies involved in neglected disease R&D—NIH, USAID, DoD, and CDC. Primary data on neglected disease R&D in financial years 2000 and 2004 was also collected from NIH, USAID and CDC, and investment data for contraceptive R&D in fiscal years (FY) 2000, 2004, 2007, 2008, 2009 and 2010 from NIH and USAID. Trends for the decade were extrapolated from this data with reasonable confidence; given that these three agencies typically account for more than 92% of US Government investments in global health R&D (see full methodology in Appendix 1).

The lists of new global health products and products in development were compiled from existing databases, data from product developers, and discussions with the five federal agencies.

INTRODUCTION

The government of the United States has long played a role in development of new global health products that have transformed communities in the poorest countries in the world and saved the lives of millions. From the eradication of smallpox to the development of game-changing HIV drugs, American efforts have contributed to many global health success stories in human history. As infectious diseases continue to claim the lives of nearly 9 million people each year,[2] the US Government has maintained its commitment to new product development and its position as the preeminent funder of global health R&D in the world.

However, with increasing political pressure to scale back US Government investment in global health R&D and focus instead on programs that further national security and demonstrate quick impacts, a review of evidence on the benefits of global health R&D investments and the cost-effectiveness of US Government funding is critical. Moreover, with new actors increasingly engaged in global health R&D from both the private and philanthropic sectors, it is also an opportunity to review whether the US Government needs to reshape its role in global health R&D.

This report aims to address these questions by analyzing the impact of past US Government investments, and reviewing the role of ongoing US investments in global health R&D.

Background

Progress in global health over the last half-century has been remarkable. Life expectancy has increased by 17 years and the number of children who die before age five has halved since 1960[3]

Diseases such as smallpox and polio have been eradicated or near-eradicated, malaria deaths have dropped by 30% in the last decade alone,[4] and important advances in the treatment and control of infectious diseases such as HIV have been achieved. A major factor in this progress has been the creation, dissemination, and adoption of pharmaceutical and technological interventions that improve health, such as drugs, vaccines, diagnostics, contraceptives, insecticide-treated bednets and other medical devices. These products have been supported by substantial US Government funding, scientific expertise, and research capacity.

The world has changed dramatically since the US Government made its first commitments to global health R&D. Fifty years ago, the poorest countries depended on the generosity of the United States and other donor countries, with international aid accounting for 70% of capital influx into the developing world. Now it accounts for just 13%[5], creating the imperative for smarter investments that can catalyze self-sustaining progress. As international travel has expanded and global supply chains have flourished, global health too has irrevocably changed. It is no longer built solely on the premise of improving the health of people living in far-off places but is now inextricably entwined with the health of the American people and national

security, as infectious diseases can cross borders and span the world with the same ease as people and traded goods[6].

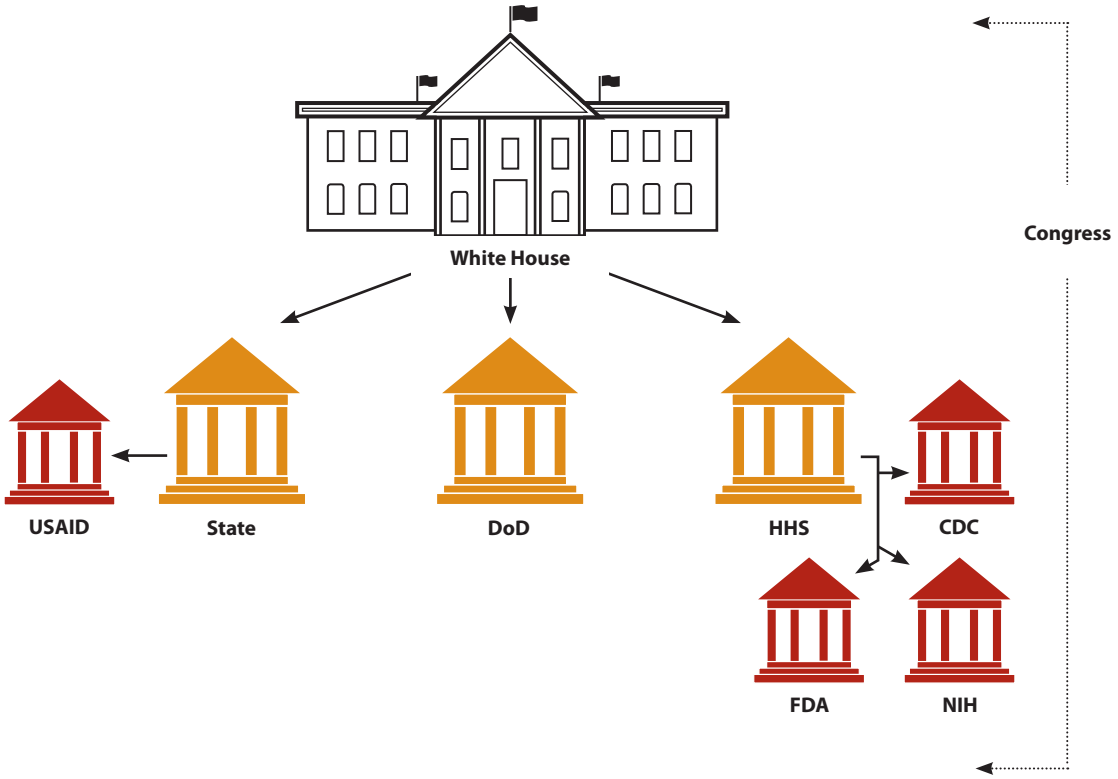
This has led to a renewed interest in global health in the US and given rise to a number of disease-specific programs including the President's Emergency Plan for AIDS Relief (PEPFAR) to combat HIV/AIDS, the President's Malaria Initiative (PMI) and USAID's Neglected Tropical Diseases (NTD) Program. These programs have elicited bipartisan support across successive administrations and brought about a substantial increase in US funding for global health, although only a small proportion of funding is specifically earmarked for R&D. For instance, in May 2009, President Obama unveiled the US Global Health Initiative (GHI), a six-year (FY2009-FY2014) $63 billion package for US government involvement in global health that included research and innovation as one of the seven core principles.[7] As actual funding for the GHI is determined annually by Congress during the appropriations process, it is unlikely the full $63 billion for the GHI will be realized.

New landscape of investment in global health R&D

US policy on global health R&D investment is increasingly complex, driven by a number of different priorities. These include: scientific and technological innovation as a key driver of US economic competitiveness; national security concerns and the need to protect the American people and the US armed forces from the threat of new and emerging diseases; global health diplomacy as an important driver of "smart power"[8]; the most engaged generation in global health in US history; convergence of disease patterns, particularly chronic diseases; and the need to find new efficiencies in global health R&D in an era of deficit spending.

US Government global health R&D architecture is equally intricate, with activities implemented by five federal agencies—NIH, DoD, USAID, CDC), and FDA—each with their own agendas and priorities, and with their budgets and appropriations overseen by over 15 congressional committees.[9] However, many global health R&D budgets are not subject to congressional appropriations and remain at the discretion of the agencies themselves. The five agencies do have complementary capabilities and expertise, but in the absence of an organizing mechanism across the many governmental structures, programs and funding streams, this complex structure does not lend itself well to collaboration and partnership between them for global health R&D.[10]

Figure 1.
US Government global health R&D architecture



Within this new political and economic environment, an active global health R&D community has also emerged, with increasing engagement of philanthropic organizations such as the Bill & Melinda Gates Foundation, the pharmaceutical and biotechnology industries, as well as academic institutions. The Bill & Melinda Gates Foundation has placed technology-based solutions at the heart of its global health program, investing almost half a billion dollars annually in its R&D portfolio.[11] Each sector has different motivations—the philanthropic sector is focused on social returns and health impact, and the pharmaceutical and biotechnology industries are driven by longer-term business considerations (encompassing corporate social responsibility and minimizing reputational risk)—that shape their role within global health R&D. With financial impetus from the US Government and other donors, industry and the philanthropic sector, global health R&D is thriving.

Making new global health products

Researching and developing a new global health product is a long and resource-intensive process. It can take 15 years, sometimes more, to achieve registration of a new product and there are no guarantees of success. For a new diagnostic test, the typical development time is around 3-5 years, for drugs it is around 7-10 years, and for vaccines it is typically 11-15 years.[12] It is also an inherently risky process—only a small fraction of the potential candidates will turn out to be safe and effective treatments, tests, or vaccines. At each stage of the R&D value chain, potential candidates will fail, particularly in the early stages. The later stages—where real-life safety and efficacy are tested—have higher success rates, but are also highly resource-intensive, and cost tens or hundreds of millions of dollars.

The process of developing a new global health product differs in one crucial aspect from development of commercial pharmaceuticals for heart disease or diabetes, for instance. In commercial areas, the public sector can focus its research investments upfront, developing early research to the point where it can be picked up by pharmaceutical companies for clinical development and commercialization. However, in the field of global health, there is no incentive for companies to conduct clinical development in poor countries and no paying market to justify their investment in commercialization. The lengthy, complex and highly technical process of neglected disease product development therefore requires partnership between government, industry and the philanthropic sector—including leadership, technical expertise and funding—throughout the development process, including the process of clinical development and commercialization for developing world use.

Just as philanthropic and industry investment decrease costs and risks for the US Government, so the involvement of the US Government helps to leverage investment from the philanthropic sector and secure the participation of industry to tackle neglected diseases by lowering risk, increasing the likelihood of uptake of the products of R&D, and providing funding, infrastructure and expertise to support the R&D process. As noted, this is equally vital in the later clinical stages of global health product development, when developers are likely to need substantial funding support for trials that can cost over one hundred million dollars, and may also rely on government or public assistance to access clinical sites in Africa, Asia, Latin America and other developing world settings.

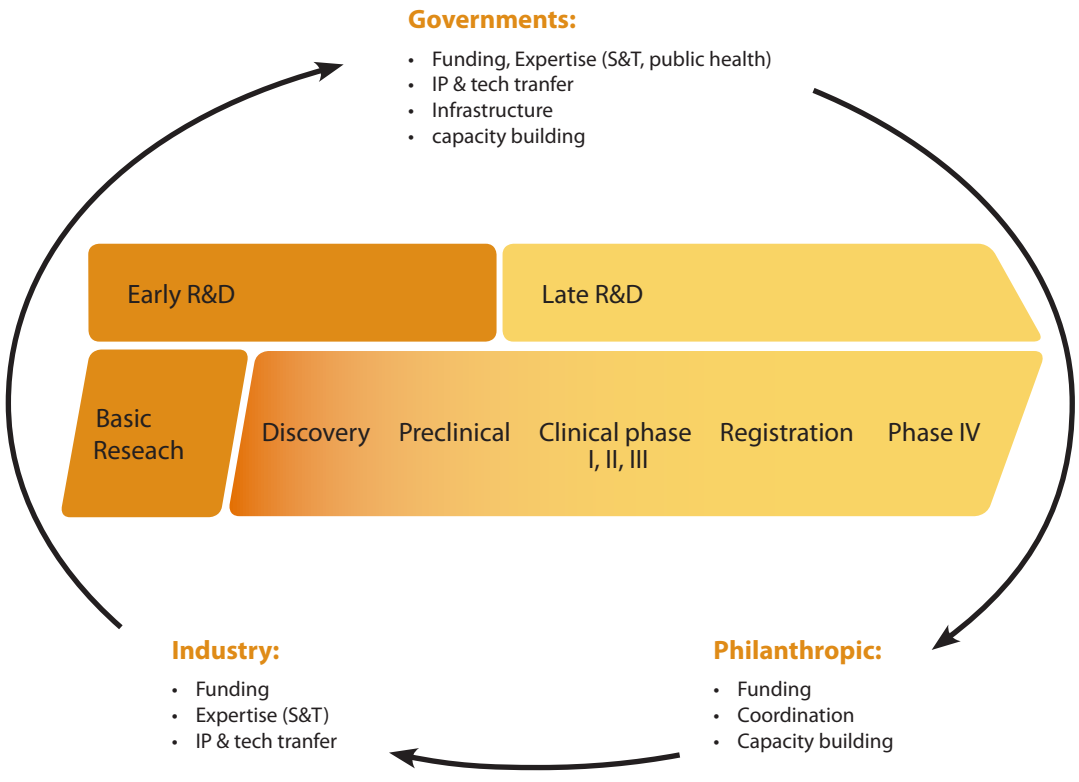


Figure 2.
The R&D process

Adapted from: Nwaka S, Ridley RG. *Virtual drug discovery and development for neglected diseases through public-private partnerships.* Nature Reviews Drug Discovery. Nov 2, 2003:919–28.

The recognition of the need for partnerships has led to increased use of existing mechanisms and creation of new mechanisms designed to harness the capabilities and resources of each sector and apply them to the development of drugs, vaccines and diagnostics for neglected diseases. The NIH has two key programs to facilitate partnerships with industry to develop innovations arising from federally funded research into products that impact health. NIH's Small Business Innovation Research (SBIR) Program, part of wider program established by the US National Academy of Science, encourages small innovative biotechnology companies to commercialize innovations prioritized by NIH, with at least 40% of early stage SBIR-funded projects reaching the marketplace. SBIR grants have helped fund early stage research for a malaria vaccine developed by Sanaria, and TB drugs developed by Sequella, both located in the heart of Maryland's Biotechnology Corridor.

The NIH also uses Cooperative Research and Development Agreements (CRADAs) to develop partnerships with industry and other federal agencies and share the responsibility of developing (and commercializing) products arising from NIH-funded research. From 2006 to 2010, the National Institute of Allergy and Infectious Diseases (NIAID), part of the NIH, negotiated dozens of CRADAs annually, including a small number for global health products: the Xpert MTB/RIF diagnostic test for TB; PA-824, a TB drug candidate; SQ109, a TB drug candidate developed by Sequella, that has benefitted from both an SBIR grant and a CRADA; and malaria vaccines developed by the pharmaceutical company Crucell (a CRADA with DoD).

However, the most prominent partnering model in the global health field has been product development partnerships (PDPs)—independent nonprofits organizations who leverage private-sector expertise and public and philanthropic resources to drive product development for neglected diseases. PDPs, with funding and strategic guidance from the philanthropic sector, build on public-sector experience in designing and delivering products intended for low resource settings. Critically, PDPs also play a pivotal role in leveraging private-sector expertise and resources where markets are not lucrative and industry cannot expect sufficient returns to justify capital-intensive R&D investments. PDPs accounted for over 40% of new global health products registered between 2000 and 2010.

US GOVERNMENT INVESTMENTS IN GLOBAL HEALTH R&D

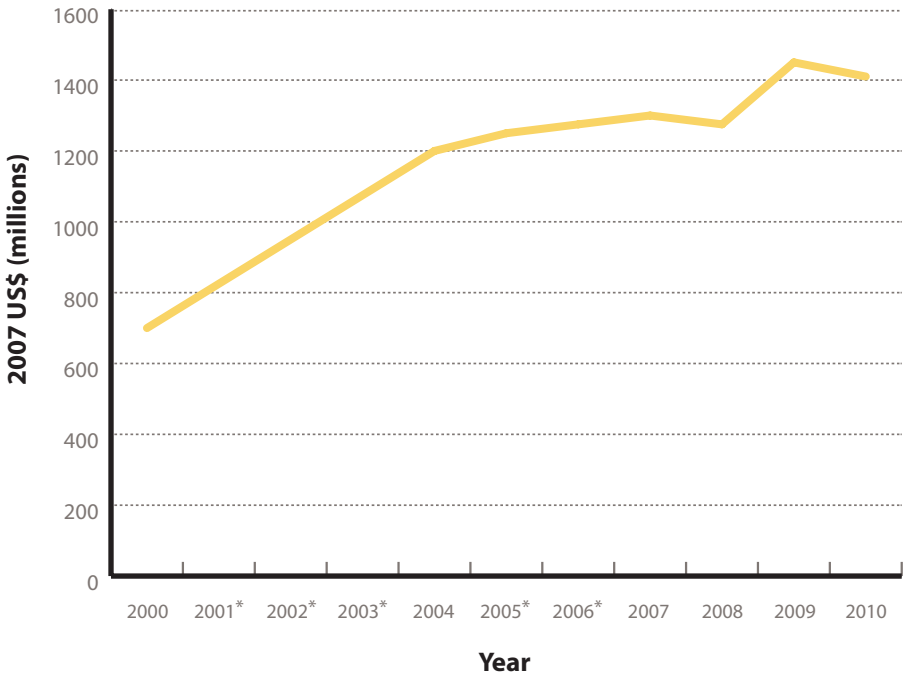
The US Government is the world's largest funder of global health R&D

The US Government is the largest funder of global health R&D in the world, contributing around 45% of total investment and 70% of all government investment in global health R&D each year[13]. In the last decade, the US Government has invested $12.7 billion into global health R&D and doubled its funding from $685 million to $1.4 billion per year. This leadership role has been underpinned by bipartisan support across successive US administrations and has given the US Government an immense capacity to engage players in the global health research community including industry, other donor countries and the philanthropic sector.

In the last decade, the US Government invested $12.7 billion into global health R&D and doubled its funding from $685 million to $1.4 billion per year.

Figure 3.
US Government funding for global health R&D between 2000 and 2010*

* estimates



Even when global health R&D investment is measured as a proportion of GDP, the US is still the largest government funder. Moreover, US Government investment has been consistent and stable over the last decade, underscoring the critical role it plays in sustaining research in the field. What is even more remarkable given their impact is that these investments—at less than 0.01% of GDP—represent only a tiny fraction of federal government expenditure and a negligible imposition on US taxpayers; Americans spend more on ice cream in three weeks[14] than the US Government spends in a year on global health R&D.

Figure 4.
US Government share of government funding for global health R&D, 2010

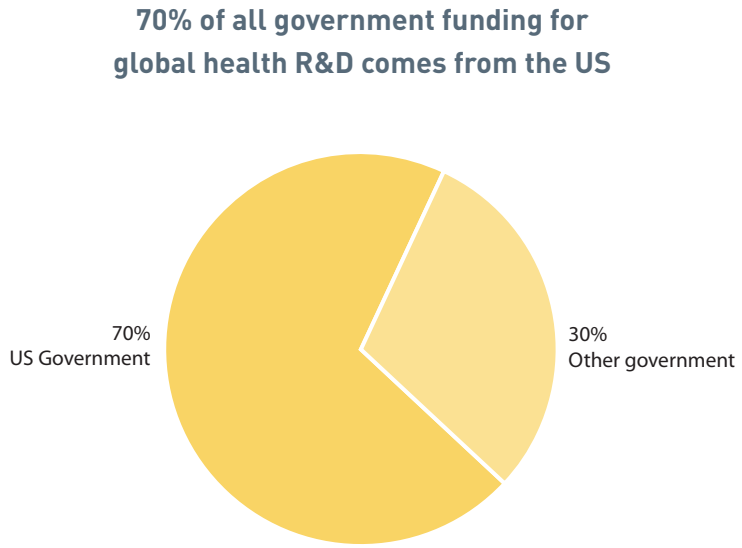
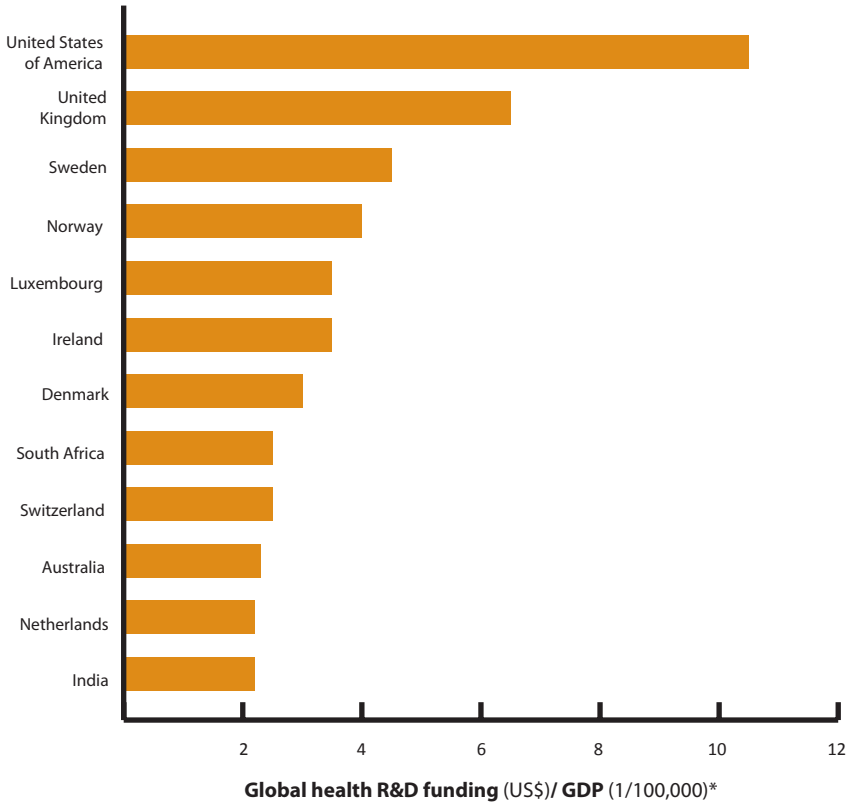


Figure 5.
Government funding for global health R&D – by proportion of GDP, 2010

* GDP figures taken from International Monetary Fund (IMF) World Economic Outlook Database



US Government investment in global health R&D is distributed across many diseases

US Government funding for global health R&D is distributed across many diseases and conditions. In the last decade, the largest portion of funds went to HIV/AIDS (57%), while sizeable investments were made in tuberculosis (12%) and malaria (10%). A handful of diseases received 2-4% of total funding each, including diarrheal diseases, kinetoplastids (such as sleeping sickness and Chagas' disease), dengue fever, parasitic worms, and family planning and contraceptive technologies. Several diseases received less than 1% of funding, including salmonella, bacterial pneumonia and meningitis, and other neglected diseases (such as leprosy, rheumatic fever, Buruli ulcer and trachoma).

This distribution of funding to some extent reflects the priorities evident in major government initiatives such as the Global Health Initiative (GHI), the President's Malaria Initiative (PMI), the President's Emergency Plan for AIDS Relief (PEPFAR), and USAID's Neglected Tropical Diseases Program, despite that the fact these programs make little provision for funding R&D. However, it is notable that even when investments have been comparatively small, the contribution of the US Government has been significant. For all but four of the diseases considered for this report—bacterial pneumonia and meningitis, dengue fever, and Buruli ulcer—the US Government is the leading funder of research worldwide.

