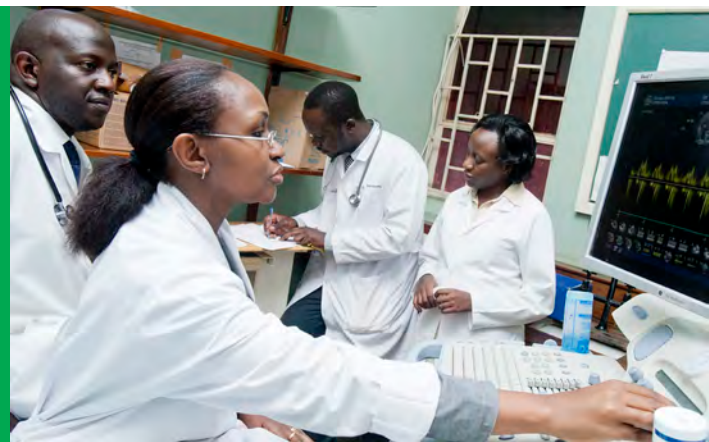




Fogarty at 5

Advancing science for global health since 1968

FOGARTY INTERNATIONAL CENTER
NATIONAL INSTITUTES OF HEALTH
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES



Fogarty at
5 

Advancing science for global health since 1968



“ I visualize this center . . . as representing the visible and tangible embodiment of this nation’s devotion to the use of science for peaceful purposes and the good of mankind. ”

**REP. JOHN EDWARD FOGARTY
1913–1967**

Vision

The Fogarty International Center's vision is a world in which the frontiers of health research extend across the globe and advances in science are implemented to reduce the burden of disease, promote health, and extend longevity for all people.

Mission

The Fogarty International Center is dedicated to advancing the mission of the National Institutes of Health by supporting and facilitating global health research conducted by U.S. and international investigators, building partnerships between health research institutions in the U.S. and abroad, and training the next generation of scientists to address global health needs.

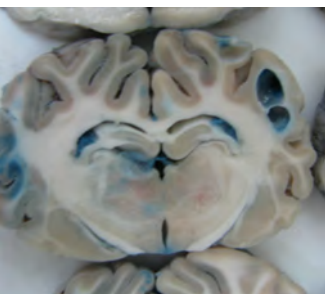


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MESSAGE FROM THE DIRECTOR

Dear Colleagues and Friends,

As we mark our 50th year, it is appropriate that we both celebrate our many accomplishments and consider how best to tackle the new global health challenges of the 21st century.

The Fogarty International Center at NIH has had a rich and varied legacy since its establishment in 1968. In our first decade, our infancy, Fogarty served as a conference center for global health policy discussions and a convener of outstanding scientists from around the world to build collaborations with U.S. investigators. In the 1980s, as the extent of the global HIV/AIDS epidemic became clear, we began our first institutional extramural grant program, the AIDS International Training and Research Program or AITRP. Fogarty developed a model of partnering U.S. and foreign institutions in low- and middle-income countries to train the next generation of young investigators, to build a research base in areas where this was lacking, with the infrastructure required to conduct ethical, groundbreaking research. This approach has become the hallmark of Fogarty programs—taking science where the problems are and building local research capacity to solve them. The scientists who were first trained through our programs have become world leaders on the front lines in the battle to staunch the global epidemic of HIV/AIDS through innovative research, in collaboration with U.S. investigators, and with additional support from many others at NIH and beyond. The return on investment in people, partnerships and policies has truly changed the world.

More recently, this model has been extended beyond infectious diseases to chronic, noncommunicable diseases and disciplines critical to advancing the global health agenda from every specialty of the medical and health sciences—including areas not traditionally considered part of global health—such as economics, law, business, architecture, engineering and others.

Fogarty remains the smallest center at NIH with what is perhaps the broadest goal—investing to build the next generation of leaders in biomedical research and supporting training to make them productive collaborators who can contribute to discoveries that improve health globally, as well as in the U.S. For the last 50 years, Fogarty's focus has been on cultivating partnerships that advance science for global health. On behalf of all of our staff and our alumni, we thank you for your continued support.

Warm regards,

Roger I. Glass, M.D., Ph.D.
Director, Fogarty International Center
Associate Director for Global Health Research, NIH





How do Americans benefit from global health research?

Ensuring our nation's safety and security

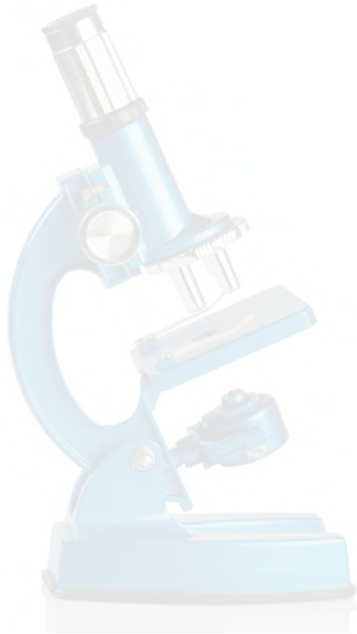
As people and goods travel ever more quickly around the globe, so too do diseases. To protect Americans from deadly outbreaks of SARS, Ebola, bird flu and Zika, it is in our own best interest to train scientists in developing countries so that they are equipped to study pandemics at their origin, contain outbreaks and minimize their impact. We are all only as safe as our weakest link, and preparedness is much less expensive than disaster response.