For all but four of these neglected diseases, the US Government is the world's leading research funder

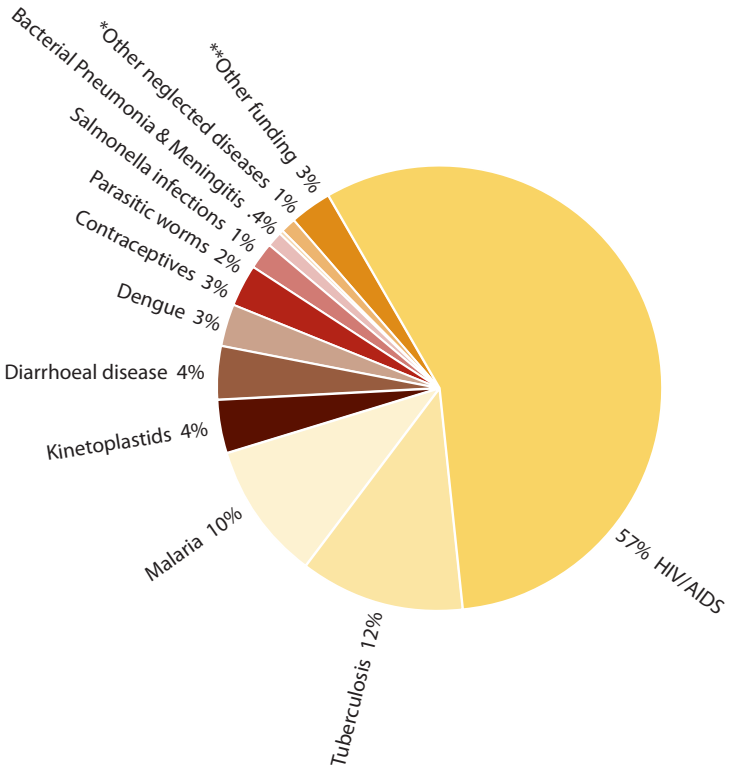


Figure 6.
US Government funding for global health R&D by disease, 2000 - 2010

* Other NDs include: leprosy, trachoma, buruli ulcer, rheumatic fever

** Other funding includes: platform technologies, core funding to multi-disease R&D organisations and unspecified R&D

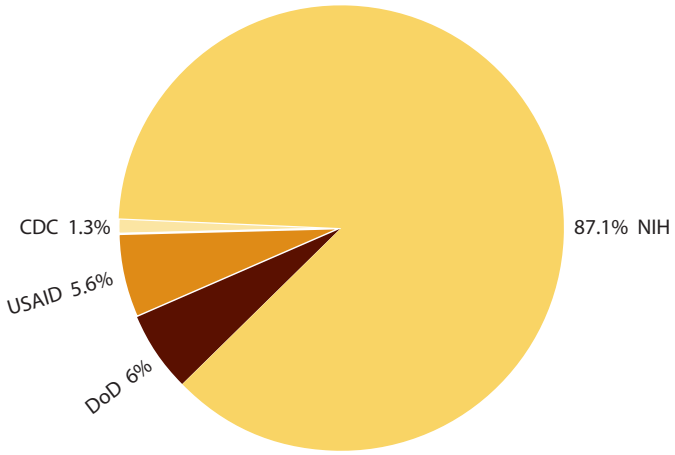
Five federal agencies have made significant contributions to global health R&D

The US contribution to global health R&D is delivered by five federal agencies—NIH, DoD, USAID, CDC and FDA—each with their own unique capabilities and expertise. US Government R&D support takes different forms, ranging from direct funding to product developers, to providing technical expertise to conducting R&D within federal research facilities.

Financial support for global health R&D is driven by three agencies—NIH, DoD and USAID—while the CDC and FDA mainly support product development by providing scientific expertise or facilitating the regulatory process. The size and scope of the investments made by each of the five federal agencies is determined by their core mission and mandate.

Figure 7.
Agency share of US Government funding for global health R&D, 2000-2010*

*FDA data not available



BOX 1

Types of US government contributions to global health R&D

Funding R&D – providing funding for neglected disease research and development.

Conducting R&D – doing the research needed to advance the science or to develop new global health technologies.

Providing intellectual property (IP) and transferring technology – including US patents or transferring knowledge, technologies, or methods of manufacturing to others.

Building R&D capacity – including research and medical training, and skills transfer.

Providing infrastructure – including physical and organizational structures to do R&D.

Providing R&D expertise – including advisory, scientific, regulatory, or other expertise (e.g., support from FDA on regulatory processes and documentation, provision of expertise as a scientific advisor).

Supporting delivery and implementation of new products – including demand forecasting, supply chain management, and field research to validate the introduction and scale-up of interventions on the ground.

As a dedicated research agency, the NIH drives the majority of the US Government's financial investment in R&D. In the last decade, NIH funding accounted for nearly 90% ($11 billion) of total US Government spending on global health R&D. Indeed, the NIH is the largest funder of global health R&D in the world, providing around 40% of global R&D funding.

NIH accounted for nearly 90% ($11 billion) of US Government spending on global health R&D in the last decade

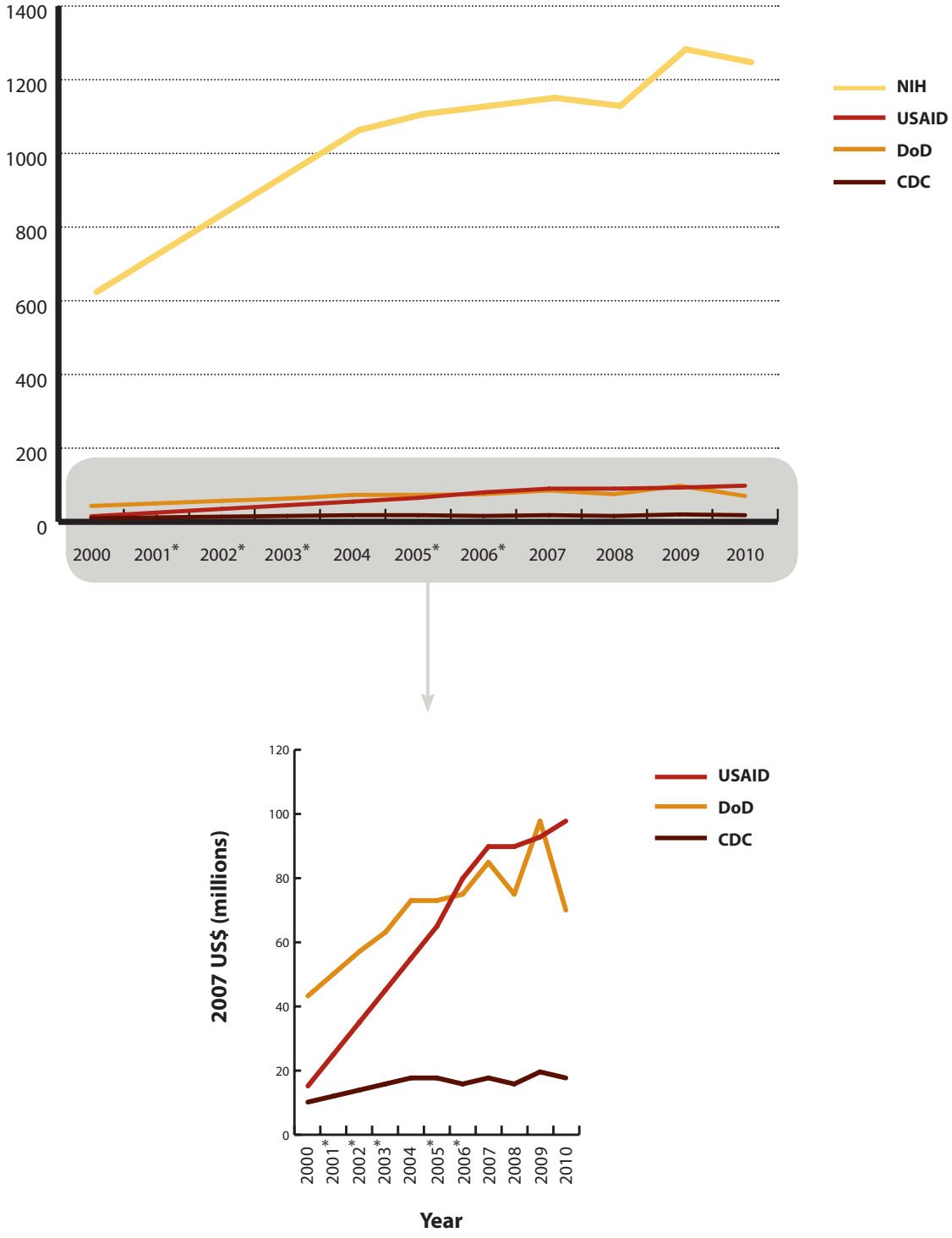
NIH spending on global health R&D doubled between 2000 and 2010 from $619 million to $1.2 billion, reflecting increases to the NIH's overall budget in that period. Part of the growth in NIH's budget stems from the 2009 American Recovery and Reinvestment Act (ARRA), which was signed into law to stimulate the US economy through the support of scientific research, providing an additional $10.4 billion to the NIH[15].

The DoD, through its Military Infectious Diseases Research Program, provided 6% ($765 million) of US Government funding for global health R&D over the last ten years. The DoD has a far more limited mandate than either NIH or USAID when it comes to global health R&D, focusing its efforts on the development of products that are primarily used to protect the US armed forces from infectious diseases. While its contribution to global health R&D funding is significant, it represents only a tiny fraction (0.0001%) of the overall defense budget[16]. Annual contributions to global health R&D have waned as the US went to war in 2003 and "shifted resources away from research toward near-term projects"[17].

USAID also provided 6% ($707m) of total US Government investment over the decade. As a development assistance agency, USAID has a strong track record in delivering new products once they have been developed, but is also a significant funder of global health R&D in its own right. Annual contributions to global health R&D have increased steadily over the decade, spurred by the growth of several PDPs that have become partners for USAID since their inception.

Figure 8.
US Government funding for global health R&D - by agency* between 2000 and 2010

* FDA data not available



BOX 2

The NIH's role in global health R&D

The NIH is the leading US agency for funding and conducting medical research and the biggest funder of global health R&D in the world. The NIH is composed of 27 institutes and centers, and invests over $30 billion in medical research annually. The agency funds, conducts, and builds capacity for R&D in over 90 countries across the globe.[18]

Key NIH Contributions

Funding R&D

World leader in global health R&D funding with annual spending of around $1.2 billion

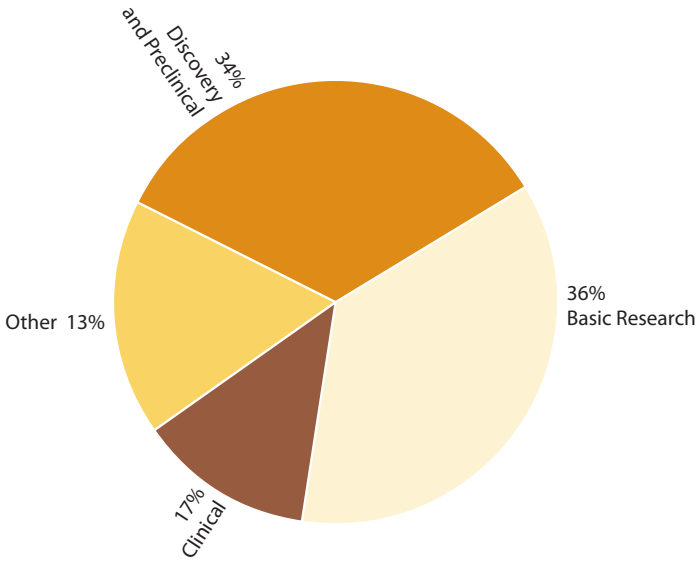
- Top research funder in 11 neglected diseases – HIV/AIDS, malaria, dengue, diarrheal diseases, kinetoplastids, worm infections, salmonella, leprosy, trachoma, TB and rheumatic fever.
- World's greatest contributor to basic research, funding nearly two-thirds (62%) of the global total.
- Leading investor in early research, providing almost 50% of global discovery and preclinical funding.

Figures 9 and 10.
NIH global health R&D funding, 2000-2010

* Other NDs include: leprosy, trachoma, buruli ulcer, rheumatic fever

** Other funding includes: platform technologies, core funding to multi-disease R&D organisations and unspecified R&D

BY R&D STAGE



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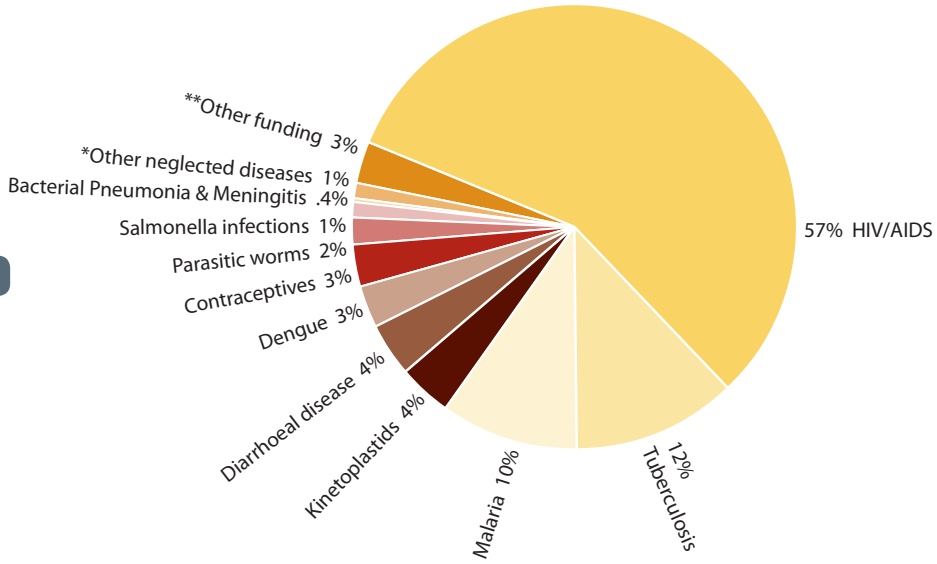


Conducting R&D, providing IP, and transferring technology

Leader in the discovery and development of innovative new global health products

- Developed the first vaccine to protect children against typhoid fever,[19] a disease that kills an estimated 216,000 people each year, predominantly school children and young adults.[20]
- Developed (and recently improved) the first vaccine against rotavirus,[19] the main cause of acute childhood diarrhea leading to 450,000 deaths each year.[21]
- First institution to donate its IP to the Medicines Patent Pool for the HIV/AIDS antiretroviral drug darunavir.[22]
- Supported development of the first rapid diagnostic test for TB (this technology platform can also be used to diagnose anthrax and other diseases that threaten US health and security).[23]
- Discovered the first effective drug against HIV/AIDS, improving patient life expectancy and decreasing risk of transmission.[19]
- Developed a technology to make vaccines cheaper, more effective and more consistent—as successfully used in the newly registered MenAfriVacTM meningitis vaccine.[19, 24]

Leads research for the scientific understanding of the causes of neglected diseases through multiple in-house research centers, which have mapped the genetic code of many organisms causing neglected diseases.[19]

Building R&D capacity and providing infrastructure

- Supports more than 19 neglected disease specific clinical trial networks.[ii]
- Enables researchers in poor countries to conduct global health R&D.[25,26,27] For instance, the University of Bamako in Mali has become an International Center of Excellence in Research[18] with NIH's know-how, financial and technical support since the 1980s.
- Provides training and education support to scientists in over 12 countries in sub-Saharan Africa via the Medical Education Partnership Initiative, partnering with at least 30 national and regional partners that receive PEPFAR support with more than 20 US and foreign collaborators.[28]
- Supported the development of 39 HIV research centers in 10 African, Asian, and Latin American countries and 10 new international centers of excellence for malaria research in Africa, Asia, the Pacific Islands, and Latin America.[29] These initiatives bring critical infrastructure to local organizations and help build training and research capacity to combat neglected diseases.

[ii] NIH is the primary funder of the following clinical trial networks: For HIV/AIDS: (1) Adolescent Trials Network for HIV/AIDS Interventions (ATN), (2) Adult AIDS Clinical Trials Group (AACTG), (3) Centre for the AIDS Programme of Research in South Africa (CAPRISA), (4) Clinical Directors Network (CDN), (5) HIV Netherlands Australia Thailand Research Collaboration (HIVNAT), (6) HIV Prevention Trials Network (HPTN), (7) HIV Vaccine Trials Network (HVTN), (8) International Maternal Pediatric Adolescent AIDS Clinical Trials (IMPAACT), (9) International Network for Strategic Initiatives in Global HIV Trials (INSIGHT), (10) Microbicide Trials Network (MTN), (11) NICHD Domestic and International Pediatric and Maternal HIV Studies Network, (12) Pediatric AIDS Clinical Trials Group (PACTG), (13) US Military HIV Research Program (MHRP), (14) RCMI Translational Research Network. For enteric diseases: (1) Food and Waterborne Diseases Integrated Research Network (FWD IRN). For bacterial pneumonia and meningitis: (1) Bacteriology and Mycology Study Group (BAMSG). For women's and children's health: (1) Global Network for Women's and Children's Health. For TB: (1) Tuberculosis Research Unit (TBRU). For vaccine research: (1) Vaccine and Treatment Evaluation Units (VTEUs) Networks led by others where NIH financially contributes: (1) Armed Forces Research Institute of Medical Services (AFRIMS), (2) Thailand AIDS Vaccine Evaluation Group (TAVEG), (3) African Malaria Network Trust (AMANET), (4) INCLEN TRUST (INCLEN), (5) Tuberculosis Trials Consortium (TBTC)

BOX 3

The DoD's role in global health R&D

The DoD is one of the longest and most active developers of global health technologies worldwide. DoD built its R&D capabilities as part of its mandate to protect US troops from disabling and debilitating infectious diseases. As a result, while some of the resulting technologies have had broader global health applications, not all have been suitable or affordable for developing country populations.

Key DoD Contributions

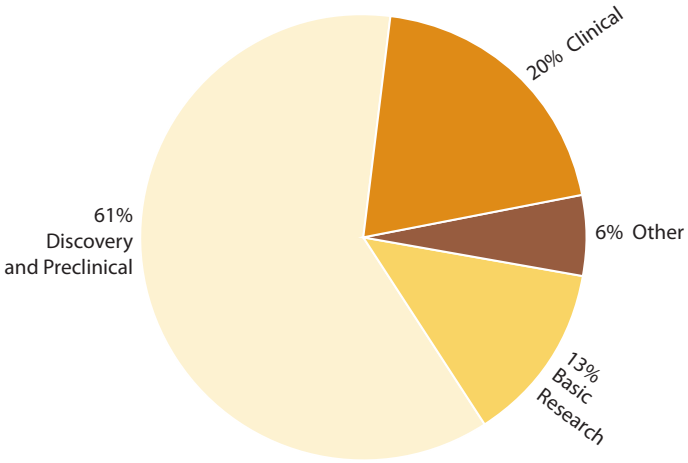
Funding R&D

Eighth-largest funder of global health R&D in the world, with an annual spend of around $82 million

- Top 12 R&D funder for five neglected diseases – HIV/AIDS, malaria, dengue, diarrheal diseases, and meningitis

Figures 11 and 12.
DoD global health R&D funding, 2000-2010

BY R&D STAGE



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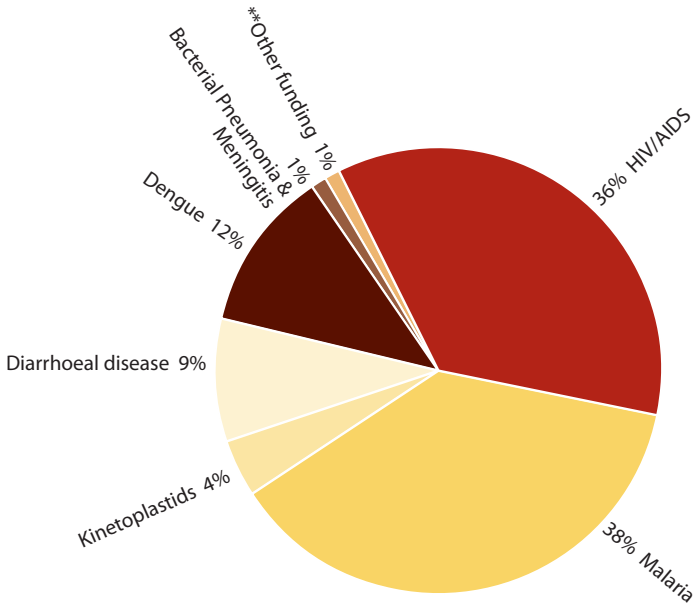


Conducting R&D

World leader in vaccine R&D for neglected disease

- Participated in the development of one of every four vaccines approved by the FDA in the last century, helping to control infectious diseases such as meningitis, typhoid, Japanese encephalitis, yellow fever, mumps, measles, and polio.[30,31]
- Lead funder of the RV144 clinical study in Thailand, the largest HIV vaccine trial in history and the first to show that a safe and effective HIV vaccine is possible.[32]
- Lead partner (with GlaxoSmithKline Biologicals) in the early development and clinical testing of RTS,S, the world's most advanced malaria vaccine candidate.[33]

Developer of neglected disease drugs, diagnostics, and insect control products

- Developed the first effective drugs against malaria,[30] (although not suitable for developing country applications).
- Developed rapid diagnostics, bed nets, insecticides and electronic detection systems against tropical diseases transmitted by insects such as malaria, leishmaniasis and dengue.[34,35,36]

Conductor of clinical trials in endemic countries

- Tested at least 27 new drugs and vaccines in clinical trials in five regional facilities in Africa, Asia, and Latin America.[37]

Conducts basic research to support the development of new neglected disease products

- Contributed to the genetic sequencing of the malaria parasite, supporting a new generation of improved products to tackle the disease.[38]
- First to identify new dengue strains in Latin America,[37] reviving the field of dengue R&D.
- Operates the sole US based discovery program for malaria and the only accredited diagnostic laboratory worldwide for leishmaniasis.[37]

Building R&D capacity and providing infrastructure

- Provided training and education support to scientists in the developing world. Since 2004, more than 846 professionals from 22 African and Asian countries have received laboratory training.[37]
- Provides infrastructure for trials conducted by PDPs, industry and other US public agencies, through a network of clinical trial sites supported by the agency's four overseas medical research laboratories in Egypt, Thailand, Kenya, and Peru.[37]

BOX 4

USAID's role in global health R&D

USAID is the chief federal agency providing development assistance worldwide. The Global Health Bureau, the agency's health division, is a key component of USAID's mission in international development, working to ensure the quality, availability, and use of essential health interventions in developing countries. With a total budget of $5.27 billion in 2009,[39] USAID leads several programs under the Global Health Initiative, including the President's Malaria Initiative and the Neglected Tropical Diseases Program. Several of these are procurement programs that play a vital role in delivering health interventions to the developing world, including HIV drugs through PEPFAR; malaria drugs, diagnostics and bednets through PMI; and contraceptives and condoms through a range of public- and private-sector programs. Although valuable, these programs are not discussed further here as they are outside the R&D remit of this report.

Key USAID Contributions

Funding R&D and providing R&D expertise

Key funder of breakthrough products for global health

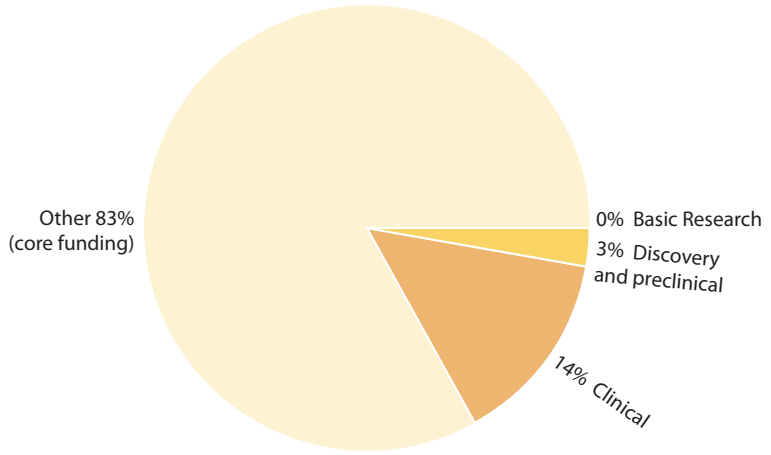
- USAID's Malaria Vaccine Development Program has been funding vaccine R&D since 1966,[40] supporting early-stage research that was essential for the development of RTS,S—the most advanced malaria vaccine—including the development of malaria parasite cultures, demonstration of protection by experimental vaccines, and discovery of the main target protein for a vaccine to attack.
- Funded 90% of the $18 million CAPRISA microbicide trials,[41] which first showed that vaginal microbicides can safely and effectively reduce HIV transmission from men to women.
- Supported development of pivotal contraceptive technologies, including the first long-acting vaginal ring, due in 2013; and Depo-subQ Provera 104™ in Uniject™ a contraceptive injection device targeted for roll out in 2013.[39]

Provides funding to a range of PDPs

- The largest funder of the International AIDS Vaccine Initiative (IAVI), providing over $100 million since 2006.[11]
- Also supports PDPs developing new malaria drugs and vaccines, TB drugs, diagnostics for Chagas' disease, and microbicides to prevent HIV.[11]

Figures 13 and 14.
USAID global health R&D funding, 2000-2010

BY R&D STAGE



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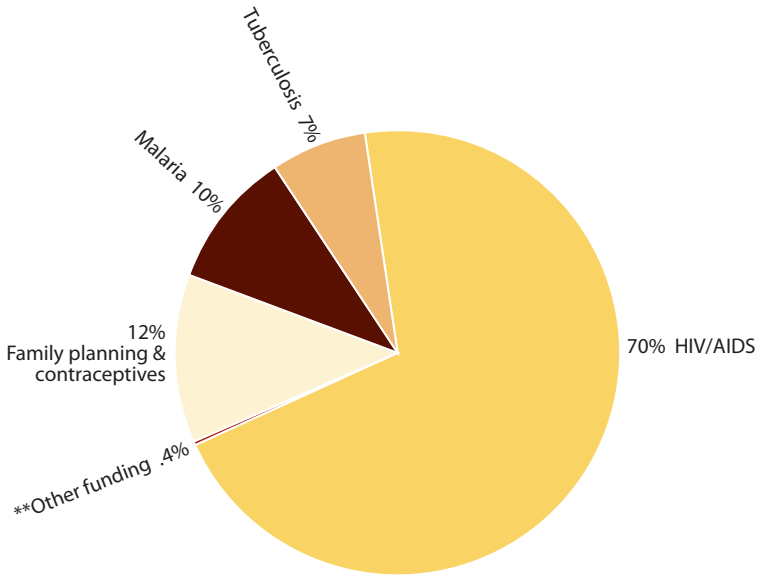


Supporting delivery and implementation of interventions in global health

Providing R&D expertise

- Provides technical leadership and strategic advice in the R&D of contraceptives, microbicides, and vaccine R&D for malaria and HIV.

Providing global expertise

- Provides expertise in demand forecasting, supply and procurement, and distribution and delivery of new and existing vaccines to developing countries.

Evaluating and scaling-up new tools to achieve impact on-the-ground

- Steers the development and introduction of family planning and reproductive health interventions that reduce pregnancy risks, HIV/AIDS, and other sexually-transmitted infections
- Supports field research and clinical trials for TB diagnostics, short course TB treatment, and TB-HIV care (supported by PEPFAR).
- Principal funder of field trials validating malaria control measures such as insecticide treated bed nets, artemisinin combination therapies (ACTs), and intermittent treatment for pregnant women.

BOX 5

The CDC's role in global health R&D

The CDC is the principal US federal agency commissioned with promoting and protecting US public health and safety, and is an implementing partner in the President's Malaria Initiative, USAID's Neglected Tropical Diseases Program and PEPFAR. In 2012, Congress provided $340 million for CDC global health programs, which include AIDS, malaria, TB, influenza, neglected tropical diseases, immunization, disease detection, and public health capacity development.[31]

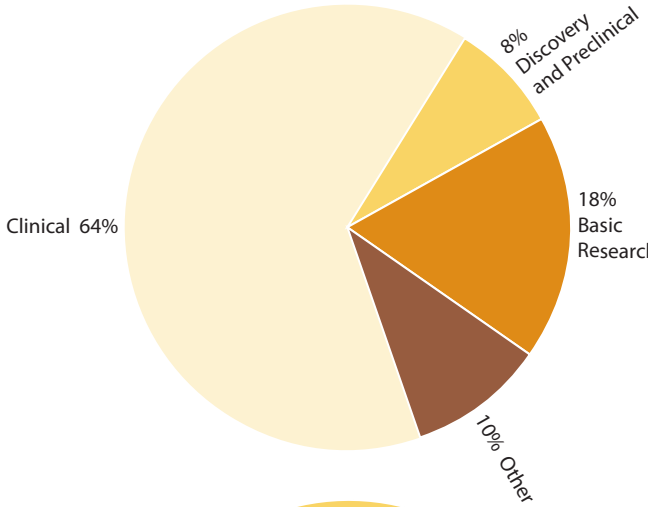
Key CDC Contributions

Funding & Conducting R&D

- Leads the TB Trials Consortium, which includes a global network of clinical trial sites in over eight countries, and conducted over nine major trials and 15 sub-studies on TB treatment and prevention interventions since 1997 (annual operating budget of $11 million).[42]
- Tests the performance (with the WHO and the Foundation for Innovative New Diagnostics (FIND)) of commercial rapid diagnostics tests for malaria, and works to improve TB screening and diagnostics.
- Modifies existing diagnostic tools for more effective field use, while developing new diagnostics for parasitic diseases such as schistosomiasis, onchocerciasis and leishmaniasis.
- Tests potential malaria vaccine candidates using animal models, and conducts basic research into malaria disease biology, transmission, and immunity.

Figures 15 and 16. CDC global health R&D funding, 2000-2010

BY R&D STAGE



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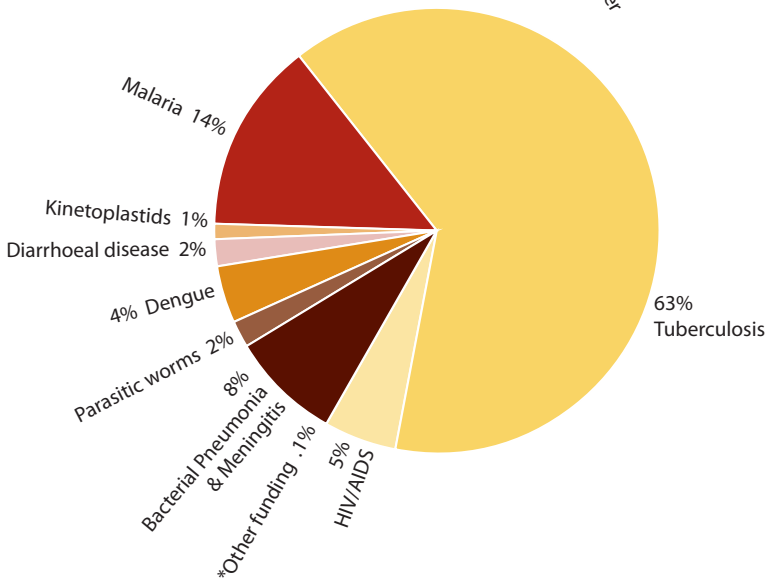


* Other funding includes: platform technologies, core funding to multi-disease R&D organisations and unspecified R&D

Building R&D capacity and providing infrastructure

Worldwide leader in disease detection and surveillance

- CDC builds in-country capacity and enhances rapid response to infectious diseases in developing countries.
- The first to call attention to antimalarial drug resistance in Africa in the 1980s, documenting its public health impact and establishing drug resistance monitoring networks.[43]
- Strengthens in-country capacity for AIDS surveillance in over 40 PEPFAR countries, with epidemiologists and public health experts employed on-the-ground.

BOX 6

The FDA's role in global health R&D

The FDA is the largest regulatory authority of pharmaceuticals in the world. The principal focus of the FDA is to ensure the effectiveness and safety of health and other products[44] in the US, but increasingly it is playing a role in global health R&D.

Funding and conducting R&D

- **Invests in R&D of global health technologies**. Highlights include development by the Center for Biologics Evaluation and Research (CBER) of the technology used in the first long-acting meningitis vaccine for Africa;[45] and the Critical Path Initiative (CPI), which funds development of new TB drugs, vaccines and diagnostics.[46]
- Incentivizes neglected disease R&D through the Priority Review Voucher (PRV) Program Under the PRV Program, companies that develop an approved drug for a neglected tropical disease can obtain "priority" review for another product, such as a commercial drug. This can potentially help a company to bring a commercial drug to market 4-12 months earlier, reaping the extra profits this entails, although to date only one PRV has been issued (for the anti-malarial drug Coartem™). [47,48]

Providing R&D regulatory expertise

- **Approves new global health products for use in the US, which can facilitate their introduction into developing countries.** The FDA has approved more than 50 drugs, vaccines, and diagnostics for neglected diseases,[49] including the first diagnostic test for dengue in April 2011.[50]
- Evaluates the quality of generic drugs for developing country use. Since 2004, the FDA has approved over 141 generic AIDS drugs[51] that have been given to more than 2.1 million patients[52] under PEPFAR.
- Actively partners with the WHO[53] to verify vaccine quality. The FDA has worked with the WHO to verify the quality of seven US licensed vaccines,[53] including a rotavirus vaccine that has already been introduced in five developing countries,[21] and a pneumonia vaccine that has already been introduced in 15 countries of Africa and Latin America.[54]
- Creates new regulatory approaches to accelerate development of global health products. Development and review of improved standards and principles for the registration of new drugs, vaccines, and diagnostics against neglected diseases, especially TB.[49]

Building R&D capacity

- Helps to grow the expertise of developing country regulators. Working with the WHO African Vaccine Regulatory Forum (AVAREF) and the WHO Developing Country Vaccine Regulators Network (DCVRN) to share expertise, through information sharing, training, and mentoring activities.[53]

NEW GLOBAL HEALTH PRODUCTS ARE ALREADY ON THE GROUND

In the last decade, the US Government invested $12.7 billion in global health R&D. This investment has generated significant value—new scientific knowledge, new technologies, and new research facilities in developing countries—and has contributed to the creation of 45 new global health products that have brought lasting benefits both to developing countries and to the US.

Forty-five new global health products were registered between 2000 and 2010

Between 2000 and 2010, 45 new global health products were registered to tackle a wide variety of health problems and neglected diseases. Many of these new drugs, diagnostics, contraceptives, and vaccines have already been introduced in the developing world where they are saving lives, improving health and bringing much-needed cost savings to over-stretched health systems. Some have been incremental improvements, but others—including the MenAfriVac™ meningitis vaccine and the Xpert® MTB/RIF diagnostic, highlighted later in this section—have been major breakthroughs for both patients and health systems.

The US Government's role in creating these new products

One or more of the five US Government agencies was involved to some extent in development of half of all new global health products introduced in the decade, representing 24 (53%) of the 45 products. These US agency supported products span several diseases including eight new drugs to treat malaria in a broad range of target populations and five new tests to diagnose TB at different stages of disease progression.

US Government support was predominantly financial, with 47% of new products funded to some extent by one or more of the federal agencies. For 22% of new products, US Government support involved other inputs such as R&D, technical expertise, the development of infrastructure, or IP and technology transfer. As expected, given the magnitude of its funding for global health R&D, the NIH supported the development of more products than any other agency, although more than half of US-supported products derived inputs from more than one federal agency.

The two case studies below—the meningitis A vaccine and a new TB diagnostic—highlight the range of roles that US Government agencies can and have played, and how this has contributed to bringing new products to patients in the developing world.

Table 1.
New products registered during 2000-2010

*Diagnostic products have been grouped for certain diseases by type of technology

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
$$$	>50%
$$	20-50%
$	<20%

PRODUCT	PRODUCT/RESEARCH PROGRAM	FINANCIAL SUPPORT: Industry	FINANCIAL SUPPORT: Philanthropy	FINANCIAL SUPPORT: Other governments	FINANCIAL SUPPORT: US Government	NON-FINANCIAL SUPPORT (US agencies): NIH	NON-FINANCIAL SUPPORT (US agencies): DoD	NON-FINANCIAL SUPPORT (US agencies): USAID	NON-FINANCIAL SUPPORT (US agencies): CDC	NON-FINANCIAL SUPPORT (US agencies): FDA
Chagas'	Drug	Pediatric benznidazole	$	$$	$$						
	Diagnostic	Chagas' assays	$$$								
		Chagas' RDTs	$$$								
Cholera	Vaccine	Oral cholera vaccine (Shanchol™)	$	$$$							
	Diagnostic	Cholera SMART™ / Dipsticks for rapid diagnosis	$$$								
Family Planning	Contraceptive	Nesterone/ Ethinyl Estradiol contraceptive vaginal ring				$$$ (NIH) $$ (USAID)	INF		EXP		
		Depo-SubQ Provera 104 ™ in the Uniject™ Injection System	$$$			$$ (USAID)					
Dengue	Diagnostic	Dengue ELISAs	$					R&D			
		Dengue RDTs	$$$								
Giardia	Diagnostic	Giardia / Cryptosporidium quick chek	$$$								
HIV/AIDS	Diagnostic	HIV RDTs	$$$								
		CD4 + T-Cell Counting Technologies	$$$								
		NAT and non-NAT based technologies	$$$					EXP			
		HIV P24 ELISA Kit	$$$								
Leishmaniasis	Drug	Paromomycin I/M		$$$				INF EXP			
		Miltefosine	$$		$$$	$ (NIH) $ (USAID)					
	Diagnostic	Leishmaniasis RDTs	$$$		$	$ (NIH)		EXP			

Table 1.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
$$$	>50%
$$	20-50%
$	<20%

PRODUCT	PRODUCT/RESEARCH PROGRAM	FINANCIAL SUPPORT: Industry	Philanthropy	Other governments	US Government	NON-FINANCIAL SUPPORT (US agencies): NIH	DoD	USAID	CDC	FDA
Lymphatic filariasis	Diagnostic	Filariasis RDTs	$$$								
Malaria	Drug	Pyramax®	$$	$$	$$	$ (NIH); $ (USAID)		EXP			
		Eurartesim®	$$	$$	$$	$ (NIH); $ (USAID)					
		Coartem ® Dispersible	$$	$$	$$	$ (NIH); $ (USAID)					
		Artesunate injection	$$$	$	$	$ (NIH); $ (USAID)		R&D			
		ASAQ Winthrop®	$$	$	$$$						
		ASMQ	$	$	$$$						
		Chlorproguanil/dapsone	$$		$$$	$ (USAID)					
		Artemotil	$		$$$	$ (USAID)					
	Diagnostic	"Malaria RDTs "	$$$			$ (DoD)					
Meningitis	Vaccine	MenAfriVac ™	$	$	$	$ (USAID); $ (CDC)	IP		EXP	R&D	IP
	Diagnostic	Dipstick rapid diagnostic test			$						
Onchocerciasis	Diagnostic	Ov-16 rapid immunochromatographic card test									
Pneumonia	Vaccine	Synflorix ®	$$$			$ (NIH)					
		Prevnar 13® (PCV13)	$$$			$ (NIH)					
Rotavirus	Vaccine	RotaTeq®	$$$								
		Rotarix ®	$$$								

Table 1.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
$$$	>50%
$$	20-50%
$	<20%

			FINANCIAL SUPPORT				NON-FINANCIAL SUPPORT (US agencies)				
PRODUCT	PRODUCT/RESEARCH PROGRAM		Industry	Philanthropy	Other governments	US Government	NIH	DoD	USAID	CDC	FDA
Rotavirus	Vaccine	Human-bovine rotavirus reassortants				$$$ (NIH)	IP				
Schistosomiasis	Diagnostic	Schistosomiasis RDTs	$$$								
Tuberculosis	Diagnostic	Liquid culture	$$$	$	$	$ (NIH)					
		Microscopy	$$	$$	$	$ (NIH)					
		NAAT automated detection and MDR screening	$$	$$	$	$ (NIH)					
		Xpert® MTB/Rif	$$$	$	$	$$ (NIH)	EXP	IP		EXP	
		NAAT non automated or case detection screening	$$$								
		Capilia TB	$$$	$	$	$ (NIH)					
		LAMP of DNA (TB)	$$	$$	$	$ (NIH)					
		Phage-based tests	$$$		$$						
Trachoma	Diagnostic	Dipstick immunoassay RDT			$$$						

Case Study 1

The meningitis A vaccine

The new meningitis A vaccine highlights the benefits of R&D, and the range of inputs from US Government agencies in its development.

Meningococcal meningitis is a deadly, highly contagious disease that sweeps across sub-Saharan Africa bringing life-threatening risks for infants, children, and young adults. The disease causes high fever, vomiting, headaches, and stiffness of the neck, and is spread by sneezing, coughing, or sharing eating utensils. One in 10 people that develop symptoms die within a few days. Among those who survive, one in five is left with permanent life-limiting disabilities such as mental impairment, deafness, or epilepsy.[55]

During the dry season, 430 million people in a region known as the "meningitis belt," which stretches from Senegal to Ethiopia, live in fear of a meningitis epidemic. The last major epidemic in 1996 and 1997 infected more than a quarter of a million people, killing 25,000 and disabling 50,000 more.[56] More recently in 2009, an epidemic accounted for close to 90,000 cases of meningitis. These epidemics can have a devastating impact on communities, with more than half of all cases among working age adolescents and young adults.

The public health response to meningitis outbreaks has typically been too little, too late. The disease spreads too quickly to make early diagnosis and treatment a viable option. Instead, countries have relied on emergency immunization campaigns triggered at the first sign of an epidemic. Unfortunately, the vaccines used in these campaigns provide only limited protection to those who were vaccinated and no protection to infants or those who were not vaccinated. Moreover, by the time these control measures were rolled out, thousands may already have died. Between 1999 and 2003, an estimated $160 million was spent on emergency vaccination, yet epidemics still occurred.[57]

The new meningitis A vaccine

Recognizing that existing tools were insufficient to tackle meningitis epidemics, a group of senior health officials, scientists, and public health organizations called for a new, low-cost vaccine. The Bill & Melinda Gates Foundation responded in 2001, providing 10 years of grant funding to establish and operate the Meningitis Vaccine Project (MVP), a partnership between PATH and the WHO. Further support was provided by government agencies and philanthropic funders including USAID, CDC, the GAVI Alliance, UNICEF, and others.

MVP quickly established key global partnerships to assist in developing the new vaccine. The Serum Institute of India, one of the world's largest producers of vaccines, agreed to manufacture the new vaccine at a cost that no manufacturer in the developed world could match. Synco Bio Partners, a Dutch vaccine manufacturing company, developed a low-cost process to produce a key component of the vaccine. The US Government, led by the Center for Biologics Evaluation and Research (CBER) at the FDA, donated a technology critical to creating a more effective vaccine, through a technology transfer agreement negotiated with help from the NIH. The new vaccine was tested in India, Mali, Ghana, the Gambia, and Senegal and then licensed in India, with USAID and Healthe Canada providing support to the Indian regulatory authority to ensure it had the capabilities to provide oversight for the new vaccine. In 2010, a new meningitis A conjugate vaccine—the first vaccine developed specifically for Africa and the first to be introduced in Africa before the rest of the world—was ready to be rolled out.

The FDA donated the Meningitis A vaccine technology, NIH helped negotiate the technology transfer agreement, CDC assisted with the rollout, and USAID trained scientists tracked the spread of the disease

The new vaccine, MenAfriVac™, protects against meningitis A, the strain that was once responsible for 85% of epidemics in Africa.[58] In contrast to the old vaccine, the new vaccine is able to protect infants, is expected to be long lasting after only one dose, and prevents transmission, thereby protecting people who have not been vaccinated.[59] The price for MenAfriVac™—at less than 50 cents a dose—was set at a level identified by African countries as realistically affordable.[60] In the US, Novartis and Sanofi Pasteur market a similar vaccine targeting Western strains for $80-$100 per dose.[61] MenAfriVac™ was developed in less than half the time of a typical vaccine and at a fraction of the several hundred million dollars typically needed to develop a vaccine.

In December 2010, national immunization campaigns commenced in Burkina Faso, Mali, and Niger to vaccinate children and young adults against meningitis with MenAfriVac™. In less than one month, 19.5 million people were vaccinated. The CDC assisted the countries' ministries of health, WHO, UNICEF, and NGOs, by providing the necessary epidemiologic analysis to determine the disease burden. The CDC also worked with health authorities in Burkina Faso on the country's first MenAfriVac™ vaccination campaign, while USAID-trained scientists in Burkina Faso, Mali, and Niger to track the spread of the disease. (45)

Case Study 2
A new TB diagnostic

This new test detects drug-resistant TB and diagnoses TB in HIV patients. The US Government played a significant role in its development and rollout in the developing world.

At the beginning of the twentieth century, TB—known as consumption—claimed more lives in the US than any other disease,[62] and it was not until the development of antibiotics in the 1950s that TB was fully controlled in the US and Europe. Now, TB has re-emerged as a leading cause of death, this time concentrated in the developing world.

One in 10 of those infected with TB will eventually become sick with a persistent cough, night sweats, fever, and weight loss. Without treatment, they in turn can infect 10-15 people each year[63]—usually family and friends—and their own condition can deteriorate, leading to death. In 2010, 8.8 million people became ill with TB and 1.4 million died.[64] It is estimated that TB will cost the world's poorest countries $1-3 trillion over the next decade.[65]

People with HIV are particularly susceptible, being 20-30 times more likely to develop TB. TB is the leading cause of death among those with HIV[66] and is responsible for half of all AIDS-related deaths in sub-Saharan Africa.[67] In recent years, drug-resistant forms of TB have also emerged. These forms of TB—known as multi-drug resistant (MDR) and extensively-drug resistant (XDR) TB—are extremely difficult and expensive to treat. In Russia, it has been estimated that one

in three newly-diagnosed TB cases are MDR.[68] Treatment for MDR-TB takes up to 24 months, has significant side effects, and—worst of all—often fails, with four out of every 10 patients dying despite treatment.[69] If drug-resistant TB continues to spread, our ability to contain TB is in serious jeopardy.