At Fogarty, our core mission is to build research capacity in low- and middle-income countries—a long-term investment that pays huge dividends. In the case of the Ebola outbreak, countries with little or no scientific capacity suffered the most, and the cost of unpreparedness soared above \$2 billion. Sufficiently strengthening expertise at local institutions, training health leaders and linking them to the global network of experts would require just a fraction of that amount. We know people with Ebola traveled across borders into some of the countries surrounding Guinea, Liberia and Sierra Leone. Why didn't outbreaks occur there? Because well-trained epidemiologists, lab technicians and others were on the scene, prepared to identify and treat those who were infected and ensure the disease did not spread. They were linked to global resources, and had access to technical advice and support—essential for pandemic response.

Promoting stability and economic development abroad

By supporting research that improves health in developing countries, NIH and Fogarty are also helping ensure societal stability and a healthy workforce, which can drive economic productivity. Data show malaria-free countries have economic growth that is five times greater than that of countries struggling with the disease.

Life expectancy has risen dramatically across sub-Saharan Africa as HIV/AIDS treatment and prevention programs have made inroads, but now chronic illnesses of aging pose new threats and require research to determine cost-effective interventions. Six of the fastest growing global economies are located in Africa, according to the World Bank, which makes the continent an increasingly important U.S. trading partner.



Remaining globally competitive in science

The growing complexity of health problems, advances in genomics and other fields, and the explosion of resulting data make international scientific collaboration more important than ever, if we are to maintain our position as a global leader in biomedical research. After all, good ideas can come from anywhere. Only by collaborating with others can Americans remain at the forefront of scientific discovery, in a position to rapidly move new drugs, diagnostics, vaccines and other advances from the lab to the clinic.



Producing discoveries that improve health

Global health research also pays dividends through scientific breakthroughs that result in new treatments that benefit Americans:

► Chemotherapy

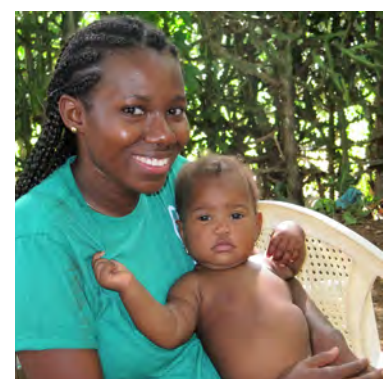
Research conducted in Uganda in the 1960s laid the groundwork for chemotherapy treatment and accelerated research into whether viruses can cause cancer. After establishing a link between the newly discovered Epstein-Barr virus and a disfiguring form of non-Hodgkin lymphoma that mainly affected African children, Dr. Denis Burkitt brought chemotherapy drugs from the U.S., where they were being developed, back to Uganda and administered them to a child with full-blown disease. The child's tumor melted away in several weeks and chemotherapy became the treatment of choice for this lymphoma.

► Alzheimer's disease

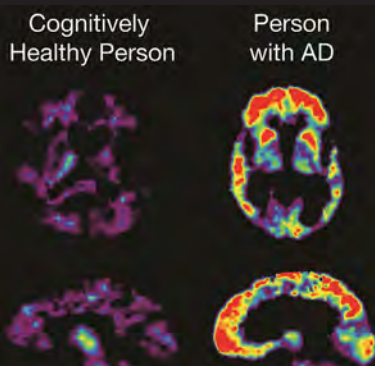
We may learn the key to preventing the ravages of Alzheimer's disease by studying a small population in Colombia. Members of an extended family carry an unusual genetic mutation that raises the risk of both early onset Alzheimer's—as young as 35 years—and its rapid progression to severe senility. A U.S.-Colombian research collaboration is studying the relatives for genetic clues, trying to identify new biomarkers to monitor disease progression, and testing new treatments to slow down or ultimately halt its progression. With the economic cost of Alzheimer's set to reach \$1 trillion annually by 2050, this is critically important work.

► Oral rehydration therapy

Studies conducted during a deadly cholera epidemic in Bangladesh in the 1970s, showed a simple, homebased remedy—a package of oral rehydration salts—when added to water could exactly replace the fluids and electrolytes lost from the disease and save the patient's life. The medical journal *The Lancet* touted this as one of the greatest public health breakthroughs of the 20th century and has attributed the treatment to saving one million lives a year. Today, many parents in America treat their sick children with Pedialyte® and similar products, which have their roots in the original cholera research.



In almost every branch of medicine, research conducted overseas has allowed us to advance our discoveries faster, cheaper and more efficiently than we ever could have at home. Americans are leaders in global health because we have been able to engage others to do studies that are not only locally relevant but also have clear implications for the U.S. Global health research truly is the new frontier of science.



Fogarty at 50: an introduction

These are exciting times for global health, with new opportunities for partnerships, emerging technologies with the potential to transform research, and scientific priorities that are evolving to match the changing burden of disease. Capitalizing on these developments demands a nimble and multidisciplinary research workforce that can function across cultures and borders to solve health problems.

Over the decades, Fogarty's programs have made significant contributions by filling the pipeline of global health leaders, extending the frontiers of science and accelerating discovery. Above all, Fogarty has invested and will continue to invest in people—the most important resource in global health research—who serve on the front lines of the fight against diseases that threaten populations in the U.S. and around the world.

Since its formation, Fogarty has served as a bridge between NIH and the greater global health community by facilitating exchanges among investigators, providing training opportunities and supporting promising research initiatives in developing countries. Over the last five decades, Fogarty programs have provided significant research training for about 6,000 scientists worldwide.

Fogarty supports research training at all career stages

Initial Experience

Fogarty Scholars

Dr. Magaly Blas began her global health career as a Fogarty Scholar, with a year of mentored research on HIV/AIDS. After earning her master's and Ph.D., she was able to conduct independent research as a Fogarty Fellow. Like her, 80 percent of all program participants continue in global health.



Early Career

Fogarty Fellows

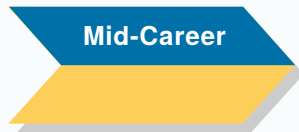


Post-docs like **Dr. Bhakti Hansoti** can receive support for a year or two to continue field research and generate findings necessary to secure future funding, in addition to helping train foreign scientists. Participants form international research partnerships they often maintain throughout their careers.

Today, Fogarty funds some 500 research and training projects involving about 100 U.S. and foreign universities, as well as supporting activities in 120 countries. Fogarty research training programs are anchored to peer-reviewed research grants and designed to be collaborative, long-term, and flexible, meeting the research priorities of both the U.S. and foreign collaborators. Newly trained foreign scientists are encouraged to return home with the skills that allow them to conduct research. In countries where a critical mass of scientific capacity has been developed, local training programs are created and customized to address national research needs and priorities.

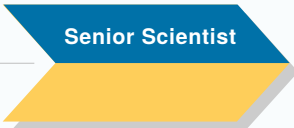
Health research in the 21st century is increasingly a team effort. Interdisciplinary research groups have been prime movers in the development of low-cost diagnostics and cost-efficient ways to prevent and treat disease. Research groups are best suited to address global health issues when the teams are multinational and sensitive to local culture and context. Building such teams in institutions around the world has been an important Fogarty strategy for decades.

To ensure research discoveries are more efficiently translated into health policy and practice, Fogarty has supported implementation science across its programs. Another area of focus has been to explore how mobile



Support to bridge the gap

Bridging support is available to enable mid-career scientists, such as **Dr. Thomas Gaziano**, to advance to the next stage. He received a Fogarty Independent Research Scientist Development Award, which provided a stepping stone to competing successfully for an R01.



Trainee becomes trainer, research leader



After earning her master's and Ph.D. with Fogarty support, **Dr. Patty Garcia** became a principal investigator and mentor, building a research and training grant portfolio that encompasses more than 40 NIH awards at her institution in Peru. Recently, she served as her country's Minister of Health.



devices, electronic medical records and new technologies can be leveraged to revolutionize research approaches, support online collaborations and develop new teaching tools and methods of knowledge exchange.

Fogarty also convenes the best scientific minds around the world to address critical global health research problems such as polio eradication, the impact of climate change on disease outbreaks and strengthening research capacity in Africa. The Center's in-house scientists collaborate with colleagues globally to conduct research on the epidemiology and modeling of infectious diseases, producing data used to develop countermeasures for potential bioterror agents and public health actions to control the spread of infectious diseases. Meanwhile, Fogarty's international relations team identifies opportunities for collaboration and develops new partnerships among U.S. scientists, institutions and counterparts abroad to advance research and training.

Given the success of international efforts to prevent and treat HIV/AIDS, malaria and TB, life expectancy has risen dramatically in low- and middle-income countries (LMICs). These countries now share the same health challenges that we are facing in the U.S., such as cardiovascular disease, cancer, diabetes and other chronic diseases. Today, global health and local health are becoming one and the same and research conducted anywhere can help people everywhere.

Fogarty principles of successful programs



Responsive to national and global priorities

Durable national commitment



Long-term and multigenerational institutional and individual partnerships



Training linked directly to innovative research

Mutually beneficial to collaborators



Selection of trainees and research projects by collaborating LMIC institutions



Long-term commitment

Flexibility in types of training, research and management mechanisms



Over time, center of gravity shifts to the lower-income countries



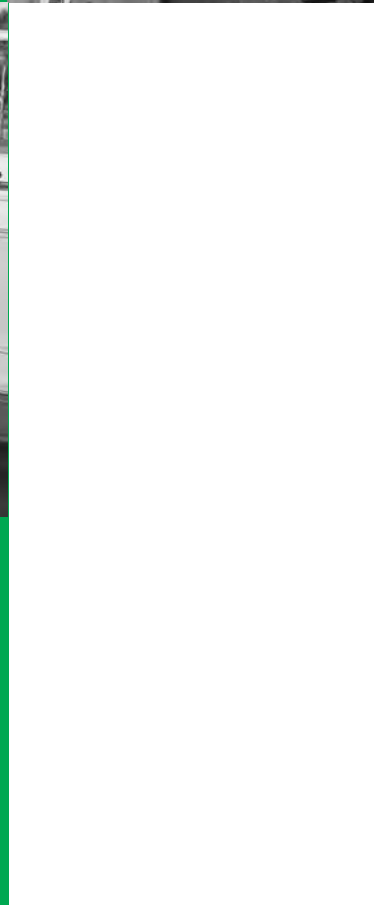
Research capacity strengthening tied to public health