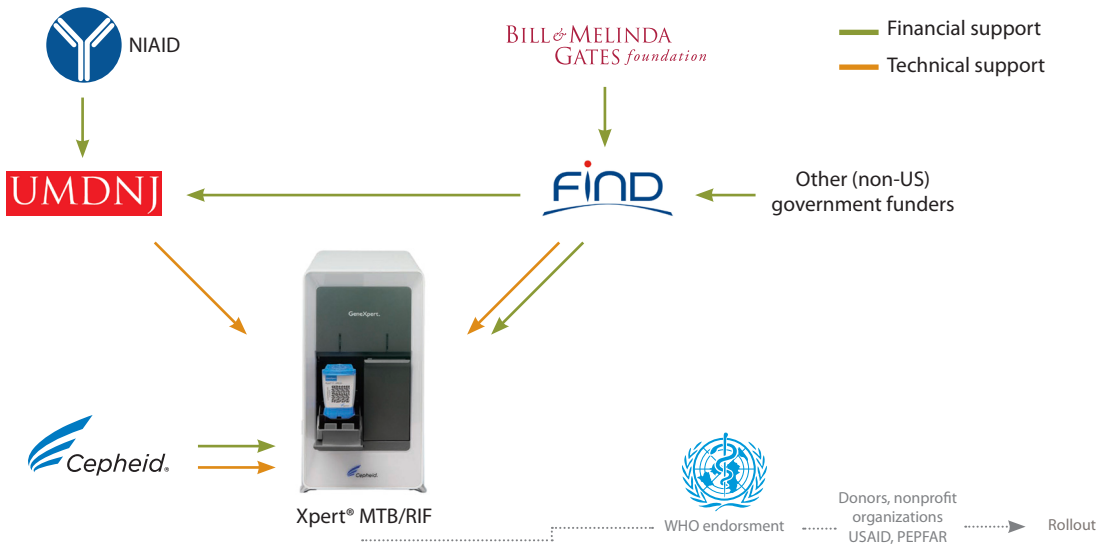
Part of the difficulty in managing HIV-positive and MDR-TB patients is that standard TB tests—including diagnosis by microscopy and manual culture of TB microbes for drug-testing—are simply too old for the jobs they are needed to do. As a result, 1.6 million TB cases went unreported in 2008, and fewer than half of the cases in HIV patients are detected before death.[70] Drug-resistance cannot be detected by microscopy at all. It requires "culture," a test that can take up to six weeks to deliver a result and that involves sending sputum samples to a district or national reference hospital laboratory.

The new TB diagnostic

In 2006, FIND—a PDP specializing in diagnostic tests—reached an agreement with Cepheid, a private company from California, to co-develop a new diagnostic test for TB. Xpert® MTB/RIF is a fully automated diagnostic test without the need for microscopes or a laboratory. It is far superior to old diagnostic technologies in many ways. It is safe and simple to use; requires very little technical training to operate; is 98% accurate; detects drug-resistance; is excellent at diagnosing TB in HIV-positive patients; and takes less than two hours from start to finish. A patient can now start treatment on the same day, rather than waiting months for a laboratory result or undergoing a year of failed therapy before drug resistance is diagnosed.

The new product was built on Cepheid's GeneXpert® platform, a sophisticated machine developed in response to the 2001 anthrax threat and does not require a laboratory. Xpert® MTB/RIF was developed by FIND, Cepheid, and the University of Medicine and Dentistry New Jersey with funding from the NIH and the Bill & Melinda Gates Foundation. The new TB test was unveiled four years later, resulting in a WHO recommendation for its immediate deployment in developing countries most affected by TB.

Figure 17. Partners involved in Xpert ® MTB/RIF product development



Cepheid had already invested $300 million in the GeneXpert platform, but has spent a further $25 million on Xpert ® MTB/RIF to adapt their technology for TB. An additional $12 million came from the NIH and FIND (through its donors) to bring the new machine to market.

Trials and demonstration studies were conducted in Peru, Azerbaijan, South Africa and India in similar conditions to where the tests are most needed. More than 8,000 patients were tested over 18 months, demonstrating that Xpert® MTB/RIF was accurate, safe and easy to use. The rollout of Xpert® MTB/RIF was supported by a number of donors and non-profit agencies, including PEPFAR and USAID. It began in early 2011, and by July the same year, 26 countries had started using the test.

NIH co-funded development of the Xpert® TB test and USAID and PEPFAR are supporting its roll-out in developing countries

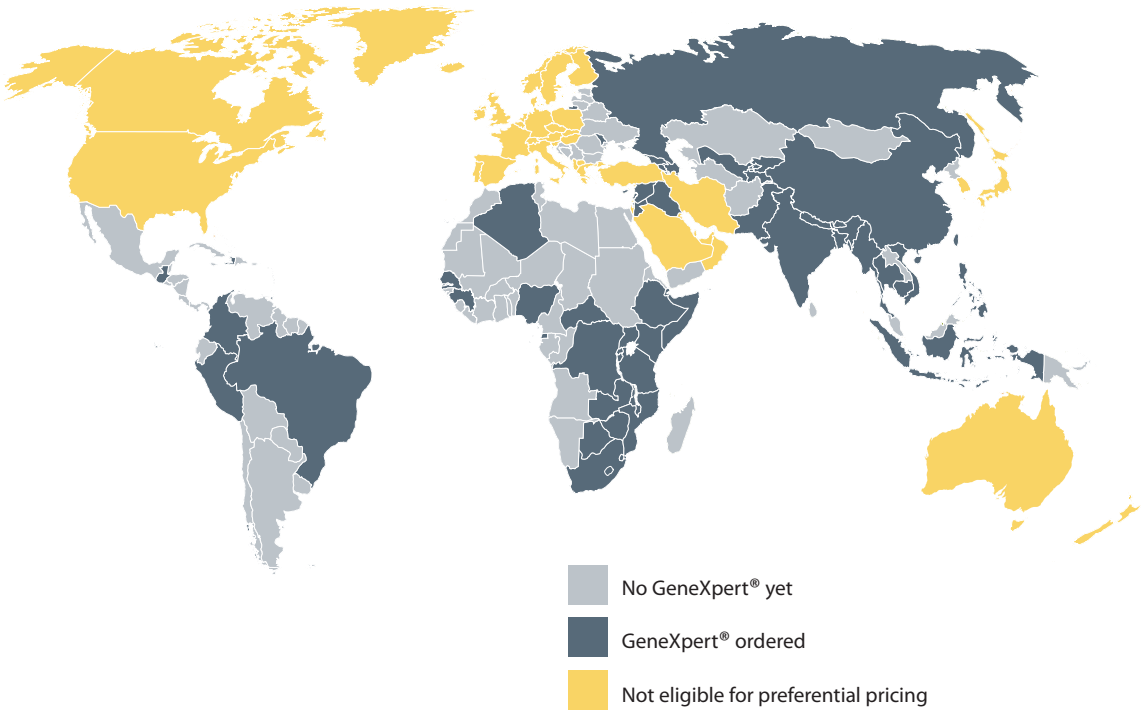


Figure 18. GeneXpert® roll out by country as of July 2011

Source: http://www.stoptb.org/wg/gli/assets/documents/map/1/atlas.html

MORE HIGH VALUE GLOBAL HEALTH PRODUCTS ARE NOW IN THE PIPELINE

The largest pipeline ever of new global health products

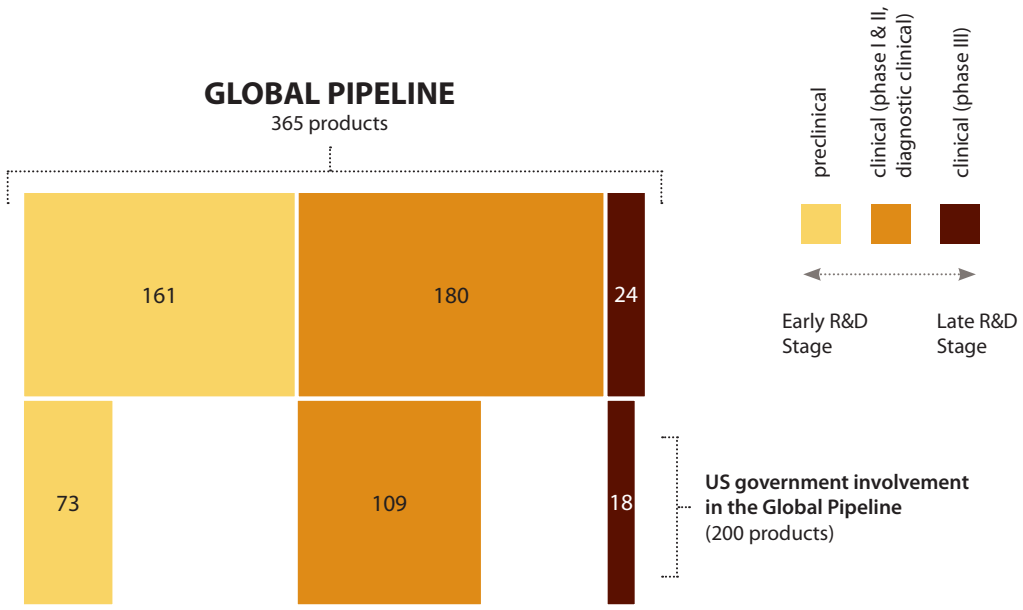
After years of neglect, the global health R&D landscape for new products has been transformed in the last decade, driven by sustained investment from the US Government and increasing support from industry, other public funders, and philanthropic agencies like the Bill & Melinda Gates Foundation. The fruits of this investment are seen not only in products that have already been registered, but also in the generation of the largest pipeline ever of new global health products.

There are currently over 360 drugs, vaccines, contraceptives, insecticides, diagnostics, and microbicides in development, of which just over half have had some US Government support. Many of these will fail at the early hurdles, as is normal in pharmaceutical development, but others will bring profound health benefits to developing countries in the next decade if funding is sustained.

The US Government's role in supporting the pipeline

The US Government has played an increasing and often influential role in expanding the pipeline of new global health products. In all, the US Government is involved to some extent in 200 (55%) of the 365 products currently in development.

Figure 19. Number of pipeline products with US Government involvement, as of January 2012



As with already registered products, the role of the US Government agencies in supporting this pipeline is rich and varied. The two case studies below—HIV preventives and new TB drugs—highlight the diversity and value of US Government inputs to the pipeline of new products, as well as the tripartite nature of product development in today's world.

Case Study 3: HIV preventives

The US Government is partnering with industry and philanthropic organizations to develop new HIV prevention technologies—such as an HIV vaccine or the Woman's Condom—that have the potential to transform the landscape in the battle against HIV/AIDS .

Since the beginning of the epidemic, HIV/AIDS has killed around 30 million people—more than the population of the states of Michigan, Georgia, and North Carolina combined. Its impact is felt by the poorest and most vulnerable, overwhelmingly in Africa—despite having just 12% of the world's population, sub-Saharan Africa is home to over two-thirds of all people living with HIV.[71] Children account for one in 10 of these cases, and women account for nearly 60%.[71] The gender disparity is often driven by gender inequality, violence, and discrimination—factors that both increase vulnerability and reduce opportunities for women to access treatment.

Children account for one in 10 of HIV cases, and women for nearly 60%

The availability of new antiretroviral treatments (ARVs)—often developed with US Government assistance—together with other interventions to prevent transmission have helped to cut AIDS-related deaths by a fifth from their peak in the mid-2000s.[71] However, overstrained health systems and resource-limited donor agencies are struggling to cope with the demands of scaling-up ARV treatment, making the need for more effective prevention methods ever more urgent.

New technologies to prevent HIV and their projected health impact

Two new products—the Woman's Condom and an HIV vaccine—have the potential to change the current landscape by significantly increasing our ability to prevent HIV infection and transmission.

The Woman's Condom allows women to control their own protection, empowering them and helping to significantly decrease the transmission of HIV. Previous versions of the female condom[1] have been proven to be as effective as male condoms in reducing HIV infections (reduction of 80-90%),[72] but were beset by shortcomings that limited their use, and thus their impact.[73] The user-driven design process for the new Woman's Condom has been a key factor in helping overcome these problems, with studies showing that it is preferred over earlier versions

1 FC1 and FC2 (Female Health Company in 1993 and 2005); Reddy FC (Reddy, 2002).

of female condoms.[72] With approval already granted in Europe in 2010 and China in 2011, the NIH is currently conducting a final trial to prepare for approval by the FDA.[74]

A vaccine for HIV is further away, but has potential for a far greater impact. The most advanced HIV vaccine candidate is the ALVAC-HIV® / AIDSVAX® B/E combination, which recently completed large-scale clinical trials in Thailand in a study known as RV144. While the results put the combination at the lower end of the efficacy scale[2] 75, the trial demonstrated for the first time that a safe vaccine against HIV is possible, and could finally reverse the tide of the pandemic.

The Woman's Condom and many of the most advanced HIV vaccine candidates have been developed in three-way partnerships between the US Government, philanthropic organizations and industry

Both the Woman's Condom and many of the most advanced HIV vaccine candidates have been developed in three-way partnerships between the US Government, philanthropic organizations, and industry. The Woman's Condom was largely funded by USAID (which contributed over half of the $9.8 million development cost), with additional funding coming from the Bill & Melinda Gates Foundation, and the government of the Netherlands.[76] It was developed by PATH, a US-based non-profit health product developer, which has partnered with the private-sector Dahua Medical Apparatus Company in China for the Condom's manufacture and distribution.[77]

The US Government also played a key role in the development of the HIV vaccines used in the Thailand trial for the ALVAC-HIV® / AIDSVAX® B/E combination, collaborating with industry[3] and academic partners. The US army provided overall expertise and project leadership for the seven-year Phase III trial and helped fund a quarter of the $105 million trial costs, with the remaining funding provided by the NIH[78]. The US Government is also heavily involved in work to deliver a more effective vaccine, for example DoD and NIH have multiple HIV vaccine candidates in early-stage clinical trials.

Case Study 4: Changing the face of TB

The US Government has been instrumental in driving the development of the next generation of TB drugs to tackle drug-resistant TB, replacing treatments that are more than half a century old.

Current TB treatments were developed in the 1950s and 1960s and have never been truly fit for purpose. Standard TB treatment involves taking a combination of four different drugs several times a day for six months, increasing the risk of non-compliance and the chances of developing drug-resistant TB.

2 HIV infection rate 31.2% lower than placebo
3 Manufacturers: Global Solutions for Infectious Diseases-AIDSVAX B/E(GSID holds the intellectual property rights to AIDSVAX B/E originally developed and previously owned by VaxGen); sanofi-pasteur-ALVAC-HIV vCP1521

Drug-resistant forms of TB are far more difficult and expensive to treat. Multi-drug resistant TB (MDR-TB) and extensively drug-resistant TB (XDR-TB) take up to two years to treat, while the drugs have more side effects, require injections, and work in only 60% of cases.[79] In addition, there is a risk that TB and HIV drugs may interact, rendering treatment for both conditions ineffective.

A new generation of TB drugs is urgently needed that will shorten the duration of treatment,

making it easier for patients to complete their course and recover fully; that can be equally effective at curing drug-resistant forms of TB and work well with HIV drugs; and that are affordable and suitable for use in the poorest countries.

A decade ago, there were no new drugs for TB in development. Now there are 10 drugs in the TB clinical pipeline

Better TB drugs in the pipeline

A decade ago, there were no new drugs for TB in development. Now there are 10 drugs in the TB clinical pipeline, including several promising candidates that are close to market.[80] These are being developed by a range of groups—including academic research institutions, PDPs, and pharmaceutical companies—with support from the US Government and public and philanthropic funders, including the Bill & Melinda Gates Foundation. The most promising candidates in the pipeline are:

- Delamanid/ OPC-67683, a completely new drug in development by Otsuka Pharmaceutical.
- Moxifloxacin, an existing antibiotic developed by the pharmaceutical multinational Bayer, and currently in clinical trials as a treatment for TB by the Global Alliance for TB Drug Development (TB Alliance), a PDP.
- PA-824, a completely new drug in development by the TB Alliance, and currently being tested in clinical trials.
- Bedaquiline/ TMC207, a new drug in development by Johnson and Johnson.
- SQ109, a new drug in development by the biotech company Sequella.

The US Government is playing a major role in development of new TB drugs and drug regimens, with key contributions from the NIH, FDA, CDC, and USAID. The NIH funded preclinical development of both PA-824 and SQ109, and provided clinical trial facilities to test the new drug regimens. CDC supported clinical testing of moxifloxacin through its TB Clinical Trials Consortium (TBTC), and USAID has co-funded the clinical development of both PA-824 and moxifloxacin as individual drugs and is supporting late-stage trials of the new TB drug regimens that include PA-824, moxifloxacin, and TMC-207 in high TB burden countries.

The FDA has played a pivotal role through its work to streamline the regulatory framework for TB drugs through the Critical Path to TB Regimens Initiative—a ground-breaking initiative

that enables drug developers to test combinations of new TB drugs before they are licensed individually, potentially cutting development time of a totally novel regimen from decades to years, and saving millions of R&D dollars in the process.

The US Government is playing a major role... the NIH has funded preclinical TB drug development and provided clinical trial facilities, USAID and CDC are supporting TB drug trials and the FDA has helped cut development time of TB drug combinations from decades to years

HAS THE US GOVERNMENT INVESTMENT PAID OFF?

It is clear that US Government investment in global health R&D has helped fuel the creation of a critical mass within the global health R&D community, as reflected in the 45 new products delivered in the decade and in the burgeoning pipelines of products in development.

However, it is not just about product numbers, nor about flow-on benefits such as new scientific knowledge, R&D infrastructure, and job creation. The real issue is whether these new global health products are realizing the developing world health (and economic) benefits that would justify the U.S. Government's investment in their creation, and underpin the case for continuing investment in the global health product pipeline. For most U.S. funders and taxpayers this is thea key issue: is whether the Government's investment has succeeded in saving the lives of millions of men, women and children in the developing world that are now being wasted.

The four case studies below—the meningitis A vaccine, TB diagnostic, HIV vaccine candidate, and a new TB drug regimen—show that the U.S. Government investment in global health R&D has paid off, with current and projected health and economic savings from these four products alone tallying up to millions of developing world lives and hundreds of millions of dollars. These four products are typical of the diseases and technologies in which the U.S. Government has invested over the past decade—the sum benefit of all products being supported by U.S. Government investment is unimaginably larger. This is a remarkable return on an investment that represents less than 0.01% of the United States' GDP.

The impact of the new meningitis A vaccine

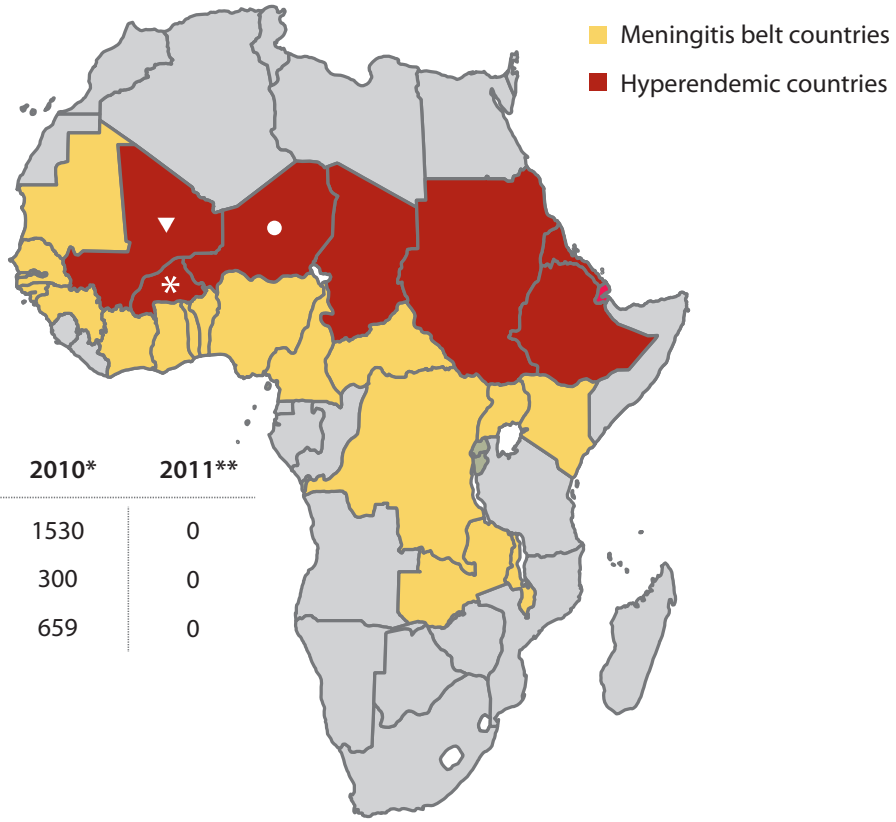
Since its introduction in early 2011, the health impact of the new meningitis A vaccine has been dramatic. In the following epidemic season, there were no cases of meningitis A among people who were vaccinated. The unprecedented success of MenAfriVac™ prompted a second wave of vaccination campaigns in Chad, Cameroon, and Nigeria using vaccine supplies procured by the GAVI Alliance and co-funded by the countries themselves. To date, more than 56 million people have received the vaccine and not a single case of meningitis A has been identified in the vaccinated population. The target is for all 26 countries in the "meningitis belt" to be vaccinated by 2016. Work is ongoing to develop a strategy for routine use of the vaccine in childhood vaccinations, which is important to establish long-term protection of populations.

Zero cases of meningitis A amongst the vaccinated population in 2011

Figure 20.
Meningitis A cases among vaccinated population in the African belt, 2010-2011

*2010 figures derived from total reported meningitis cases multiplied by meningitis A proportion

** among vaccinated



Meningitis cases	2010*	2011**
✳ Burkina Faso	1530	0
▼ Mali	300	0
● Niger	659	0

Modeling suggests that MenAfriVac™ will prevent approximately 437,000 cases[4] of meningitis over the next 10 years, saving around 43,500 lives[5] and averting around 105,000 disabilities[6,81].