Program outcomes: scientific and public health leaders



Collaborating institutions develop winning partnerships





Rep. John Fogarty was a champion for NIH and for medical research





Congressman John Edward Fogarty: champion for global health research

Decades before phrases like “globalization” and “multiculturalism” became commonplace, Rep. John Edward Fogarty (D-RI) advocated for international health research to reduce suffering and foster peace and prosperity throughout the world. Over the course of his 27 years in Congress, Fogarty was a champion for NIH and for the value of medical research. During his tenure as chairman of the appropriations subcommittee with responsibility for health funding, the budget for NIH grew from \$37 million in 1949 to \$1.24 billion in 1967.

Fogarty’s remarkable achievements belie his humble beginnings. Born in Rhode Island to a second-generation Irish immigrant family, his formal education was limited and he followed his father into the bricklaying trade. His political career began when he was elected president of the local bricklayers’ union. Three years later, he defeated five prominent Democrats in the primaries and went on to win a seat in Congress. He was a mere 26 years old.

Over the years, Fogarty repeatedly, but unsuccessfully, argued for the creation of an international health research institute to promote the study of global health problems. His sudden death of a heart attack on January 10, 1967, provided the catalyst that finally brought his “Health for Peace” center into existence in July 1968. Since then, the John E. Fogarty International Center has assumed a prominent place in the global health community, funding research and building sustainable scientific capacity at home and abroad.

Fogarty International Center: a brief history

When World War II ended, the nations of Europe were devastated, their economies destroyed, their cities in ruin, their populations starving. In 1948, the U.S. implemented the European Recovery Program—popularly known as the “Marshall Plan.” The idea was to provide financial and material assistance to participating countries in Western Europe to aid them in rebuilding. A decade later, NIH launched its version of the Marshall Plan to replace and strengthen European capacity to conduct biomedical research. The International Research Fellowship (IRF) program aimed to develop a cadre of foreign investigators who would be trained at the NIH and in American academic institutions, and return to take their places in Europe’s leading universities and research centers.

After the Fogarty International Center was established at NIH in 1968, management of the fellowship program was transferred to the new Center. During three decades of the program, more than 2,500 scientists from 55 countries were trained at a total cost of \$50 million. The majority of fellows returned home to pursue careers in research, teaching and administration, often keeping in close touch with their American colleagues. The list of mentors in the early decades reads like a Who’s Who of leading American scientists, including a number who became Nobel laureates, among them Drs. Christian Anfinsen, Julius Axelrod, David Baltimore, Baruj Benacerraf, Arthur Kornberg and Severo Ochoa.

By 1969, the new Center began to establish a program of workshops and conferences designed to foster international scientific collaborations on common challenges. It also began the Scholars in Residence, or SIR, program to bring internationally renowned scientists—both American and foreign—to NIH, some for a year or more. At any given time, there would be half a dozen or more of

1967



Congressman John E. Fogarty dies

1968

- Congress establishes the Fogarty International Center



Dr. Milo Leavitt is named director

- The Center takes over management of the International Research Fellowship program

1969

- Scholars in Residence program begins



Drs. Albert Sabin and Margaret Mead were among the illustrious scientists who conducted research in residency at NIH

1975

- Senior International Fellowship program begins

1978







- Dr. Leon Jacobs becomes director

these scholars in residence at Stone House on the NIH campus. During their stay, they would hold seminars and workshops, write books and conduct research in collaboration with colleagues in other NIH institutes. Housing scholars together prompted informal discussions and daily exchanges, which helped spark creative ideas and innovations. The program succeeded in bringing a pantheon of gifted scientists to NIH over the years—more than 200—including Drs. Margaret Mead and Albert Sabin; Nobel prize winners Drs. Daniel Bovet, Rita Levi-Montalcini, Sir Hans Krebs and Ragnar Granit; a number of Lasker award winners and others recognized as leaders in their fields.

As a Fogarty Scholar in Residence, Sabin brought to NIH his commitment to rid the world of polio using his oral vaccine, which had already debuted on the international scene having been tested in Russian schoolchildren. During his periodic stays at NIH in the early 1980s, Sabin oversaw strategies that would lead to the complete elimination of polio in the Western Hemisphere by 1993. He worked with governments, international organizations such as Rotary International, and the World Health Organization to incorporate annual national vaccination programs into routine health services in developing countries.

Among the earliest Scholars was Sir George Godber, the architect of the British National Health Service. Other notables over the years included Peter Perlmann, from the University of Stockholm, who developed the ELISA technique, widely used in research and diagnostics, such as blood tests for HIV and other pathogens. In 1990, Fogarty welcomed its first African scholar, Olufemi Williams from Nigeria, who completed a book while in residence detailing comparisons between AIDS in Africa and AIDS in the U.S.

1980	1981	1984	1987	1988
<ul style="list-style-type: none"> The Center hosts international meetings on eradication of polio and other diseases 	 <ul style="list-style-type: none"> Dr. Claude Lenfant becomes director 	 <ul style="list-style-type: none"> Dr. Craig K. Wallace becomes director 	<ul style="list-style-type: none"> The Center serves as co-chair and secretariat of Third International AIDS Conference 	 <ul style="list-style-type: none"> Dr. Philip E. Schambra becomes director Institutional awards begin through AIDS International Training and Research Program

In 1992, Dr. Lev Bergelson arrived as the first scholar from Russia, noted for his studies of the role of lipids in heart disease and cancer.

Another fellowship established during Fogarty’s first decade, the Senior International Fellowship (SIF) program, sought to recruit leading U.S. investigators to travel abroad—perhaps during sabbatical years—to take advantage of outstanding research opportunities at other major centers, study unique patient populations or learn new techniques from international colleagues. While Fogarty primarily managed fellowship programs and convened scientific symposia for its first two decades, it also began facilitating and implementing international agreements for scientist exchanges and research collaborations.

Fogarty as a convener

The decade of the 1970s marked one of the greatest global health achievements of all time, the eradication of smallpox. While Fogarty was not directly involved in this monumental achievement, the global scientific community turned to the Center as a place to examine the potential to control or even eradicate other major infectious diseases. In 1979, Fogarty convened a conference of the world’s leading infectious disease experts to consider what diseases might potentially be eliminated. Polio, measles, rubella, yaws and other endemic treponematoses were recommended as candidates. Following this initial gathering, the Center convened a series of discussions to examine each disease in more detail. These meetings are now recognized as the beginning of the global campaign to eliminate polio.

In the mid-1990s, Fogarty brought together U.S., British and French scientists and officials to consider a study the Center conducted on the





1989	1998	2000	2001	2002
<p>Fogarty’s “Stone House” renamed the Lawton Chiles International House to honor the Florida senator</p> 	 <p>Dr. Gerald T. Keusch becomes director</p>	<p>Division of International Epidemiology and Population Studies is launched</p>	<p>Fogarty hosts international conference on stigma and global health</p> 	<p>Fogarty organizes the Pan-African Conference on Malaria</p> <p>Disease Control Priorities Project begins</p> 

scope of biomedical research in Africa, and for subsequent discussions on how best to deploy research to improve African health. It was decided that a focus on malaria would be the most productive. From these meetings sprang the idea to plan and host the first Pan-African Conference on Malaria, held in Senegal in 1997, which brought together funding agencies and malariologists to develop a research agenda and prioritize needs. The meeting marked the birth of a new global effort, the Multilateral Initiative on Malaria, which continues today.

Stigma was the topic of another landmark symposium organized by Fogarty in 2001. Attendees considered the relationship between stigma and public health, how stigma prevents people from seeking diagnosis or treatment—such as for HIV/AIDS—and the related research agenda needed to advance the field, especially as it pertains to the developing world. The discussion led to Fogarty’s establishment of a stigma research program the following year, which awarded \$17 million in 18 grants. Although the program was discontinued in 2009, stigma research continues to be supported through other Fogarty and NIH initiatives.

The AIDS epidemic causes a shift in direction

Perhaps the most pivotal gathering of all was the third International Conference on AIDS, held in Washington, D.C., in 1987. Fogarty served as co-chair and secretariat, engagement that motivated the Center to focus its activities on low- and middle-income countries (LMICs)—beginning with a major effort to build research capacity to combat the emerging HIV/AIDS epidemic. This program is largely credited with building the scientific leadership in LMICs that helped change an HIV diagnosis from a death sentence to a manageable disease. With proof of concept, Fogarty transformed its entire extramural portfolio to focus on building core foundational capacity through research training programs in bioethics, genetics, informatics, stigma, and health and economic development.

2006	2009	2010	2012	2018
	<ul style="list-style-type: none"> Fogarty becomes founding member of the Global Alliance for Chronic Diseases Fogarty co-hosts inaugural meeting of the Consortium of Universities for Global Health 	<ul style="list-style-type: none"> Medical Education Partnership Initiative launches Fogarty partners with the Fulbright Program to offer Fulbright-Fogarty fellowships 	<ul style="list-style-type: none"> Center for Global Health Studies forms at Fogarty 	<ul style="list-style-type: none"> Fogarty International Center marks 50th anniversary 
<ul style="list-style-type: none"> Dr. Roger I. Glass is named director 		<ul style="list-style-type: none"> Fogarty and NIH help found the Global Alliance for Clean Cookstoves 		

Sparking a scientific revolution to address the HIV/AIDS crisis

Turn back the clock several decades and research laboratory equipment in some developing countries amounted to no more than a mirror and a light microscope sitting on a desk. As a result, it was not uncommon for so-called “parachute scientists” from the U.S. or Europe to drop in for a quick visit to collect data and samples and take them home for analysis. Today, the scene is much different, with well-trained local researchers using cutting-edge equipment and working as equal partners in collaboration with their counterparts around the world.

Driving this dramatic change has been a devastating catalyst: the HIV/AIDS epidemic. More than 35 million people have succumbed globally and more than 36 million are living with HIV, as of 2015. Sub-Saharan Africa has borne the heaviest burden, virtually losing a generation and now harboring two-thirds of all people in the world who are HIV positive.