Compared to the existing strategy of emergency immunization, MenAfriVac™ should bring significant cost savings to health systems in affected countries that will not have to purchase vaccines and administer vaccination campaigns each time there is a meningitis epidemic. More significantly, MenAfriVac™ prevents transmission of the disease, eliminating outbreaks altogether and in turn the need for emergency immunization campaigns. As a result, introduction of MenAfriVac™ is estimated to save about $570 million in the next decade, freeing much needed resources for use elsewhere in overstretched health systems. Moreover, the new vaccine would bring further cost savings by cutting the cost of treating survivors of meningitis who are left with disabilities such as deafness, epilepsy, and mental impairment, as well as the economic benefits derived from children being able to complete their education and lead healthier, productive lives. The development and delivery of MenAfriVac™ is also a model for capacity building and scientific exchange between the United States and endemic countries, with a zero-year lag period between product development and widespread introduction in Africa.

4 Modelling range: MenAfriVac™ will prevent 433,600 – 441,462 meningitis cases
5 Modelling range: MenAfriVac™ will save 42,879 – 44,210 lives
6 Modelling range: MenAfriVac™ will avert 104,064-105,951 disabilities

Most experts agree that the new vaccine is a cost effective intervention, particularly in countries with the highest numbers of people suffering from meningitis such as Chad, Mali, Ethiopia, Sudan, Burkina Faso, Niger, and Nigeria. The challenge now is to raise the remainder of the $570 million budget that experts believe will allow vaccination of 300 million people in the meningitis belt, putting an end to the threat of the most common cause of meningitis epidemics in sub-Saharan Africa once and for all.

The impact of the new TB diagnostic

Xpert ® MTB/RIF, the new TB diagnostic, is transforming TB control in the countries where it has been introduced, by correctly identifying more TB-infected patients and enabling them to start treatment on the same day. However, the most pronounced benefits are being felt by those with drug-resistant TB and HIV co-infection. Xpert ® MTB/RIF is expected to triple the number of patients diagnosed with drug-resistant TB, curbing the spread of drug resistance and enabling patients to be prescribed the correct treatment immediately. And Xpert ® MTB/RIF will double the diagnosis of TB in HIV-infected patients, saving many lives by allowing an early start to treatment (HIV-infected TB patients decline far more rapidly than other TB patients). Modeling suggests that in India alone, using Xpert MTB/RIF as a replacement for microscopy can avert approximately 100,000 deaths a year.

Xpert ® MTB/RIF will double the diagnosis of TB in HIV-infected patients allowing early life-saving treatment

However, Xpert® MTB/RIF is expensive, costing upwards of $60,000 for the machine and $60 for each test cartridge. As part of its co-development agreement, FIND negotiated concessionary pricing in 145 countries for both the machine (price cut by 60% to $17,000) and the cartridges (price cut by 75% to $16.86) but this is still unaffordable for many of the poorest countries most affected by TB. The discount will increase as more machines are bought but, even at a reduced price of $17, the new test is still considerably more expensive than the current microscopy test (about ~ $6) although cheaper than culture (about ~ $22).

Data from India, South Africa, and Uganda suggest that, when compared to current approaches, Xpert ®MTB/RIF will nevertheless be cost effective either in addition to, or as a replacement for microscopy in certain groups of patients:

- In high-burden countries or countries where existing diagnostic pathways are very poor
- In HIV-infected patients starting ARVs, where Xpert ® MTB/RIF has been shown to avert more deaths and cost less than currently used diagnostics.
- For patients suspected of having MDR-TB, for example those who have been in close contact with an MDR-TB sufferer. Xpert ® MTB/RIF detects 90-95% of resistant cases in these patients, compared to 60-63% through normal methods.

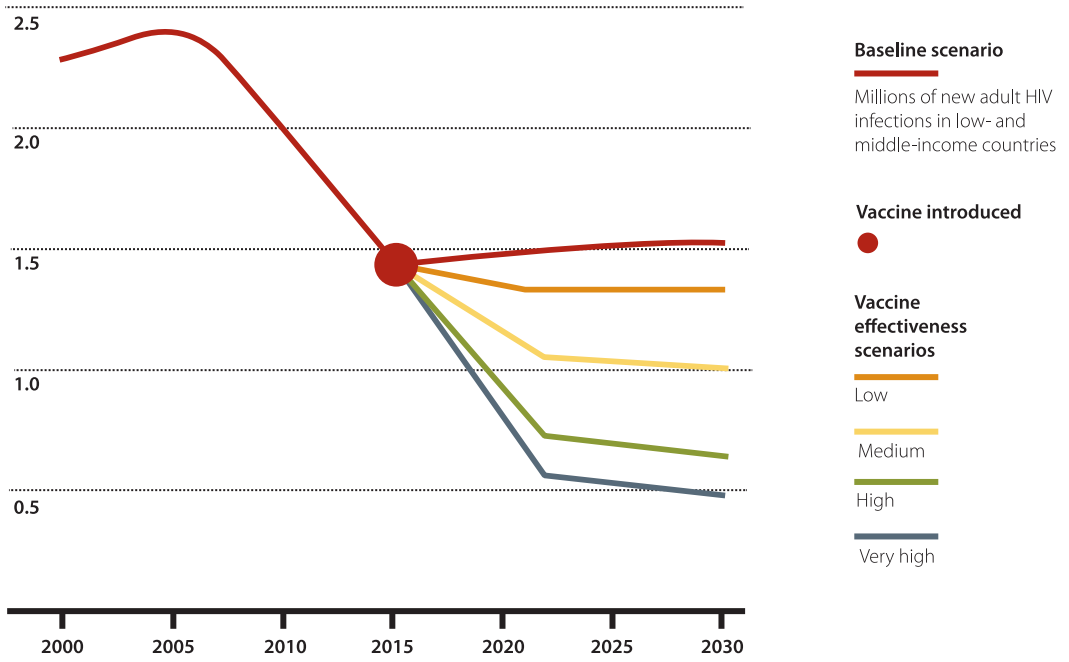
Even when Xpert® MTB/RIF is cost effective, that does not mean countries will be able to afford it without either finding new funds, or diverting existing funds away from TB treatment programs or other much-needed health interventions. Despite its remarkable health benefits, at $17 a test Xpert® MTB/RIF may not make economic sense for all developing countries, or for all TB groups in these countries. Countries will need to make that decision themselves, based on their budgets and the current cost of TB control. However, if resources can be found to cover the high initial cost of buying Xpert® MTB/RIF machines, the benefits of scaling up Xpert® MTB/RIF in high-burden countries are clear.

The impact of an HIV vaccine

A vaccine for HIV is further away, but offers the promise of massive impact. Modeling[7] has suggested that even a modestly efficacious vaccine would have profound effects—a vaccine with 50% efficacy provided to just 30% of the population could reduce the number of new HIV infections in the developing world by a quarter over 15 years, preventing 5.6 million new infections.[1] If a vaccine with 70% efficacy was provided to 70% to 90% of the population, this would reduce the number of new infections globally by 88% to 94% a year, nearly stopping the spread of AIDS.[1] The ALVAC-HIV® / AIDSVAX® B/E combination HIV vaccine, currently in development, is expected to have an efficacy of about 30%, but is still projected to avert one in 10 new infections.[82]

Figure 21.
Effect of a vaccine on AIDS incidence and mortality

Source: International AIDS Vaccine Initiative, Estimating the Impact of an AIDS Vaccine in Developing Countries, August 2009.



7 This modeling is based on the assumption that universal coverage with ARVs is achieved by the time a vaccine is introduced. The absolute impact of the vaccine is likely to be even larger given that the UN goals for ARV coverage may not be achieved in this timeframe(19)(20)

The impact of new TB drugs

The first new TB regimen to be tested under the new development paradigm is PA-M-Z, a combination of two new drugs (PA-824 and moxifloxacin) and pyrazinamide, an existing TB drug. This regimen has the potential to shorten treatment of both drug-resistant and drug-sensitive TB to just four months, and has no interactions with HIV drugs, enabling doctors to treat both diseases simultaneously.

Modeling the potential health impact of a shorter treatment regimen suggests that a four-month treatment course could reduce transmission of TB by 10%, resulting in fewer infections and fewer people requiring treatment for TB. In South-East Asia alone, the new drug combination is projected to prevent over 8 million cases of TB and 2 million deaths by 2050.[83] If accompanied by better diagnostic tests—like Xpert® MTB/RIF—that can detect drug-resistant forms of TB, the new regimen has the potential to save even more lives and dramatically reduce the cost of treatment.[84]

The new drug combination is currently being evaluated at eight trial sites in Africa and South America. Based on data from initial studies, it is expected to reduce the cost of MDR-TB treatment by 90%,[85] from $2,000-$9,000 per patient[86, 87] to just $300 for the drugs alone.[88] However, this shorter, simpler treatment will also require far less management from clinic staff, bringing significant cost savings and freeing up much needed resources at health care facilities. Patients' out-of-pocket expenditures will also be reduced by fewer clinic visits to receive medication and check-ups over many months or years.

DISCUSSION

Why should the US Government continue to invest in global health R&D?

Current investments in global health are already on course to save millions of lives and dollars in the developing world

The previous case studies provide a clear cut case for global health R&D investment. New global health technologies save millions of lives, and often also millions of dollars, just as polio and measles vaccines did for previous generations throughout the world.

However, while the health and economic benefits of new technologies are evidence enough, there are also other persuasive reasons for continued US Government investment in global health R&D.

The next generation of global health products is imminent and promises to deliver even greater health and economic gains to the developing world

US Government investment has driven the creation of the largest global health product development pipeline in history that will deliver the next generation of life saving drugs, diagnostics and vaccines. US agencies are working with others to support development of 200 products across 19 neglected conditions, as well as family planning: HIV/AIDS, TB, malaria, diarrheal diseases, bacterial pneumonia and meningitis, kinetoplastid diseases like sleeping sickness and Chagas', salmonella infections, dengue, parasitic worms, contraceptives and trachoma.

Progress in global health R&D in the past decade has been remarkable but the gains are fragile. Sustained funding over the last decade has created a critical mass within the global health R&D community and built momentum steadily over the decade. Scaling back funds for global health R&D puts the entire product development pipeline at risk. Decommissioned research programs cannot easily be restarted, skilled scientists will be lost and the hard-won build-up of political will, expertise, and industry and philanthropic commitment may never be regained. A retreat from funding R&D would waste billions of dollars of investment, and condemn promising drugs, vaccines, and diagnostics now in the final stages of development to the scrapheap.

Failing to replace old ineffective with new and better ones costs lives and wastes money

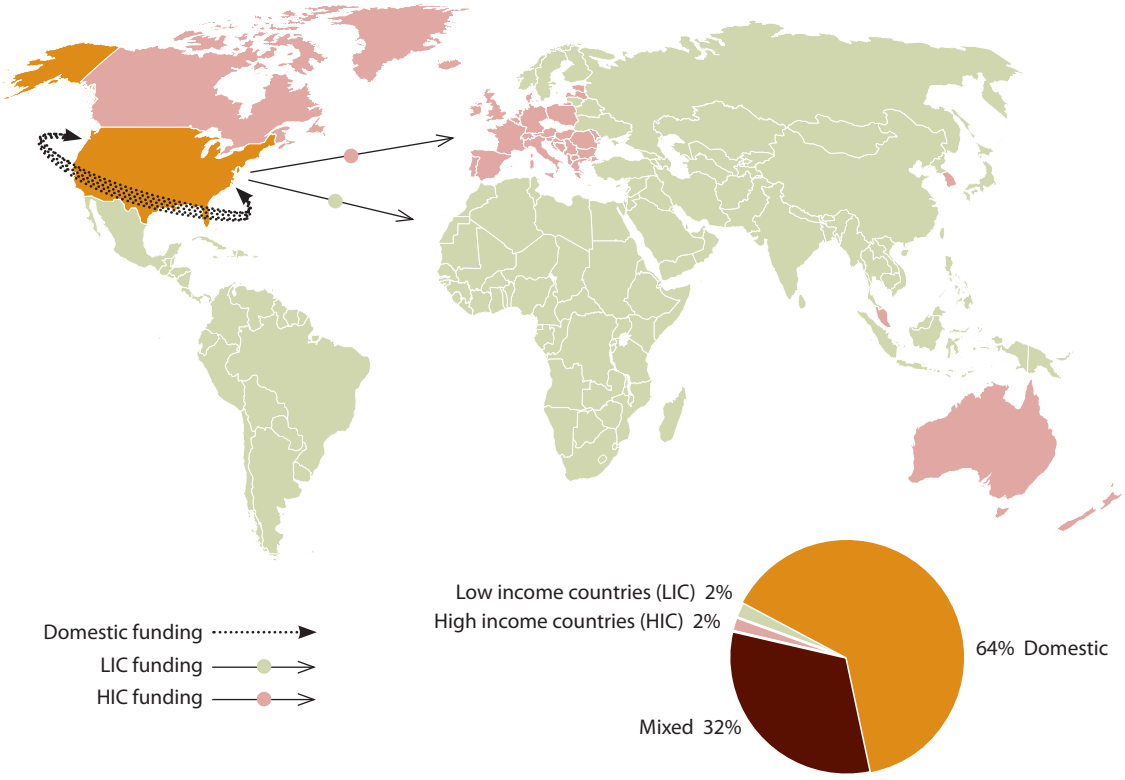
New products are still desperately needed to prevent, diagnose, and treat diseases that disproportionately affect those living in developing countries. Some of these—like a malaria or HIV vaccine—are needed to fill a critical gap in our arsenal to combat disease. Others—like new drugs for malaria—are needed to replace tools that have been rendered impotent by disease resistance. Many global health products have an inherently limited lifespan, with utility declining as drug resistance develops, so it is critical that replacement products are developed before current therapies become ineffective. As the effectiveness of drugs decline, treating diseases and caring for patients becomes significantly more expensive.

Funding global health R&D benefits the United States

Benefits to the US economy

Although US investment in science and technology for global health improves lives worldwide, it also reaps significant rewards for Americans at home. In fact, almost two-thirds (64%) of US Government funding for global health R&D goes to researchers and products developers who are working in US laboratories, universities, and companies to develop new products for the developing world. In California—the largest state economy in the US—the global health sector benefits significantly from federal support. In 2007, the US government funding for global health supported over 8,500 jobs for Californians, and paid nearly $540 million in labor wages.[89] Federal funds are also used to support California-based PDPs such as OneWorld Health in San Francisco and the IAVI Neutralizing Antibody Center at The Scripps Research Institute in San Diego.[90]

Figure 22. Flows of US Government funding for global health R&D -- by recipient location, 2010 snapshot



National security

Containing diseases in developing countries has an important national security dimension. Funding global health R&D creates products and technologies that protect US citizens—both at home and abroad—and US troops on active duty. Indeed, the DoD's involvement in global health R&D evolved from the need to protect US service men and women from infectious disease threats: malaria has caused more US army casualties than enemy fire.[91] But with more than a million people crossing US borders daily[92] it is becoming increasing critical to protect US citizens closer to home. The next generation of global health products will not only prevent and treat infectious diseases in the developing world, but will also become critical tools to prevent those diseases from spreading to the US For example, the leishmaniasis rapid diagnostic test, funded by the NIH, has greatly enhanced detection of leishmaniasis cases in the developing world, but is also being used to screen US blood supplies.

Global health diplomacy

The US contribution to global health R&D is an important instrument of foreign policy and diplomacy that highlights the US at its best, sharing knowledge in developing countries and creating products that are not only needed, but also appreciated. The challenges of global health transcend national boundaries and can provide areas of common ground and mutual understanding, particularly when trade and foreign policy relations become strained. Indeed, global health diplomacy lies at the heart of all five federal agencies contributing to global health R&D: it is a core component of the US Department of Health and Human Services' Global Health Strategy and has been a central element of USAID and the DoD's work in global health R&D for many years. For example, the DoD has built strong diplomatic relationships with local governments by building local disease detection capacity[93] and advancing R&D on diseases of local significance—Egypt has benefited from research on cholera, typhus, and Rift Valley Fever virus;[37] Cambodia has obtained a malaria multi-drug resistance surveillance system;[37] and the Peruvian army has received an electronic disease detection system developed by the US military.[37]

The US Government's role in global health R&D decreases risk and leverages inputs from the philanthropic sector, and the pharmaceutical and biotechnology industries

Without government support—including US Government support—industry and philanthropic involvement in global health R&D are at risk of winding down or ceasing.

As emphasised above, global health R&D is a tripartite initiative. The US Government's presence in global health R&D is vital to decreasing risk and leveraging inputs from the philanthropic and private sectors, who cannot bear this responsibility alone. The partnership between the US Government, industry and the philanthropic sector shares the funding burden, minimizes the risk of failure, improves R&D outcomes and enables each partner to use their complementary skills and capabilities while building on their areas of comparative advantage.

A notable feature of the list of new products (Appendix Table 2)—beyond the fact that they exist, in itself a remarkable step forward from the neglect of the last half century—is that most are the result of collaboration and inputs across all three sectors (government, private, and philanthropic), and many across more than one US Government agency.

How can the US Government generate greater impact from its investment?

The US has played a key role in some of the most promising new global health products that have been developed, including the upcoming new malaria vaccine, new TB drugs, and a range of diagnostics.

However, the US Government's substantial research investment has not always translated sufficiently into successful products. The US Government was not involved in around half of all successful products or products in development since 2000 and, when it was involved, this was sometimes as a more minor partner rather than as the lead funder or supporter.

Two factors lie behind this—addressing these could substantially increase the impact of US Government investments in global health research.

- Lack of consistency of US Government investment across the research value chain, with a drop off in funding for translation research and particularly for clinical development.
- Limited government focus on translation mechanisms and partnering pathways suited to global health product development.

Increasing consistency of US Government investment across the value chain

US Government funding for global health R&D is primarily directed to the early stages of the R&D process, with two-thirds of total funding going to basic research, discovery, and pre-clinical work but only around one-fifth to clinical studies in humans.

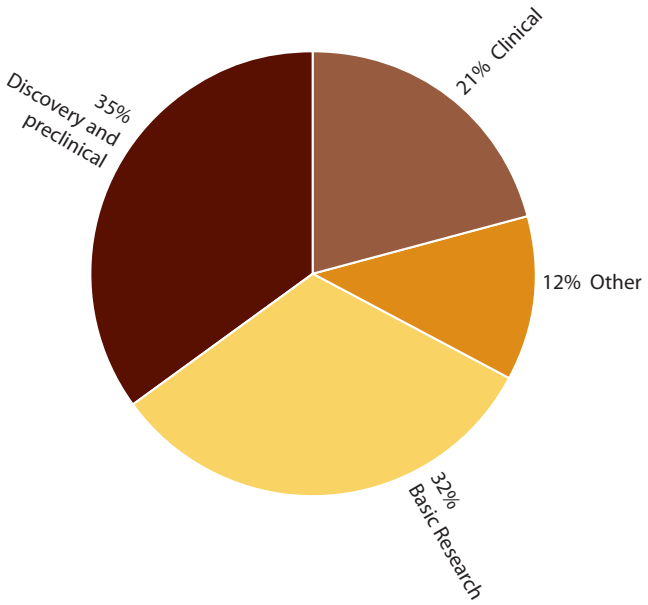


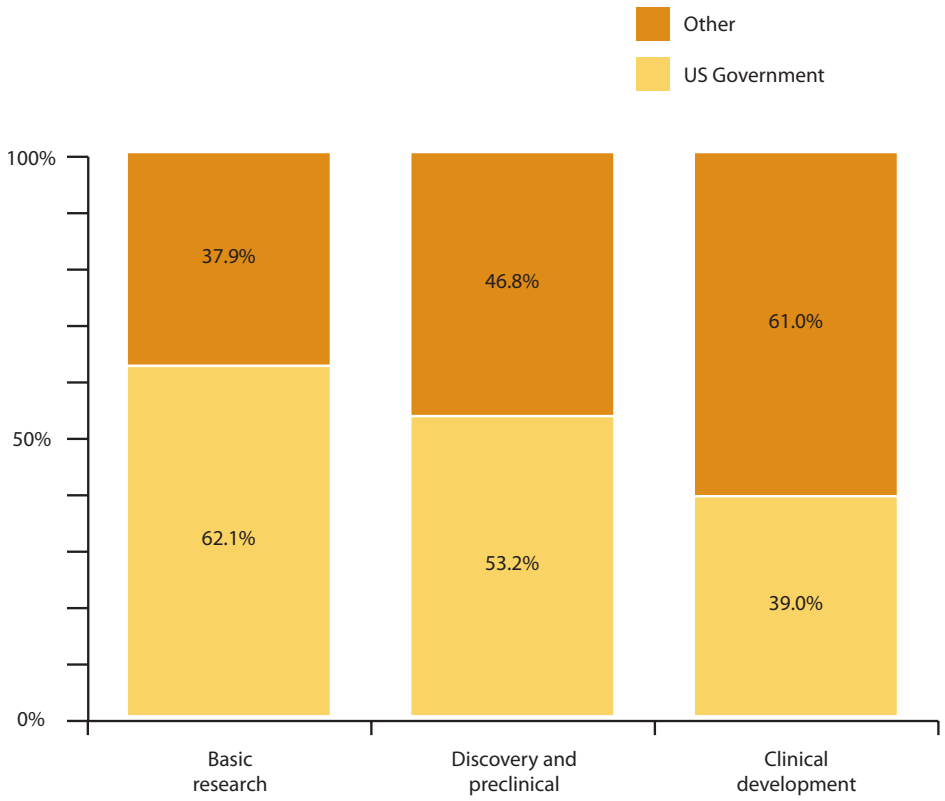
Figure 23. US Government funding by R&D stage, 2010

This preference for early R&D stages is even more prominent when looking at the US Government share of global R&D funding by stage. As noted above the US provides 45% of overall global health R&D funding, but nearly two-thirds of global investments in basic research (62%) compared with around half of global funding for discovery and pre-clinical (53%), and only 39% for clinical development.

The relatively low US presence in clinical development is striking given its otherwise lead role in global health research, and the fact that it is the clinical stages that finally deliver the fruits of research to patients in the form of new products that save lives. The falloff in funding

is also notable given that clinical development is not only the most expensive stage, but is currently also the most in need of funding as global health products enter expensive final trials and funding for global health R&D drops away.[13] It appears that the US Government is playing a substantial role in creation of new knowledge and leads, but that the responsibility for converting these into new technologies for patients is being primarily borne by other governments, as well as private and philanthropic funders (in particular the Bill & Melinda Gates Foundation),—or not being done at all. This is unlikely to be sustainable as more products move into late-stage clinical trials in developing countries, an activity that is unfamiliar, risky, and expensive for companies to embark on alone.

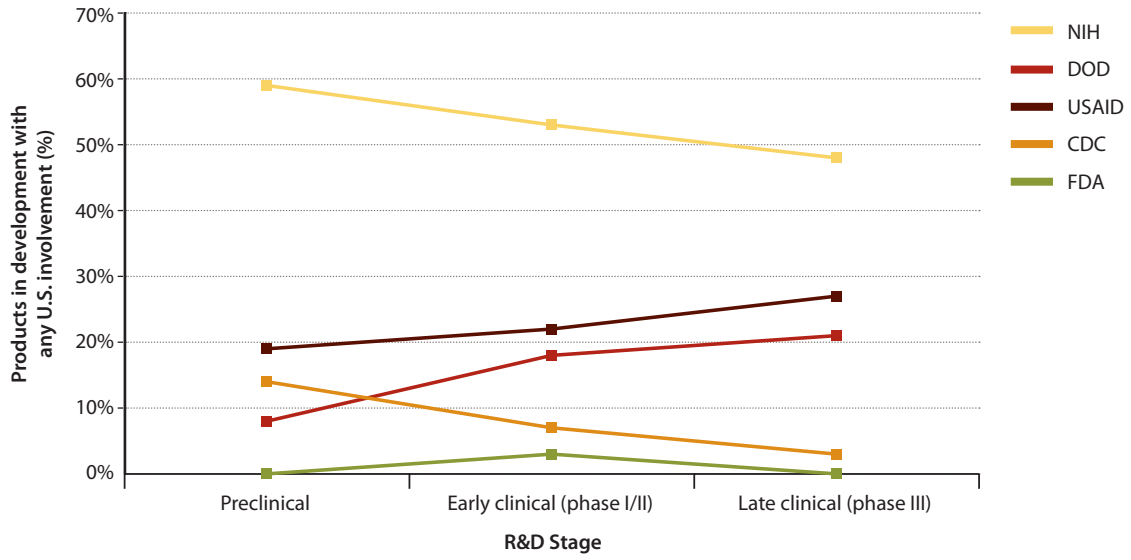
Figure 24. US Government funding as a proportion of global R&D funding -- by R&D stage, 2010



Although, the US Government funds across the R&D value chain, the five federal agencies have varying levels of involvement at different stages, largely determined by their focus and mandate. Involvement by the NIH and CDC tails off as the products progress through the pipeline, reflecting their early-development role, while the more product-focused USAID and DoD are increasingly involved as the candidates mature, although it should be noted—as highlighted in the case studies—that agency involvement includes a broad range of inputs (such as expertise or use of infrastructure), not just funding. The FDA is involved with only three products in development, consistent with their more circumscribed role as a provider of regulatory expertise in the R&D process. Figure 25 shows any product with US agency involvement, even if minor (see Appendix 3 for greater detail on US agency inputs for a range of products in development).

Figure 25.
US agency involvement in the global health pipeline, as of January 2012

Increased support for translation mechanisms, including partnerships aimed at converting research into products for patients in the developing world



The US Government has several partnering programs designed to provide government funds to industry to support translation of research into new health products, for example, the SBIR program and CRADAs. By cutting the costs and risks of research, government funding under these programs is designed to tip a company's market return on investment into profitability, thus incentivizing greater industry translation and commercialization of promising leads. However, these programs are poorly suited to many global health areas since, even with research costs reduced to zero, a company will still not make a commercial return on products for diseases such as sleeping sickness or Kala Azar. For example, the SBIR Program may provide funds for early stage research but it does not address the more fundamental problem of market failure or provide incentives for the pharmaceutical and biotechnology companies to take promising technologies to registration.

CRADAs are also likely to work best if there is a market pull at the end. As an example, when the pneumonia vaccine was introduced in the United States in 2000, NIAID negotiated a CRADA with Wyeth (now Pfizer Inc.) to also test the vaccine in Africa in a clinical trial in the Gambia. However, it was only ten years later, when other governments and philanthropists created a public market in the form of a $1.5 billion Advance Market Commitment (the US did not participate), that the vaccine reached children in the developing world: we note that more than 1 million children in the developing world died each year from pneumonia during that time.[94]

However, the most notable gap in US Government translational funding and policy relates to product development partnerships (PDPs). The key feature of PDPs is that their sole focus on translation: taking promising research and developing it into registered products for a range of diseases like malaria, sleeping sickness and leprosy that have little or no commercial market, but are responsible for a huge burden of disease and suffering in the developing world. The translation focus of PDPs is evidenced by their predominance in global product development

compared to their global funding base: PDPs now represent around 22% of global health R&D funding, but were responsible for over 40% of new products developed last decade.[13]

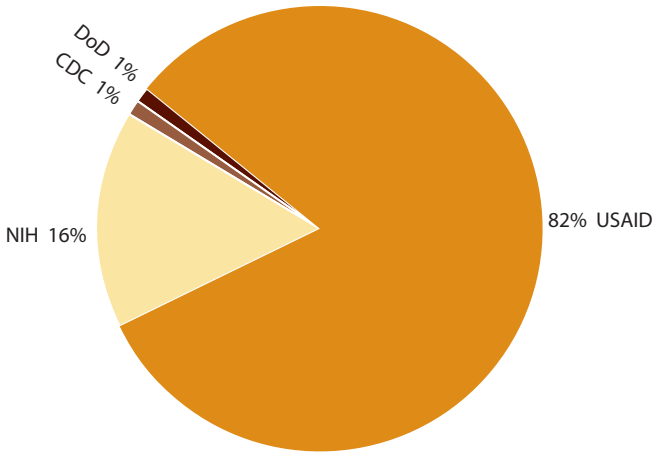
However, US Government support for PDPs has been slow and limited. The US Government has provided only 11% of PDPs' global funding commitments from 1993 to 2019—even less if HIV is taken out of the equation, since over 70% of US Government funding for PDPs goes to those in the HIV field. Four of the five federal agencies active in global health R&D continue to provide little or no funding to PDPs, with USAID accounting for 82% of the total; and a modest 2009 commitment to PDPs under the NIAID budget has not fulfilled its initial promise.

Table 2.
US Government funding commitments to PDPs (1993-2019), as of December 2011

*Figures not adjusted for inflation

	Millions in US dollars*	Percent of US PDP funding
HIV/AIDS	$424.3	71%
TB	$88.1	15%
Malaria	$52.4	9%
Other	$35.7	6%

Figure 26.
US agency funding commitments to PDPs (1993-2019), as of December 2011



The US Government was a late comer to the PDP field, commencing its PDP investments on average four and a half years after the Bill & Melinda Gates Foundation, Rockefeller Foundation and United Kingdom's Department of International Development (the British equivalent of USAID). US Government investment also continues to be very limited in scope, with 94% of funds going to PDPs working on HIV, TB, and malaria products, but little investment into those developing new products for diarrheal illnesses, salmonella infections, worm infections, and other high-burden neglected tropical diseases.

Signs of change?

In 2011, two initiatives were set up that include specific measures to support translation of global health products: USAID's Center for Accelerating Innovation and Impact and the NIH's National Center for Advancing Translational Sciences (NCATS).

USAID too have acknowledged the need to apply private sector approaches and expertise to reduce the development time of effective and affordable products for the developing world, with the establishment of the Center for Accelerating Innovation and Impact in 2011. The new Center aims to introduce business-minded approaches to the development of technology-based health solutions across all of the agency's technical teams managing USAID's R&D portfolio including late stage development of new products for HIV, TB, malaria, reproductive health and maternal health. However, it should be noted that while the Center can identify opportunities, it is a catalyst and not a financing mechanism to drive product development.

NCATS is aimed at accelerating translation of basic research into diagnostics and therapeutics for a wide range of diseases—including a small number of neglected disease products under the Therapeutics for Rare and Neglected Diseases program. For instance, the center is currently working on new treatments for the parasitic worm infection schistosomiasis. Although it is too early to assess the impact of NCATS on global health R&D,its existence is implicit recognition that bottlenecks in the translation from basic research are hampering the development of new global health products.

RECOMMENDATIONS

The above analysis shows that over the past decade the US Government has done a great deal to create the new drugs, vaccines, diagnostics, and other products that have saved and will save the lives of millions in the developing world who would otherwise die. This is an honourable achievement. However, the impact and value of this investment would be greatly increased by implementing the following recommendations:

1. **The US Government should maintain its funding for global health R&D, and increase this funding where possible.**

   Current investments in global health R&D are already on course to save millions of lives and millions of dollars. The next generation of global health products is imminent and promises to deliver even greater health and economic benefits to the developing world. US Government investment in global health R&D works, but also benefits the United States, boosting the domestic economy, protecting US citizens and troops on active duty, and highlighting the US at its best.

2. **The US Government needs to have a greater focus on translational research, in particular clinical development, to fully leverage their global health R&D investments**

   The US Government's substantial global health R&D investment has not always translated promising research into new products that can impact health. The US Government needs a greater focus on translation, research; in particular it needs to increase funding for costly late—stage clinical trials to maximize the outputs from its investment in global health R&D.

3. **The US Government should increase funding to partnering mechanisms that are focused on translation of global health research, including PDPs and other partnering approaches**

   Global health R&D requires partnering between the government, industry, and philanthropic sector to translate promising research into successful products. The Government should:

   - Review current programs that support industry translation for their suitability to companies working on global health products.
   - Increase the size and scope of funding to product development partnerships.
   - Increase translation funding and PDP support from NIH as well as USAID.

APPENDIX 1 – METHODOLOGY

Report scope

This report provides policy analyses that will strengthen the evidence base for the effectiveness of US investment in **global health product development—that is, R&D of new products for neglected diseases—from 2000-2010.**

Our scope for global health R&D covers:

- 30 neglected diseases which meet the following three criteria: the condition disproportionately affects developing countries; there is no existing product or improved/additional products are needed; there is insufficient commercial market to attract R&D by private industry. Additionally, R&D of new reproductive health products and platform technologies that address the needs of developing-country users were included.
- 7 product categories: drugs, vaccines, contraceptives, diagnostics, microbicides, vector control products, and platform technologies.
- All types of product-related R&D, including basic research, discovery and preclinical, clinical development, Phase IV, pharmacovigilance studies, and baseline epidemiological studies.

While we recognized the importance of non-communicable diseases and maternal health in low- and middle- income countries, as well as other R&D-related activities such as operations/implementation research and capacity building, these are outside the scope of this report. We also exclude non-pharmaceutical tools for the diseases covered, such as bednets or circumcision, as well as general therapies such as nutritional supplements.

Appendix Table 1.
Scope of work

*Restricted notes a category where only some investments are eligible, as defined by G-FINDER

Table key

Included

Restricted

	Basic Research	Drugs	Vaccines (preventive)	Diagnostics	Microbicides	Vaccines (therapeutics)	Vector Control Products	Contraceptives
Bacterial pneumonia and meningitis								
N. meningitides			R	I				
S. pneumoniae			R	I				
both bacteria				I				
Buruli Ulcer	I	I	I	I				
Dengue	I	I	I	I			I	
Diarrhoeal diseases								
Rotavirus			R					
Exterotoxigenic E. coli (ETEC)			I	I				
Cholera	I	R	I	I				
Shigella	I	R	I	I				
Cryptosporidium	I	R	I	I				
Enteroaggregative E. coli (EAggEC)			I	I				
Giardia				I				
Multiple diseases	I	R	I	I				
Family planning/contraceptives								I
HIV/AIDS	R	R	I	I	I			
Kinetoplastids								
Chagas' disease	I	I	I	I		I	I	
Leishmaniasis	I	I	I	I		I		
Sleeping Sickness	I	I	I	I			I	
Multiple Kinetoplastid diseases	I	I	I	I		I	I	
Leprosy	I	I		I				
Malaria	I	I	I	I			I	
Parasitic worms (helminth infection)								
Roundworm (Ascariasis)	I	I						
Hookworm (Ancylostomiasis & Necatoriasis)	I	I	I					
Whipworm (Trichuriasis)	I	I						
Strongyloidiasis & other intestinal roundworms	I	I	I	I				
Lymphatic Filariasis (Elephantiasis)	I	I		I			I	
Onchocerciasis (River Blindness)	I	I	I	I			I	
Schistosomiasis (Bilharziasis)	I	I	I	I			I	
Tapeworm (Cysticercosis/Taeniasis)	I	I					I	
Multiple helminth diseases	I	I	I	I				
Rheumatic Fever			I					
Salmonella infections								
Non-typhoidal Salmonella enterica (NTS)	I	I	I	I				
Typhoid and Paratyphoid fever (S. typhi, S. paratyphi A)	I	I	I	I				
Multiple Samonella infections	I	I	I					
Tuberculosis (TB)	I	I	I	I		I		
Trachoma			I	I				
Platform technologies	Adjuvants and immun omodulators		Delivery technologides and devices		Diagnostic platforms			

Funding data

US Government investment data for the period 2000 – 2010 was collated from two sources:

1. **G-FINDER:** Investment data for financial years 2007, 2008, 2009 and 2010 was collated from four annual G-FINDER surveys of neglected disease R&D funding. This annual online survey collects funding information from donors, fund managers and recipients, and is believed to capture the vast majority of global R&D investments for neglected diseases. More details on the G-FINDER methodology can be found at the G-FINDER 2011 annual report.[13]

2. **US Government agencies:** NIH, USAID, CDC, DOD and FDA were asked to provide investment data by disease for financial years 2000 and 2004, as well as investment data for contraceptive R&D in financial years 2000, 2004, 2007, 2008, 2009 and 2010. NIH and USAID provided investment data for all years requested, CDC provided data only for a sub-set of diseases for years 2000 and 2004 and DOD and FDA provided no data.

Trends for the decade were extrapolated from this data with reasonable confidence, given that comprehensive primary data was obtained for six data points over the ten years included in the analysis for the three agencies that account for more than 92% of US Government investments in global health R&D – NIH, USAID and CDC.

Appendix Table 2: Data extrapolation methods by agency

US Government agency	Primary Data	Extrapolated Data
NIH	Data for years 2007 - 2010 (Source: G-FINDER) Data for years 2000 and 2004 (Sources: NIAID; OAR for HIV/AIDS data) Data on contraceptive R&D investments for years 2000, 2004, 2007, 2008, 2009 and 2010 (Source: NICHD)	Data for years 2000 and 2004, for non-NIAID investments Data for years 2001, 2002, 2003, 2005 and 2006 (Interpolated from NIH reported data for years 2000, 2004 and 2007)
USAID	Data for years 2007 – 2010 (Source: G-FINDER) Data for years 2000 and 2004(Source: USAID) Data on contraceptive R&D investments for years 2000, 2004, 2007, 2008, 2009 and 2010 (Source: USAID)	Data for years 2001, 2002, 2003, 2005 and 2006 (Interpolated from USAID reported data for years 2000, 2004 and 2007)
DOD	Data for years 2007 – 2010 (Source: G-FINDER)	Data for years 2000 - 2006 (Extrapolated from DOD reported data for years 2007 – 2010, as a ratio of NIH investments for that period)
CDC	Data for years 2007 – 2010 (Source: G-FINDER) Data for dengue in years 2000 and 2004 (Source: CDC)	Data for years 2000 - 2006 (Extrapolated from CDC reported data for years 2007 – 2010, as a ratio of NIH investments for that period)

Data adjustments

Funding data was adjusted for inflation and reported in 2007 US dollars (US$). This is important to make the data comparable across all fiscal years of the decade and to avoid conflating real year-on-year changes in funding with changes due to inflation fluctuations. Yearly inflation figures from the International Monetary Fund (IMF) World Economic Outlook Database[95] were used for the inflation adjustments.

Limitations

The key limitation concerns gaps in primary data, which were extrapolated.

Additional limitations include:

- The analysis may have missed some US contributions if they occurred during the early stages of research before our 2000-2010 timeframe.
- Agency contribution before the G-FINDER 2007-2010 period were more difficult to identify, and therefore may not have the same level of thoroughness as 2007-2010 investment data
- Some funding flows were reported in aggregate so could not be allocated to specific products.

Commitments to PDPs

Funding agencies' commitments to PDPs were not determined from the dataset described above but from information provided by the Bill & Melinda Gates Foundation. The information covered commitments by the five agencies (NIH, CDC, DoD, USAID and FDA) between 1993 and 2019. As no annual breakdown of commitments was available, the figures were not adjusted for inflation.

Product data

Product lists (Table 1. Products registered during the period 2000-2010 and Appendix 2: products currently in development) were compiled from several sources including the BIO Ventures for Global Health (BVGH) Global Health Primer, PDP websites, G-FINDER database, and information provided by US agencies during interviews. Additional input on diagnostics was provided by staff at Foundation for Innovative New Diagnostics (FIND).

Methodological decisions made when compiling these lists included:

- Registered products were defined as new pharmaceutical products that received a marketing authorization from a national regulatory authority or were pre-qualified by the WHO.
- Products registered from January 2000 to December 2011 or submitted for registration in 2010 were considered registered products.
- New treatment protocols or co-administrations that did not result in registration of a new product by a national regulatory authority were excluded (e.g., Nifurtimox-Eflornithine Co-Administration (NECT) and SSG/PM co-administration Africa).

- For simplicity, diagnostic products were grouped by disease and type of technology, as multiple R&D groups have developed and manufactured technologies that can be considered broadly equivalent.

Product development is a dynamic process, therefore any updates to product status subsequent to our data compilation period may not be reflected in our analysis.

Funding agencies' involvement at product-level

Funding agencies' involvement at the product level was determined from: G-FINDER data, information provided by some US agencies (FDA, CDC, NIH (contraceptives and TB products), USAID), the BVGH Global Health Primer, desk-based research, and direct communications with developers including MMV, DND*i*, FIND, and PATH.

APPENDIX 2 – US GOVERNMENT INVOLVEMENT IN THE GLOBAL HEALTH R&D PIPELINE AS OF JANUARY 2012

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
Bacterial pneumonia and meningitis									
Meningitis	Vaccine	MenACWY-TT (Nimenrix™)*	GlaxoSmithKline	Phase III					
Pneumonia	Vaccine	GSK2189242A	GlaxoSmithKline; PATH; MRC labs	Phase II	FIN		FIN		
		IC47	Intercell; PATH	Phase II	FIN		FIN		
		V114	Merck & Co., Inc.	Phase II					
		Pneumo meningitis & pneumonia in infants (monovalent)	Sanofi Pasteur	Phase I					
		Group-common pneumococcal vaccine	GlaxoSmithKline; NasVax	Preclinical					
		Intranasal whole-cell vaccine (WCV)	Children's Hospital Boston; PATH	Preclinical	FIN		FIN		
		Multivalent protein vaccine candidate (PATH/St. Jude)	PATH; St. Jude Children's Research Hospital; University of Adelaide; University of Alabama at Birmingham	Preclinical	FIN		FIN		
		PneuGEM	Mucosis B.V.; PATH; Radboud University Nijmegen Medical Centre	Preclinical	FIN		FIN		
		Pneumococcal conjugate vaccine	SinoVac Biotech	Preclinical					
Family Planning / Contraceptives									
Contraceptive		Sino-Implant 2	Shanghai Dahua Pharmaceutical Co., Ltd., FHI	Phase III			FIN		
		Origami Female Condom	PATH; Strata Various Product Design	Phase I	FIN		FIN		
		SILCS diaphragm	PATH; US Agency for International Development (USAID)	Clinical	FIN		FIN EXP		
		Woman's condom	PATH	Clinical	FIN EXP INF		FIN EXP		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
Contraceptive-microbicide		MIV-150 + Zinc + LNG vaginal gel	Population Council	Preclinical	FIN		FIN		
		SILCS diaphragm + 1% tenofovir gel	CONRAD	Preclinical			FIN		
Dengue									
Dengue	Vaccine	ChimeriVax™ Tetravalent Dengue Vaccine	Sanofi Pasteur	Phase III		EXP INF R&D			
		T-DEN	GlaxoSmithKline; Walter Reed Army Institute of Research	Phase II		R&D			
		DEN1-80E	Merck & Co., Inc.	Phase I					
		Multiple projects - clinical development	US National Institutes of Health	Phase I	FIN				
		TetraVax-DV	Johns Hopkins Bloomberg School of Public Health; National Institute of Allergy and Infectious Diseases; US DOD	Phase I	IP R&D	INF R&D			
Dengue	Diagnostic	Liat™ Dengue Assay	IQuum, Inc.	Clinical					
		ACA-ELISA	Environmental Health Institute	Preclinical					
Dengue	Vaccine	AltraDENV	Altravax	Preclinical					
Dengue	Drug	ASB010	Autoimmune Technologies LLC	Preclinical					
Dengue	Vaccine	AVI 6006	AVI BioPharma	Preclinical					
Dengue	Drug	CB5300	Canopus BioPharma	Preclinical					
		DengueCide	NanoViricides, Inc.	Preclinical					
Dengue	Vaccine	Live attenuated chimeric YF-DEN vaccine	Oswaldo Cruz Foundation	Preclinical					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
Dengue	Vaccine	Live attenuated dengue vaccine	Arbovax; St. Kitts Biomedical Research Foundation; Walter Reed Army Institute of Research	Preclinical		FIN			
		Multiple projects - pre-clinical development	US National Institutes of Health	Preclinical					
Dengue	Drug	Onconase (Ranpirnase), Natural P31, and Recombinant Amphinase 2	National Institute of Allergy and Infectious Diseases	Preclinical	FIN R&D				
		Onconase (Ranpirnase), Natural P31, and Recombinant Amphinase 3	Tamir Biotechnology	Preclinical					
Dengue	Vaccine	Purified inactivated tetravalent vaccine	GlaxoSmithKline; Walter Reed Army Institute of Research	Preclinical		R&D			
Dengue	Drug	PYN-18	Phynova	Preclinical					
Dengue	Vaccine	Quadravalent dengue vaccine	Inovio Pharmaceuticals, Inc.	Preclinical		EXP			
		Subunit recombinant antigen (domain III) vaccine	Cuban Center for Genetic Engineering and Biotechnology; Pedro Kouri Tropical Medicine Institute	Preclinical					
		Tetravalent DNA vaccine	GenPhar; Naval Medical Research Center	Preclinical		R&D			
Diarrhoeal diseases									
Rotavirus	Vaccine	116E	US Agency for International Development (USAID); Bharat Biotech; US Centers for Disease Control and Prevention (CDC); Ministry of Science and Technology, India; PATH	Phase III	FIN		R&D	FIN R&D	
Cholera	Vaccine	PXVX-0200	PaxVax	Phase III					
Shigellosis	Vaccine	S. flexneri type 2a-rEPAsucc	Eunice Kennedy Shriver National Institute of Child Health & Human Development	Phase III	R&D				
		S. sonnei-rEPA	Eunice Kennedy Shriver National Institute of Child Health & Human Development	Phase III	R&D				
Enterotoxigenic E.coli (ETEC)	Vaccine	ACE527	Johns Hopkins Bloomberg School of Public Health; PATH; Pierrel Research USA; TD Vaccines A/S	Phase II	FIN		FIN		
Rotavirus	Vaccine	BRV-TV	Shanthan biotech; PATH	Phase II	FIN		FIN		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Cholera	Vaccine	CholeraGarde	Celldex Therapeutics Inc.; International Vaccine Institute; Siriraj Hospital; Vaccine Technologies, Inc.	Phase II					
Shigellosis	Vaccine	Invaplex 50	Walter Reed Army Institute of Research	Phase II		R&D			
Cholera	Vaccine	Live attenuated Vibrio cholerae strain 638	Finlay Institute	Phase II					
		Peru-15 pCTB (Cholera)	Celldex Therapeutics Inc.; Christian Medical College, Vellore; International Centre for Diarrhoeal Disease Research, Bangladesh; International Vaccine Institute; National Institute of Allergy and Infectious Diseases; Vaccine Technologies, Inc.	Phase II	R&D				
Shigellosis	Vaccine	SC599	Institut Pasteur	Phase II					
Enterotoxigenic E.coli (ETEC)	Vaccine	dmLT	National Institute of Allergy and Infectious Diseases; PATH; Tulane University	Phase I	FIN R&D		FIN		
Shigellosis	Vaccine	GVXN SD133	GlycoVaxyn	Phase I					
Enterotoxigenic E.coli (ETEC)	Vaccine	Peru-15 pCTB (ETEC)	National Institute of Allergy and Infectious Diseases	Phase I	FIN R&D				
Rotavirus	Vaccine	RV3	Murdoch University; PATH; Australian govt; Bio-Farma; Gadjah Mada University; Otago University; Royal Children's Hospital; University of Melbourne; World Health Organization	Phase I	FIN		FIN		
Enterotoxigenic E.coli (ETEC)	Vaccine	SBL 109	Crucell; PATH	Phase I	FIN		FIN		
Rotavirus	Vaccine	Intramural research: Development And Evaluation Of Live, Attenuated Rotavirus Vaccines	US National Institutes of Health	Clinical					
Cryptosporidium	Diagnostic	Multiplexing screening ELISA	Techlab, Inc; US National Institutes of Health	Clinical	R&D				
Giardia	Diagnostic	Real time PCR	US National Institutes of Health	Clinical	R&D				