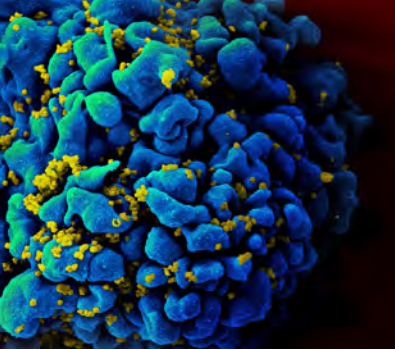
From the start, scientists recognized that research into this mysterious new disease was badly needed, not only in the developed world, but also in countries with different experiences in transmission, testing and patient care. But there was an enormous barrier: the lack of research capacity in areas most severely hit by the epidemic.

An idea for a novel program takes place

Moved by the scale of the epidemic, Fogarty’s Dr. Ken Bridbord took action. He sketched out a novel research training program that would arm promising developing country scientists with skills in epidemiology, lab techniques, ethical research practices and data analysis—in addition to subject matter expertise in HIV/AIDS and related diseases. The trainees would remain engaged in research studies of importance to their own communities and receive support to continue their projects when they returned home, a feature designed to prevent brain drain and ensure their expertise was deployed where it was needed most.

The AIDS International Training and Research Program, known as AITRP, began in 1988 and provided significant research training to more than 2,000 individuals from more than 100 countries.





One U.S. investigator recalls the void in which AITRP germinated. “We got a lot of samples from different places in Africa and Asia and brought them to Boston for testing, because there was no way to test them there—they didn’t have the equipment or personnel, didn’t have the tests,” said Dr. Max Essex of the Harvard School of Public Health. Essex received one of the first AITRP grants.

Fogarty’s approach was groundbreaking and helped to build the level of expertise necessary for sustained research efforts to study the HIV/AIDS epidemic on the ground in the locations where suffering was greatest. AITRP alumni returned to their home countries where they not only conducted critical research projects but also trained others, adding to the impact.

“It was clear we needed to enter into a partnership with colleagues in countries hardest hit,” said Bridbord. “Perhaps no single word captures the essence of AITRP more than empowerment. AITRP trainees are empowered with the knowledge, experience and increased confidence to return home and help their countries to craft and implement locally relevant strategies to tackle HIV/AIDS. This empowerment has enabled them to work on a par with scientists in the developed world.”



On his first visit to the Rakai district in western Uganda, Fred Nalugoda was horrified by the numerous worn-out people he saw wandering around listlessly, open sores evident, and being shunned by all. “I got chills and thought I could not go back,” he said.

Nonetheless, Nalugoda joined Rakai’s Health Sciences Program, which conducts extensive community epidemiologic and behavioral studies in HIV/AIDS. In 1999, he received his master’s degree under Johns Hopkins University’s AITRP grant.

Nalugoda says skills in demography and biostatistics have enabled him to collect, manage, analyze and interpret data and get his studies published. He’s been involved in many key Rakai trials, including the landmark study that found male circumcision was a highly effective barrier to HIV transmission. His mentorship experience has given him the blueprint he uses to mentor others. He’s now program director responsible for all field studies and is highly regarded for his deep knowledge of the Rakai communities.

Public awareness and the availability of interventions have changed the situation remarkably, Nalugoda noted. “People know about strategies for prevention and stigma has been reduced very much. Now HIV treatment is widely available and denial is not a big issue, especially in Rakai.”

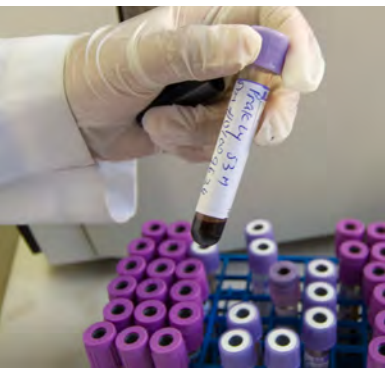
AITRP offered an unusual degree of flexibility, allowing the grantees to adapt to changing conditions. “As the epidemics evolve, the position of Fogarty has always been that if it was logical to change directions, follow new opportunities, fine, go ahead and do it,” said Dr. Warren Johnson, a longtime AITRP grantee at Weill Cornell Medical College. “It was visionary.”

A cadre of developing country scientists is trained

Under the program, developing country trainees were selected to come to U.S. grantee institutions to learn from experts and work in well-equipped laboratories. Training courses were short- or long-term and covered many different levels and topics, including master’s and doctoral degrees, laboratory skills, proposal and paper writing, epidemiology, biostatistics, ethics and HIV / AIDS related biology.

“The training provided people with a skill set that they didn’t have before, how to approach and analyze a problem, design a study, choose the right study, conducting perhaps more quantitative epidemiologic types of research,” said Dr. Art Reingold, who managed an AITRP grant at the University of California, Berkeley. “We also stressed the ethical aspects of research and encouraged a more questioning, intellectually stimulating approach in general.”