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
Enterotoxigenic E.coli (ETEC)	Vaccine	ACE920	TD Vaccines A/S	Preclinical					
Cholera	Vaccine	AKT10082	Akthelia Pharmaceuticals	Preclinical					
Cholera	Diagnostic	Chemoluminescent biosensor	Hunan University	Preclinical					
Shigellosis	Vaccine	Development of shigella vaccine	US National Institutes of Health	Preclinical					
Diarrhoeal diseases	Diagnostic	Disposable enterics card (DEC)	Micronics; PATH; US National Institutes of Health; University of Washington	Preclinical	FIN		FIN		
Enterotoxigenic E.coli (ETEC)	Vaccine	EtpA glycoprotein	University of Tennesee	Preclinical	FIN				
		FTL-LTB chimera protein	Naval Medical Research Center; Sanofi Pasteur; University of Colorado	Preclinical		R&D			
		LT/ST fusion proteins	International Enteric Vaccine Consortium; PATH; Research Council of Norway	Preclinical	FIN		FIN		
Cholera	Diagnostic	Magnetic relaxation cholera diagnostic	Burnett School of Biomedical Sciences; National Institutes of Health	Preclinical	R&D				
		Triplex PCR	AIMST University; Universiti Sains Malaysia	Preclinical					
HIV/AIDS									
HIV/AIDS	Vaccine	AIDSVAX B/E	Armed Forces Research Institute of Medical Sciences, Thailand; Global Solutions for Infectious Diseases; Henry M. Jackson Foundation for the Advancement of Military Medicine; Mahidol University; Ministry of Public Health, Thailand; National Institute of Allergy and Infectious Diseases; Royal Thai Army Medical Department; The EMMES Corporation; Tripler Army Medical Center; Walter Reed Army Institute of Research	Phase III	R&D	INF R&D			

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
HIV/AIDS	Vaccine	ALVAC-HIV (vCP1521)	Armed Forces Research Institute of Medical Sciences, Thailand; Henry M. Jackson Foundation for the Advancement of Military Medicine; Mahidol University; Ministry of Public Health, Thailand; National Institute of Allergy and Infectious Diseases; Royal Thai Army Medical Department; Sanofi Pasteur; The EMMES Corporation; Tripler Army Medical Center; Walter Reed Army Institute of Research	Phase III	R&D	R&D			
		RV144: ALVAC-HIV® (vCP1521) Priming with VaxGen gp120 B/E (AIDSVAX® B/E)	National Institute of Allergy and Infectious Diseases; US DOD	Phase III	FIN R&D	FIN INF R&D			
HIV/AIDS	Microbicide	BufferGel	National Institute of Allergy and Infectious Diseases	Phase II	R&D				
		Dapivirine gel	International Partnership for Microbicides	Phase II			FIN		
		Dapivirine ring	International Partnership for Microbicides	Phase II			FIN		
HIV/AIDS	Vaccine	DNA-C	EuroVacc; French National Agency for Research on AIDS and Viral Hepatitis	Phase II					
		HIV p17/p24:Ty-VLP (Preventative)	GlaxoSmithKline	Phase II					
		HIV p17/p24:Ty-VLP (Theraputic)	GlaxoSmithKline	Phase II					
		HIVIS 03 DNA	Karolinska Institute; Muhimbili University of Health and Allied Sciences; Swedish International Development Cooperation Agency; Walter Reed Army Institute of Research	Phase II		R&D			
		LIPO-5	French National Agency for Research on AIDS and Viral Hepatitis; Sanofi-Aventis	Phase II					
		MVA.HIVA	European and Developing Countries Clinical Trials Partnership; Medical Research Council	Phase II		R&D			
		MVA/HIV62	National Institute of Allergy and Infectious Diseases	Phase II	R&D	EXP			

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
HIV/AIDS	Vaccine	MVA-CMDR	Walter Reed Army Institute of Research	Phase II		R&D			
		NYVAC-C	EuroVacc; French National Agency for Research on AIDS and Viral Hepatitis	Phase II					
		pGA2/JS7	National Institute of Allergy and Infectious Diseases	Phase II	R&D				
		pHIS-HIV-AE	National Centre in HIV Epidemiology and Clinical Research	Phase II					
		rFPV-HIV-AE	National Centre in HIV Epidemiology and Clinical Research	Phase II					
HIV/AIDS	Microbicide	Tenofovir gel	Centre for the AIDS Programme of Research in South Africa; CONRAD; US Agency for International Development (USAID)	Phase II			FIN R&D		
HIV/AIDS	Vaccine	tgAAC09	International AIDS Vaccine Initiative; Targeted Genetics Corp.	Phase II	FIN		FIN		
		Vacc-4x	Bionor Pharma ASA; Celgene Corporation	Phase II					
HIV/AIDS	Microbicide	VivaGel	National Institute of Allergy and Infectious Diseases; Eunice Kennedy Shriver National Institute of Child Health & Human Development	Phase II	R&D				
HIV/AIDS	Vaccine	VRC-HIVADV014-00-VP	GenVec Inc.; National Institute of Allergy and Infectious Diseases; Walter Reed Army Institute of Research;	Phase II	R&D	R&D			
		VRC-HIVDNA016-00-VP	National Institute of Allergy and Infectious Diseases	Phase II	R&D				
		Ad26.ENVA.01	Crucell; HIV Vaccine Trials Network; International AIDS Vaccine Initiative; National Institute of Allergy and Infectious Diseases	Phase I	FIN INF R&D		FIN		
		Ad35-ENV	Crucell; HIV Vaccine Trials Network; International AIDS Vaccine Initiative; National Institute of Allergy and Infectious Diseases	Phase I	FIN INF R&D		FIN		
		Ad35-GRIN/ENV	International AIDS Vaccine Initiative; University of Rochester	Phase I	FIN		FIN		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
HIV/AIDS	Vaccine	Ad5.ENVA.48	National Institute of Allergy and Infectious Diseases	Phase I	R&D				
		Ad5HVR48.ENVA.01	Brigham and Women's Hospital; National Institute of Allergy and Infectious Diseases	Phase I	R&D				
HIV/AIDS	Microbicide	Amphora	National Institute of Allergy and Infectious Diseases	Phase I	R&D				
HIV/AIDS	Vaccine	AVX101	AlphaVax	Phase I					
		DCVax-001	Celldex Therapeutics Inc.; Rockefeller University	Phase I					
		EnvDNA	National Institute of Allergy and Infectious Diseases; St. Jude Children's Research Hospital	Phase I	R&D				
		EnvPro	National Institute of Allergy and Infectious Diseases; St. Jude Children's Research Hospital	Phase I	R&D				
		GTU-MultiHIV	Imperial College of London School of Medicine; Medical Research Council	Phase I					
HIV/AIDS	Vaccine	MVA-B	EuroVacc; HIV Vaccine Trials Network; National Institute of Allergy and Infectious Diseases	Phase I	INF R&D				
		MVA-mBN32	Affitech A/S; Bavarian Nordic; HIV Vaccine Trials Network; National Institutes of Health	Phase I	INF R&D				
		NYVAC-B	EuroVacc; HIV Vaccine Trials Network; National Institute of Allergy and Infectious Diseases	Phase I	INF R&D				
		PENNVAX-B	HIV Vaccine Trials Network; Inovio Pharmaceuticals, Inc.; University of Pennsylvania	Phase I	INF R&D	EXP			
		PENNVAX-G	Inovio Pharmaceuticals, Inc.; National Institute of Allergy and Infectious Diseases; US Military HIV Research Program	Phase I	R&D	R&D			

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
HIV/AIDS	Vaccine	PolyEnv1	National Institute of Allergy and Infectious Diseases; St. Jude Children's Research Hospital	Phase I	R&D				
		rAd35-EnvA	HIV Vaccine Trials Network; National Institute of Allergy and Infectious Diseases	Phase I	INF R&D	EXP			
		rAd5-EnvA	HIV Vaccine Trials Network; National Institute of Allergy and Infectious Diseases	Phase I	INF R&D				
		rAd5-EnvB	National Institute of Allergy and Infectious Diseases	Phase I	R&D				
		SAAVI DNA-C2	HIV Vaccine Trials Network; National Institute of Allergy and Infectious Diseases; South African AIDS Vaccine Initiative	Phase I	R&D				
		SAAVI MVA-C	HIV Vaccine Trials Network; National Institute of Allergy and Infectious Diseases; South African AIDS Vaccine Initiative	Phase I	INF R&D				
HIV/AIDS	Vaccine	TAT vaccine	Instituto Superiore di Sanita; South African AIDS Vaccine Initiative	Phase I					
		TBC-M4	International AIDS Vaccine Initiative; St. Stephen's AIDS Trust	Phase I	FIN		FIN		
		Tiantian vaccinia HIV Vaccine	Chinese Center for Disease Control and Prevention; National Vaccine and Serum Institute	Phase I					
HIV/AIDS	Microbicide	UC-781	US Centers for Disease Control and Prevention (CDC); CONRAD; Emory University School of Medicine; Ministry of Public Health, Thailand; National Institute of Allergy and Infectious Diseases; University of California, Los Angeles	Phase I	FIN R&D			FIN R&D	
HIV/AIDS	Vaccine	VICHREPOL	Federal Medical and Biological Agency, Russia; Ministry of Education and Science, Russian Federation; Moscow Institute of Immunology	Phase I					
		VRC4302	National Institute of Allergy and Infectious Diseases	Phase I	R&D				

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
HIV/AIDS	Vaccine	VRC-HIVDNA009-00-VP	National Institute of Allergy and Infectious Diseases	Phase I	R&D	EXP			
		VRC-HIVDNA044-00-VP	National Institute of Allergy and Infectious Diseases	Phase I	R&D	EXP			
HIV/AIDS	Diagnostic	Alere NAT System	Alere	Clinical					
		Burnet Institute CD4 Initiative	Macfarlane Burnet Institute for Medical Research and Public Health; Massachusetts General Hospital; Parnters AIDS Research Center	Clinical					
		Compact bench-top immunoassay analyzer	Advanced Liquid Logic, Inc.	Clinical					
		Daktari™ CD4 Counter	Daktari Diagnostics, Inc.	Clinical					
		Liat™ Analyzer	Iquum	Clinical					
		Mbio CD4 system, Mbio serology	Mbio, Inc.	Clinical					
		Mobile microfluidic chip for protein immunoassay (mChip)	Amsterdam University Medical Center; Claros Diagnostics; Columbia University; Rwanda-Zambia HIV Research Group	Clinical					
HIV/AIDS	Drug	Multiple HIV paediatric and label extension grants	US National Institutes of Health	Clinical					
HIV/AIDS	Diagnostic	POC rapid RT-PCR testing platform	Northwestern Global Health Foundation (NWGHF) ; Quidel Corporation	Clinical					
		Simple AMplification Based Assay (SAMBA)	University of Cambridge	Clinical					
		Zyomyx CD4 counter	Zyomyx, Inc.	Clinical					
		BED capture enzyme immunoassay	US Centers for Disease Control and Prevention (CDC)	Preclinical				R&D	
		CD4+ T-lymphocyte test	Bill & Melinda Gates Foundation; Imperial College of London School of Medicine; PATH; PortaScience; University of Washington	Preclinical	FIN		FIN		
		Cepheid GeneXpert® System	Cepheid; Foundation for Innovative New Diagnostics	Preclinical	FIN			FIN	
		Microfluidic CD4 counting chip	Harvard Medical School; Massachusetts General Hospital; Parnters AIDS Research Center	Preclinical					
HIV/AIDS	Microbicide	MIV-150 + Zinc + vaginal ring	Population Council	Preclinical	FIN		FIN		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
HIV/AIDS	Diagnostic	Multiple HIV diagnostic grants	US National Institutes of Health	Preclinical					
HIV/AIDS	Microbicide	PC-1005 Gel	Population Council; US Agency for International Development (USAID)	Preclinical			FIN R&D		
HIV/AIDS	Vaccine	PENNVAX-GP	Inovio Pharmaceuticals, Inc.; National Institute of Allergy and Infectious Diseases; National Institutes of Health	Preclinical	R&D	R&D			
		Vacc-C5	Bionor Pharma ASA; University of Maryland	Preclinical					
HIV/AIDS	Diagnostic	WAVE 80 EO-NAT HIV Rapid RNA Assay System	WAVE 80 Biosciences	Preclinical					
Kinetoplastids									
Leishmaniasis	Drug	Amphomul	Bharat Serums and Vaccines Limited; Ministry of Science and Technology, India	Phase III					
		Paromomycin - Africa	Drugs for Neglected Diseases Initiative; Leishmaniasis East Africa Platform	Phase III	FIN				
Chagas'	Drug	Azoles E1224 & Biomarker	Drugs for Neglected Diseases Initiative	Phase II	FIN				
		Posaconazole	Hospital Vall d'Hebron; Merck & Co., Inc.	Phase II					
Leishmaniasis	Drug	Sitamaquine	Galapagos NV; GlaxoSmithKline	Phase II		R&D			
HAT (Sleeping sickness)	Drug	Fexinidazole	Drugs for Neglected Diseases Initiative; HAT Platform Partners; Sanofi-Aventis; Swiss Tropical and Public Health Institute	Phase I	FIN				
Chagas'	Drug	TAK-187	Takeda Pharmaceutical Company LTD	Phase I					
HAT (Sleeping sickness)	Diagnostic	HAT Lateral-flow RDT	Foundation for Innovative New Diagnostics; Standard Diagnostics	Clinical	FIN			FIN	
		Loop-mediated isothermal amplification (LAMP) of DNA (HAT)	Foundation for Innovative New Diagnostics; Murdoch University; Obihiro University	Clinical	FIN			FIN	
		Primo Star iLED fluorescence microscope	Carl Zeiss; Foundation for Innovative New Diagnostics	Clinical	FIN			FIN	
Chagas'	Diagnostic	24-kDa fusion protein ELISA	Instituto Nacional de Laboratorios de Salud; Universidad de Barcelona; Universidade Federal de Goias; University of Geissen	Preclinical					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Leishmaniasis	Drug	Alternative formulations of Amphotericin B	Bio Delivery Sciences International; Drugs for Neglected Diseases Initiative; US National Institutes of Health; London School of Hygiene and Tropical Medicine; PolyTherics; School of Pharmacy	Preclinical	FIN R&D				
HAT (Sleeping sickness)	Diagnostic	Antibody probes	Foundation for Innovative New Diagnostics; Seattle Biomedical Research Institute	Preclinical	FIN			FIN	
HAT (Sleeping sickness)	Drug	ARA-01 lead compound program	aRigen Pharmaceuticals, Inc.; University of Tokyo	Preclinical					
Chagas'	Vaccine	Chagas' vaccine preclinical (various)	US National Institutes of Health	Preclinical					
HAT (Sleeping sickness)	Drug	CPD-0801	Consortium for Parasitic Drug Development; Georgia State University; The University of North Carolina at Chapel Hill	Preclinical	FIN				
HAT (Sleeping sickness)	Diagnostic	DEVELOPING A NEW RAPID TEST FOR HUMAN AFRICAN TRYPANOSOMIASIS	US National Institutes of Health	Preclinical					
Leishmaniasis	Diagnostic	DPP Leishmaniasis Rapid Diagnostic Test (RDT)	Bill & Melinda Gates Foundation; Chembio Diagnostics Inc.; Infectious Disease Research Institute	Preclinical	FIN				
Chagas'	Diagnostic	Electrochemical impedance spectroscopy	Oswaldo Cruz Foundation; Universidade Federal de Pernambuco	Preclinical					
HAT (Sleeping sickness)	Diagnostic	HAT lateral-flow RDT (2nd generation)	Foundation for Innovative New Diagnostics; Standard Diagnostics	Preclinical	FIN			FIN	
		HAT-PCR-Oligochromatographic dipstick	Coris BioConcept; Institute of Tropical Medicine; Rega Institute for Medicinal Research	Preclinical					
Leishmaniasis	Drug	iCo-009	Consortium for Parasitic Drug Development; iCo Therapeutics; University of British Columbia	Preclinical					
		iCo-010	Consortium for Parasitic Drug Development; iCo Therapeutics; The Ohio State University; University of British Columbia	Preclinical					
HAT (Sleeping sickness)	Diagnostic	Identifying markers for HAT staging (FIND/ Makerere/ITM)	Foundation for Innovative New Diagnostics; Institute of Tropical Medicine; Makerere University	Preclinical	FIN			FIN	

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Chagas'	Drug	K777	Drugs for Neglected Diseases Initiative; National Institutes of Health; Sandler Center for Drug Discovery	Preclinical	FIN				
Leishmaniasis	Vaccine	LeishDNAvax	Charité - Universitätsmedizin Berlin; Drugs for Neglected Diseases Initiative; European Community's 7th Framework Programme; Indian Institute of Chemical Biology; Institut Pasteur de Tunis; London School of Hygiene and Tropical Medicine; MOLOGEN AG; Rajendra Memorial Research Institute of Medical Sciences; The Hebrew University of Jerusalem	Preclinical	FIN				
Leishmaniasis	Vaccine	LEISH-F3	Infectious Disease Research Institute	Preclinical	FIN				
		Leishmaniasis vaccine preclinical (unspecified)	US National Institutes of Health	Preclinical					
Leishmaniasis	Drug	Licochalcone A	Lica Pharmaceuticals	Preclinical					
HAT (Sleeping sickness)	Diagnostic	Nanobodies antigen detection test	Foundation for Innovative New Diagnostics; University of Brussels	Preclinical	FIN			FIN	
Leishmaniasis	Vaccine	NH36/GP63 DNA vaccine	Tulane University; Universidad Autonoma de Yucatan	Preclinical					
HAT (Sleeping sickness)	Drug	Nitroimidazole backup program	Drugs for Neglected Diseases Initiative; Global Alliance for TB Drug Development; Swiss Tropical and Public Health Institute	Preclinical	FIN		FIN		
Leishmaniasis	Drug	Oleylphosphocholine	Academic Medical Center, University of Amsterdam; Dafra Pharma Research & Development BVBA; European Solutions Enterprise on Neglected Diseases	Preclinical					
Chagas'	Diagnostic	PATH Chagas Immunochromatographic Strip Test (ICS)	PATH	Preclinical	R&D		FIN		
Leishmaniasis	Drug	PPA 904	Photopharmica Ltd.	Preclinical					
Leishmaniasis	Diagnostic	Rapid Serological test for VL	Royal Tropical Institute; Special Programme for Research and Training in Tropical Diseases	Preclinical			FIN		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Leishmaniasis	Vaccine	RAPSODI	ALMA Consulting Group; European Community's 7th Framework Programme; Indian Council for Medical Research; Institut de Recherche pour le Développement; Institut Pasteur de Tunis; Instituto de Salud Carlos III; Universidad Peruana Cayetano Heredia; Virbac	Preclinical					
HAT (Sleeping sickness)	Diagnostic	RBC lysis	Foundation for Innovative New Diagnostics; Makerere University	Preclinical	FIN			FIN	
Leishmaniasis	Diagnostic	rK28-based RDT	Infectious Disease Research Institute	Preclinical	FIN				
HAT (Sleeping sickness)	Drug	SCYX-7158	Anacor Pharmaceuticals, Inc.; Drugs for Neglected Diseases Initiative; Pace University; SCYNEXIS, Inc.; Swiss Tropical and Public Health Institute	Preclinical	FIN				
HAT (Sleeping sickness)	Diagnostic	Single format IgM quantification test using 'dri dot' cards	Foundation for Innovative New Diagnostics; Institute of Tropical Medicine; Royal Tropical Institute	Preclinical	FIN			FIN	
Leishmaniasis	Vaccine	SODB1 + chitosan	Exir Pharmaceutical Company; Shiraz University of Medical Sciences; Tabriz University of Medical Science	Preclinical					
Leishmaniasis	Diagnostic	Tandem repeat antigens diagnostic project	Infectious Disease Research Institute; Special Programme for Research and Training in Tropical Diseases	Preclinical	FIN		FIN		
Leishmaniasis	Vaccine	Therapeutic CD8+ T cell-biased vaccines	The University of York	Preclinical					
Malaria									
Malaria	Drug	Arterolane + piperaquine	Ranbaxy Laboratories Ltd.	Phase III					
		AZCQ	London School of Hygiene and Tropical Medicine; Medicines for Malaria Venture; Pfizer Inc.	Phase III	FIN		FIN		
		Pyramax Paediatric	Medicines for Malaria Venture	Phase III	FIN		FIN		
Malaria	Vaccine	RTS,S/AS01	GlaxoSmithKline; Malaria Vaccine Initiative	Phase III		R&D EXP			

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
Malaria	Drug	Tafenoquine	GlaxoSmithKline; Medicines for Malaria Venture; Walter Reed Army Institute of Research;	Phase III	FIN	FIN R&D	FIN		
Malaria	Vaccine	Ad35.CS	Crucell; GlaxoSmithKline; Malaria Vaccine Initiative; National Institute of Allergy and Infectious Diseases	Phase II	R&D	R&D			
		AdCh63 AMA-1	Imaxio; Okairos Srl; The Jenner Institute; University of Oxford	Phase II		EXP			
		AdCh63 ME-TRAP	Imaxio; Okairos Srl; The Jenner Institute; University of Oxford	Phase II		EXP INF			
		AdCh63 MSP-1	Imaxio; Okairos Srl; The Jenner Institute; University of Oxford	Phase II					
		AdVac	Crucell; Malaria Vaccine Initiative; US Agency for International Development (USAID)	Phase II		EXP	FIN R&D		
		AMA1-C1/Alhydrogel	National Institute of Allergy and Infectious Diseases; University of Oxford	Phase II	R&D				
Malaria	Drug	ARCO	Chinese Academy of Military Medical Sciences	Phase II					
		Artemisone	Hong Kong University of Science and Techology; Medicines for Malaria Venture; University of Oxford	Phase II	FIN		FIN		
		ArTiMist	Eastland Medical Systems Ltd; HC Berlin Pharma AG; Proto-Pharma Limited	Phase II					
Malaria	Vaccine	DNA-Ad	Naval Medical Research Center; Vical, Inc.	Phase II		R&D			
Malaria	Drug	Fosclin	Jomaa Pharma	Phase II					
Malaria	Vaccine	GMZ2	African Malaria Network Trust; Statens Serum Institut; Vakzine Projekt Management GmbH	Phase II					
		MSP3-LSP	African Malaria Network Trust; London School of Hygiene and Tropical Medicine	Phase II					
		MVA AMA-1	Imaxio; Okairos Srl; The Jenner Institute; University of Oxford	Phase II		EXP			
		MVA ME-TRAP	Imaxio; Okairos Srl; The Jenner Institute; University of Oxford	Phase II		EXP			

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Malaria	Vaccine	MVA MSP-1	Imaxio; Okairos Srl; The Jenner Institute; University of Oxford	Phase II					
		NMRC-M3V-Ad-PfCA	Naval Medical Research Center; Walter Reed Army Institute of Research	Phase II		R&D			
		NMRC-M3V-D/Ad-PfCA Prime/Boost	US Agency for International Development (USAID); Naval Medical Research Center; Walter Reed Army Institute of Research; GenVec Inc.; Vical, Inc.	Phase II		R&D	FIN R&D		
Malaria	Drug	OZ 439	Medicines for Malaria Venture; Monash University; Swiss Tropical and Public Health Institute; University of Nebraska	Phase II	FIN		FIN		
Malaria	Vaccine	p52-/p36- GAP Vaccine	Seattle Biomedical Research Institute; Walter Reed Army Institute of Research	Phase II		R&D			
		PfSPZ	Malaria Vaccine Initiative; Naval Medical Research Center; Sanaria, Inc.; University of Maryland Center for Vaccine Development; US National Institutes of Health	Phase II	R&D	R&D			
Malaria	Vaccine	PvCSP/AS01 (VMP001/AS01B)	GlaxoSmithKline; Malaria Vaccine Initiative; Walter Reed Army Institute of Research	Phase II		R&D			
Malaria	Drug	Tinidazole	Walter Reed Army Institute of Research	Phase II		R&D			
		97/78	Central Drug Research Institute; Ipca Laboratories Ltd	Phase I					
		AQ-13	Immtech Pharmaceuticals Inc.; Tulane University	Phase I	FIN			FIN	FIN
Malaria	Vaccine	BSAM-2/Alhydrogel	National Institute of Allergy and Infectious Diseases	Phase I	R&D				
		EBA-175 RII-NG	Baylor College of Medicine; National Institute of Allergy and Infectious Diseases	Phase I	R&D				
		EP1300 polyepitope DNA vaccine	Ichor Medical Systems, Inc.; National Institute of Allergy and Infectious Diseases; Vax-Onco	Phase I	R&D				
		JAIVAC-1	Bharat Biotech; European Vaccine Initiative; International Centre for Genetic Engineering and Biotechnology	Phase I					
Malaria	Drug	NITD 609	Medicines for Malaria Venture; Novartis Institute for Tropical Diseases	Phase I	FIN		FIN		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Malaria	Drug	N-tert butyl isoquine	GlaxoSmithKline; Liverpool School of Tropical Medicine	Phase I					
Malaria	Vaccine	PEV301 & 302	Mymetics S.A.; Pevion Biotech Ltd.; Swiss Tropical and Public Health Institute	Phase I					
Malaria	Drug	Sevuparin	Dilafor	Phase I					
Malaria	Diagnostic	Lifelens	University of California, Davis	Clinical					
Malaria	Drug	Malaria drug grants (various)	US National Institutes of Health	Clinical					
Malaria	Vaccine	Malaria vaccine development grants (various)	US National Institutes of Health	Clinical					
Malaria	Drug	2-0, 3-0 desulfated heparin (ODSH)	ParinGenix, Inc.	Preclinical					
		4-aminoquinoline derivatives	DesignMedix; Portland State University	Preclinical					
		99/411	Central Drug Research Institute; Ipca Laboratories Ltd	Preclinical					
Malaria	Vaccine	AMA1-DiCo	Biomedical Primate Research Centre; European Vaccine Initiative	Preclinical					
Malaria	Drug	AN3661	Anacor Pharmaceuticals, Inc.; Medicines for Malaria Venture; University of California, San Francisco	Preclinical	FIN		FIN		
Malaria	Vaccine	AnAPN-1	Johns Hopkins University Medical School; Malaria Vaccine Initiative; Sabin Vaccine Institute	Preclinical					
		CelTOS + GLA-SE	Bill & Melinda Gates Foundation; Infectious Disease Research Institute; US Agency for International Development (USAID); Walter Reed Army Institute of Research	Preclinical	FIN R&D	FIN R&D	FIN R&D		
Malaria	Drug	CEM 101	Cempra Pharmaceuticals	Preclinical					
		Centanamycin	McGill University; Spirogen Ltd.	Preclinical					
		GNF156	Genomics Institute of the Novartis Research Foundation; Medicines for Malaria Venture	Preclinical	FIN		FIN		
Malaria	Vaccine	iBIO malaria vaccine research program	iBIO	Preclinical					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Malaria	Diagnostic	Identification of new diagnostic targets	Foundation for Innovative New Diagnostics; Queensland Institute for Medical Research; Royal Tropical Institute	Preclinical	FIN			FIN	
Malaria	Vaccine	IMX-MSP4	Imaxio; University of Oxford	Preclinical					
Malaria	Diagnostic	LAMP Plasmodium assay	Eiken Chemical; Foundation for Innovative New Diagnostics; Hospital for Tropical Diseases	Preclinical	FIN			FIN	
		Magneto-optic Hemozoin detection	Institute for Electrical and Electronics Engineers	Preclinical					
Malaria	Vaccine	Malaria DNA vaccine	Avanti Therapeutics	Preclinical					
Malaria	Drug	Malaria drug grants (various)	US National Institutes of Health	Preclinical					
Malaria	Vaccine	Malaria vaccine pre-clinical grants (various)	US National Institutes of Health	Preclinical					
Malaria	Drug	ND-901	NeED Pharma	Preclinical					
Malaria	Vaccine	NIH/Cytos malaria vaccine research program	Cytos Biotechnology; National Institutes of Health	Preclinical	R&D				
Malaria	Drug	NPC1161B	University of Mississippi	Preclinical	FIN				
		P218	Medicines for Malaria Venture	Preclinical	FIN		FIN		
Malaria	Vaccine	P27A	ALMAC Group; European Vaccine Initiative; Universite de Lausanne	Preclinical					
Malaria	Drug	PA1103/SAR116242	Palumed; Sanofi-Aventis	Preclinical					
Malaria	Vaccine	pDNA malaria vaccine	Inovio Pharmaceuticals, Inc.; Malaria Vaccine Initiative; University of Pennsylvania	Preclinical					
Malaria	Vaccine	PlasProtecT	Griffith University	Preclinical					
Malaria	Drug	PMX-30024 and PMX-70008	PolyMedix Inc.	Preclinical					
Malaria	Vaccine	PvRII	International Centre for Genetic Engineering and Biotechnology; Malaria Vaccine Initiative	Preclinical					
Malaria	Drug	Restanza	Advanced Life Sciences; Walter Reed Army Institute of Research	Preclinical		R&D			
		RKA 182	University of Liverpool	Preclinical					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Parasitic worms									
Schistosomiasis	Vaccine	Bilhvax	Eurogentec; French National Institute of Health and Medical Research; Institut Pasteur	Phase III					
Schistosomiasis	Drug	Co-Arinate FDC	Dafra Pharma Research & Development BVBA	Phase III					
Onchocerciasis	Drug	Moxidectin	Pfizer Inc.; WHO/TDR	Phase III			FIN		
Schistosomiasis	Vaccine	Sm14 (Schisto)	Brazillian Innovation Agency; Oswaldo Cruz Foundation	Phase I					
Onchocerciasis	Diagnostic	Diethylcarbamazine (DEC) patch test	College of Dermatology, University of Nigeria; World Health Organization	Clinical			FIN		
		Oncho-C27 antigen dipstick	Ministry of Technical Scientific Research; University of Dschang; University of Yaounde I	Clinical					
Schistosomiasis	Diagnostic	Urine-CCA dipstick	European Veterinary Laboratory; Leiden University Medical Center; Rapid Medical Diagnostics	Clinical					
Onchocerciasis	Drug	Closantel	Scripps Research Institute	Preclinical					
Onchocerciasis	Diagnostic	DNA detection test strips	Bernard Nocht Institute for Tropical Medicine	Preclinical					
Onchocerciasis	Drug	Emodepside	Bayer AG	Preclinical					
Lymphatic filariasis	Drug	Flubendazole	Drugs for Neglected Diseases Initiative; McGill University; Michigan State University	Preclinical	FIN				
Schistosomiasis	Drug	Miltefosine (Schisto)	Alexandria University	Preclinical					
Onchocerciasis	Diagnostic	Multi-antigen luciferase immunoprecipitation systems (LIPS)	National Institutes of Health	Preclinical	R&D				
Schistosomiasis	Vaccine	Multiple project grants	US National Institutes of Health	Preclinical					
Hookworm	Vaccine	NaAPR-1	Human Hookworm Vaccine Initiative; Oswaldo Cruz Foundation; Sabin Vaccine Institute	Preclinical					
		NaGST-1	Human Hookworm Vaccine Initiative; Oswaldo Cruz Foundation; Sabin Vaccine Institute	Preclinical					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
Schistosomiasis	Diagnostic	Oligochromatographic dipstick	Coris BioConcept; Nigerian Institute of Medical Research; Wolfson Wellcome Biomedical Laboratories	Preclinical					
Onchocerciasis	Diagnostic	Paper chromatography hybridization assay	Washington University in St. Louis, School of Medicine	Preclinical					
Schistosomiasis	Vaccine	rSm-p80	Texas Tech University	Preclinical					
Schistosomiasis	Diagnostic	Schistosoma RD-PCR	Institute of Tropical Medicine; University of Leuven; Wolfson Wellcome Biomedical Laboratories	Preclinical					
Schistosomiasis	Vaccine	Sm-p80-VR1020	Texas Tech University	Preclinical					
		TSP2	Instituto Butantan; James Cook University; Oswaldo Cruz Foundation; Sabin Vaccine Institute	Preclinical					
Schistosomiasis	Diagnostic	Up-converting phosphore technology lateral flow assay (UPT-LF)	Leiden University Medical Center	Preclinical					
Salmonella infections									
Typhoid	Vaccine	M-01ZH09	Emergent BioSolutions	Phase II					
		Ty800	Celldex Therapeutics Inc.	Phase II					
		Vi-CRM197	Novartis Vaccines Institute for Global Health	Phase II					
Typhoid	Vaccine	Vi-rEPA Conjugate Vaccine	Eunice Kennedy Shriver National Institute of Child Health & Human Development	Phase II	R&D				
		CVD 909	Crucell; Sanofi Pasteur; University of Maryland Center for Vaccine Development	Phase I	FIN INF				
		Phase I trial of two candidate live oral salmonella enterica serovar paratyphi A	National Institutes of Health; Shantha Biotech	Phase I	FIN				
		FB-1811	Folia Biotech	Preclinical					
		OmpC-Vi conjugate vaccine	All India Institute of Medical Sciences	Preclinical					
		Vi-DT conjugate vaccine	International Vaccine Institute; National Institutes of Health	Preclinical	R&D				

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
Tuberculosis									
TB	Drug	Moxifloxacin	Bayer AG	Phase III	R&D				
		Moxifloxacin (+ H, R, Z)	Global Alliance for TB Drug Development	Phase III	R&D		FIN		
		Moxifloxacin (+ R, Z, E)	Global Alliance for TB Drug Development	Phase III	R&D		FIN		
TB	Vaccine	Mycobacterium vaccae (ID)	National Institute of Allergy and Infectious Diseases	Phase III	FIN				
		AERAS-402/Crucell Ad35	Aeras Global TB Vaccine Foundation; US Centers for Disease Control and Prevention (CDC); Crucell; Kenya Medical Research Institute; South African Tuberculosis Vaccine Initiative; US Agency for International Development (USAID)	Phase II	FIN R&D		FIN R&D	FIN R&D	
		M72	Aeras Global TB Vaccine Foundation; GlaxoSmithKline; South African Tuberculosis Vaccine Initiative	Phase II	FIN R&D			FIN	
		MVA85A	Aeras Global TB Vaccine Foundation; Emergent BioSolutions; Isis Innovation; Oxford-Emergent Tuberculosis Consortium; South African Tuberculosis Vaccine Initiative; University of Cape Town; Wellcome Trust	Phase II	FIN R&D			FIN	
		Mycobacterium vaccae (oral)	Immunitor	Phase II					
TB	Drug	OPC-67683	Otsuka Pharmaceutical Co., Ltd.	Phase II					
		PA-824	Global Alliance for TB Drug Development; Novartis AG	Phase II	FIN R&D				FIN
		PA-824/ Moxifloxacin/ Pyrazinamide (PA-M- Z)	Global Alliance for TB Drug Development	Phase II	FIN INF		FIN EXP	FIN INF	FIN EXP
		PA-824/Pyrazinamide	Global Alliance for TB Drug Development	Phase II	R&D		FIN		
		PA-824/TMC207	Global Alliance for TB Drug Development	Phase II	R&D		FIN		
		PNU-100480	Pfizer Inc.; Special Programme for Research and Training in Tropical Diseases; WHO/TDR	Phase II	R&D		FIN		

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
TB	Drug	Rifalazil (TB)	ActivBiotics Pharma	Phase II	FIN R&D				
TB	Vaccine	RUTI	Archivel Farma SL	Phase II					
TB	Drug	SQ-109	National Institute of Allergy and Infectious Diseases; Sequella, Inc.	Phase II	FIN R&D				
		TMC207	Global Alliance for TB Drug Development; Tibotec	Phase II	FIN R&D		FIN		
		TMC207/Pyrazinamide	Global Alliance for TB Drug Development	Phase II			FIN		
TB	Vaccine	VPM1002	TuBerculosis Vaccine Initiative; Vakzine Projekt Management GmbH	Phase II					
		Ad5Ag85A	McMaster University	Phase I					
		AERAS-422	Aeras Global TB Vaccine Foundation; Center for Vaccine Development	Phase I	FIN R&D			FIN	
TB	Drug	AZD5847	AstraZeneca	Phase I	R&D				
TB	Vaccine	H1-CAF01	Statens Serum Institut	Phase I					
		H1-IC31	Statens Serum Institut	Phase I					
		IMX-TB2	Imaxio; University of Oxford	Phase I					
		SSI H56-IC31	Aeras Global TB Vaccine Foundation; Intercell AG; Statens Serum Institut	Phase I	FIN R&D			FIN	
		SSI/SP H4-IC31	Aeras Global TB Vaccine Foundation; Intercell AG; Sanofi Pasteur; South African Tuberculosis Vaccine Initiative; Statens Serum Institut	Phase I	FIN R&D			FIN	
TB	Drug	Sudoterb	Lupin Pharmaceuticals, Inc.	Phase I					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
TB	Diagnostic	Aerosol TB Screening Test - Animal Detection	APOPO	Clinical	FIN				
		Breathalyser screening test	Rapid Biosensor Systems Ltd	Clinical	FIN				
		Colorimetric redox indicators	Academic laboratories	Clinical					
		Genedrive	Epistem; Xcelris Labs	Clinical					
		LED microscopy	Liverpool School of Tropical Medicine; Special Programme for Research and Training in Tropical Diseases; WHO/TDR	Clinical			FIN		
		Lipoarabinomannan (LAM) detection in urine	Inverness Medical Innovations, inc.	Clinical	FIN R&D				
		Microscopically observed drug susceptibility (MODS) project	Imperial College of London School of Medicine; LEPRA Society; PATH; Wellcome Trust	Clinical	FIN		FIN		
		Nitrate reduction assay (NRA), e.g. Griess method	Academic laboratories	Clinical	FIN				
TB	Drug	TB drug development grants (various)	US National Institutes of Health	Clinical					
TB	Diagnostic	TB Patch Test	Sequella	Clinical	FIN				
TB	Vaccine	TB vaccine clin development grants (various)	US National Institutes of Health	Clinical					
TB	Diagnostic	Thin layer agar culture (TLA)	Academic laboratories	Clinical					
TB	Vaccine	Ag85A DNA or ESAT6/ Ag85A chimeric DNA vaccines	Shanghai H&G Biotechnology; Infectious Disease Research Institute	Preclinical	FIN				
TB	Drug	Alpha-1-Antitrypsin (AAT)	OmniBio	Preclinical					
TB	Diagnostic	Antibody detection test	Antigen Discovery Inc.; Foundation for Innovative New Diagnostics; Public Health Research Institute	Preclinical	FIN			FIN	
TB	Vaccine	Carbohydrate-protein conjugate vaccines	Karolinska Institute	Preclinical					

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development				
					NIH	DoD	USAID	CDC	FDA
TB	Drug	CPZEN45	Eli Lilly and Company	Preclinical	R&D				
		DasKloster 0249-01	mondoBIOTECH AG	Preclinical					
TB	Diagnostic	Direct antigen detection assay	Bill & Melinda Gates Foundation; Chembio Diagnostics Inc.; Foundation for Innovative New Diagnostics	Preclinical	FIN			FIN	
TB	Vaccine	ID83-GLA-SE	Infectious Disease Research Institute (IDRI)	Preclinical	FIN R&D				
		ID93 GLA-SE	Infectious Disease Research Institute (IDRI)	Preclinical	FIN R&D				
TB	Diagnostic	Immunodiagnostics	ViTi, Inc.	Preclinical	FIN				
		Integrated microanalytical extraction for ampl. for TB detection	Northwestern University; PATH; University of Cape Town	Preclinical	FIN		FIN		
TB	Vaccine	Live, attenuated Mtb derivatives (AECM)	Albert Einstein College of Medicine	Preclinical	FIN				
TB	Diagnostic	Microcalorimeter for TB detection	Swiss Tropical and Public Health Institute; University of Basel	Preclinical					
		mRNA target for TB detection	Tyrian Diagnostics	Preclinical	FIN				
TB	Drug	ND801	NeED Pharma	Preclinical					
TB	Drug	Nitroimidazoles	Global Alliance for TB Drug Development; University of Auckland; University of Illinois - Chicago	Preclinical			FIN		
TB	Diagnostic	Novel antigen panel for lateral flow test	Infectious Disease Research Institute	Preclinical	FIN				
		Nucleic acid amplification-based tests (NAAT) POC	Academic - multiple	Preclinical	FIN				
TB	Drug	PMX-10072	PolyMedix Inc.	Preclinical					
		Q-201	Quro Science	Preclinical					
TB	Diagnostic	Rapid colorimetric drug susceptibility test (MDR-XDRTB Colour Test)	Foundation for Innovative New Diagnostics	Preclinical	FIN			FIN	

Appendix Table 2.
continued

Table key

IP	IP and technology
INF	Infrastructure
EXP	Expertise
R&D	R&D
FIN	FINANCIAL

		PRODUCT/RESEARCH PROGRAM	KEY DEVELOPERS/ PARTNERS	STAGE	US Government agency engagement in product development: NIH	DoD	USAID	CDC	FDA
TB	Drug	RBX8700	Ranbaxy Laboratories Ltd.	Preclinical					
		SND-159	Snowdon Inc.	Preclinical					
		SQ-609	National Institute of Allergy and Infectious Diseases; Sequella, Inc.	Preclinical	FIN R&D				
		SQ-641	National Institute of Allergy and Infectious Diseases	Preclinical	FIN R&D				
		TB drug pre-clinical grants (various)	US National Institutes of Health	Preclinical					
TB	Vaccine	TB vaccine pre-clinical grants (various)	US National Institutes of Health	Preclinical					
		TB-SLP	ISA Pharmaceuticals; TRANSGENE	Preclinical					
TB	Diagnostic	TREK MYCOTB MIC plate	Thermo Scientific	Preclinical	R&D				
		Urinary antigen detection (LAM)	Foundation for Innovative New Diagnostics	Preclinical	FIN			FIN	
		Volatile organic compounds-based TB breath test	Menssana Research, Inc	Preclinical	FIN				
		Volatile organic compounds-based TB urine test	International Centre for Genetic Engineering and Biotechnology; Lala Ram Sarup Institute of Tuberculosis and Respiratory Diseases; National University of Singapore	Preclinical					
Trachoma									
Trachoma	Vaccine	Oral Chlamydia vaccine	Wayne State University	Preclinical	FIN				
Trachoma	Vaccine	PmpD multivalent chlamydia vaccine	National Institute of Allergy and Infectious Diseases	Preclinical	FIN R&D				
		rMOMP vaccine	National Institute of Allergy and Infectious Diseases; University of California, Irvine	Preclinical	FIN R&D				

APPENDIX 3 - ADVISORY GROUP & EXTERNAL ADVISORS

Policy Cures in consultation with GHTC, identified an Advisory Group of experts and leaders from developers, funders, and advocacy groups, to provide strategic guidance and advice on key methodological issues including the scope and timeframe of the analysis, the selection of health impact and cost benefit measures, and the selection of case studies.

Advisory group members and advisors included:

ADVISORY GROUP MEMBER	ORGANISATION	TITLE
Kevin Callahan	NIAID at National Institutes of Health (NIH)	Director, Office of Strategic Planning, Initiative Development, and Analysis
Julia Lynch	Department of Defense (DoD)	Director, Military Infectious Disease Research Department (MIDRP)
Wendy Taylor	United States Agency for International Development (USAID)	Director, Center for Accelerating Innovation and Impact
Gray Heppner	Crucell	Vice President, Clinical Development
Sarah Ewart	Bill & Melinda Gates Foundation	Senior Program Officer, Global Health Program
Barry Bloom	Harvard School of Public Health	Julius H. Jacobsen Professor of Public Health
Jennifer Chow	Research! America	Director, Global Health R&D Advocacy
Thomas Bollyky	Council of Foreign Relations	Senior Fellow for Global Health, Economics, and Development

EXTERNAL ADVISER	ORGANISATION	TITLE
Robert B. Eiss	NIH Fogarty International Center	Senior Advisor

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