Another unique aspect of AITRP was how it encouraged trainees to exercise their new skills back at home. After their education there, many scientists face the temptation to remain abroad in relatively well-paid jobs, leaving their home country no better off. So the AITRP grantees incorporated both a carrot and a stick. The carrot was re-entry funding for mentored research projects at home, where support might otherwise be hard to obtain. The stick was an explicit expectation that the trainees should return home and put their new knowledge and skills to work, as a way to repay their AITRP support. These conditions encouraged the flow of bright, qualified and empowered scientists back to developing countries, making the overall AITRP re-entry success rate in excess of 80 percent.





Changing the research landscape in developing countries

As skilled scientists became established in developing countries and rose to leadership positions in academia, health ministries and the private sector, they made attractive partners for global collaborations and began to successfully compete for NIH research grants, in addition to funding from international foundations and other sources.

“We’ve seen a whole series of individuals go through the program who are back in their home countries now and doing pretty phenomenal work; whether it’s in Uganda, Zimbabwe, or some other institutions or countries, it’s the collective effort that is really impressive in terms of what has come out of all of this,” Reingold said.

One shining example of AITRP’s impact is in Malawi. “When we started the program, Malawi did not have a medical school. It had a very limited professional base. Malawians who had medical training were trained either in the UK or other African countries. There was really very little in the way of advanced technical capacity to respond to the epidemic and to do research,” said Dr. Christopher



“ I can say that for us in Haiti, Fogarty has been the cornerstone of our entire program. Fogarty support has allowed us to train the leaders in our field, who themselves have trained thousands of others. We rest on three legs—research, training and service. They are all inter-related and one makes the other one stronger. So it is through research that we find results and it is through training that we expand the results. The services we provide get the benefit of both the research and the training. And Fogarty has been instrumental in all three aspects.”

Dr. Bill Pape
GHESKIO Director

Fogarty grantee

“ Fogarty training has given us Africans the skills we need to conduct research, document illness and look at possible interventions that work in Africa. Fogarty has changed the face of HIV medicine. ”



Dr. Ruth Nduati

University of Nairobi

Fogarty trainee and grantee

“ Without Fogarty, I quite simply wouldn't be who I am today. ”



Dr. Elioda Tumwesigye

Uganda's Minister of Science, Technology and Innovation

Former Fogarty trainee

Beyrer, of Johns Hopkins Bloomberg School of Public Health.

On a visit to Malawi, Beyrer was encouraged to hold discussions with policymakers. “I met with the Minister of Health, the head of the national AIDS program and the head of the immunization program—and all of them had had training through our AITRP. You realize that you have really helped build in-country expertise. That was very powerful for me,” he said.

Longtime AITRP collaborator in Uganda, Dr. David Serwadda, of Makerere University, said the program concept is unique. “Fogarty's model of integrating training and research has been more successful than the model in which scholarships are given, Ugandans go to train, and they come back and say ‘Now, what? What am I going to do?’ Those programs tend to have a much higher brain drain compared to Fogarty's.”

AITRP trainees contribute to discoveries

Former AITRP trainees around the world have made an enormous impact on virtually every area of HIV / AIDS science. “The trainees contribute to critical research projects,” said Myron (Mike) Cohen, of the University of North Carolina. “This is not a hobby. This is deadly serious science.”

Many of the scientific advances preventing mother-to-child transmission, therapy as prevention, and the benefits of microbicides and male circumcision—have been discovered by research teams led by or including former AITRP trainees.



Fostering long-term research collaborations is a key factor in AITRP's success. By providing a forum for sharing information and lessons learned, the program's impact is multiplied. One grantee cited how the head of China's AIDS program, after observing HIV was spreading in sex workers, reached out to AITRP alumni in Thailand who had already implemented an effective condom promotion program to reduce transmission.

"When you go through graduate training together, it's like being in the trenches, you sort of become buddies," said Dr. Roger Detels of the University of California, Los Angeles. "That kind of interaction and mutual support between people from different countries really wasn't going on in the '80s, but it is now."

As former AITRP trainees have added to their country's pool of skilled scientists and health leaders, they have helped lay the groundwork for other U.S. efforts, such as the President's Emergency Plan for AIDS Relief (PEPFAR). These projects then feed research further, allowing experts on the ground to craft new research projects involving PEPFAR patients, AITRP grantees noted.

AITRP changes the academic culture

Visiting the U.S. for training has been a valuable experience on many

Scientific advances made with assistance from Fogarty trainees

Treatment as Prevention

A multi-country study demonstrated that patients who took antiretroviral drugs soon after diagnosis were 96 percent less likely to infect their HIV-negative heterosexual partner than if they waited until the virus climbed to a specific concentration in their blood. As a result, the WHO updated its guidelines on when to begin antiretroviral therapy. The finding was named "Breakthrough of the Year" by *Science* magazine in 2012.

Circumcision

A study in Uganda's Rakai district confirmed that male circumcision reduces HIV incidence. This discovery prompted the WHO to recommend circumcision as a way to help curb HIV infection in high-risk populations.

Tuberculosis

Co-infection

A house-to-house study in rural Kenya used cough monitors to determine the prevalence of HIV and TB coexistence and the severity of multidrug resistance in rural Kenya. The technique has now been replicated in other countries.

Discordant Couples

A large survey in Uganda revealed that HIV prevalence had leveled off, so researchers investigated the predominant way HIV was being transmitted. They found that transmission was no longer via casual encounters but rather occurred in established relationships. Their findings led to changes in prevention strategies in Uganda and other countries.

Antiretroviral Adherence

With the advent of antiretroviral drugs, some questioned whether patients in low-resource, low-education settings could follow the regimen of multiple drugs to be taken at precise times each day. AITRP trainees in Port-au-Prince, Haiti, helped conduct a study showing that patients in such settings were able to adhere to the drug regimen as effectively as patients in New York City.





levels for AITRP trainees, some of whom had not traveled outside their country before. The U.S. academic teaching styles often differ substantially from what they were used to, for instance in the interaction with mentors, style of networking and examples of role models.

Many trainees came from former British or French colonies, where the education system remains based on top-down, didactic teaching.

“Education there basically amounts to professors talking to you, you writing it all down, being tested on how well you wrote it down and remembered it. It’s not an interactive process where you argue, disagree, discuss, and that is central to the way we educate people in our graduate school,” Reingold observed. “I think many of them did go home with a refreshingly more candid, open, argumentative (in a good way) approach to things, questioning their elders or the system or how things are done—and that’s a good thing.”

Many developing countries did not have a tradition of research as part of academia and AITRP provided a roadmap for success. “It really helped lay down the template showing that a large part of achieving academic success is through international-level research, collaboration, publication and presentations,” Beyrer said.

AITRP has also benefited U.S. institutions, as visiting trainees bring an added dimension to classroom discussions with their firsthand knowledge of conditions and needs. The connections formed often lead to long-term research collaborations and lasting friendships.

Faculty members and both U.S. and visiting trainees gain from their experience of working together. “We develop these relationships which shape our lives. We don’t look at the world the same way, because we’re working with people from other countries,” Cohen said. “I can see generations of people from other countries, as well as from our faculty, whose not just careers but



personal lives, personalities, view of the world are all really shaped by AITRP.”

Preparing to meet new challenges

Several decades on, research priorities are shifting toward treating HIV as a chronic disease, dealing with co-infections and studying the effects of treatment over time. For instance, scientists do not understand why long-term antiretroviral treatment, while extending life, also accelerates aging and the development of related conditions such as cardiovascular disease and certain cancers. To meet these new challenges, Fogarty has consolidated AITRP with another implementation research training effort, the Fogarty HIV Research Training Program.

“I remember when AITRP was just an idea in ‘85. To see it evolve in the magnificent way it has is really hard to believe. The breadth of the effect of AITRP has been remarkable,” said Dr. Charles Carpenter of Brown University.

“There’s no question that the training and the empowerment of the developing country scientists and their institutions to do AIDS research has just been enormous,” Beyrer said. “Without it, we would not be anywhere near where we are today in the global response. It is a powerful legacy.”



“ I will never forget meeting these three young women in Uganda who told their stories about how research made it possible for them to be alive, all of them having participated in clinical trials. One had become HIV-infected early on when there was no treatment available except in trials. Another was able to prevent her baby from becoming infected as part of a PMTCT study. And a third, who was participating in a trial of a female vaginal ring approach to HIV prevention, putting women more in charge of their own destiny, instead of having to depend on men.

With tears in their eyes and sincerity in their voices, the women said ‘Thank you, America, you saved us.’ And they meant it.

People need to be reminded that the human consequences of what we do are really quite profound. ”

Dr. Francis S. Collins
NIH Director

Promoting bioethics to protect lives in service to research

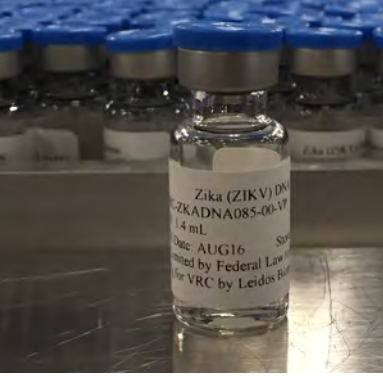
The rising death toll of the AIDS epidemic created an urgent need for investigators to conduct research in developing countries, yet there was little framework to guide the ethical dilemmas involved. Clinical trials often provided participants the only access to treatment. How could scientists ensure consent was freely given and that subjects understood the risks? What obligation, if any, did the researchers have to treat those found to be HIV positive? How could privacy be preserved, especially in small communities?

Bioethics and the protection of human subjects are the foundation that enables clinical research. The combination of the globalization of the biomedical industry and the surge in research activity to address HIV and malaria proved overwhelming in many low- and middle-income countries (LMICs). To participate in NIH trials or receive NIH funding, studies must be designed and implemented to conform to the same standards as U.S. clinical trials. In locations with little expertise in bioethics, that proved extremely challenging.

Concern for research subjects grew from the horror of the Nazi experiments on humans, spurring an effort to lay out ethical guidelines in the Nuremberg Code in 1947, followed by the World Medical Association's Declaration of Helsinki in 1964. The field of bioethics was largely the domain of philosophers and theologians until the 1970s, when the tremendous growth of biomedical science expanded it to a multidisciplinary endeavor involving anthropologists, policymakers, physicians, sociologists and the public at large.

"In order to preserve the health of society and its overall humanity, it's important that research be conducted in an ethical fashion," according to Nigerian scientist, Dr. Clement Adebamowo, who directs the Fogarty bioethics program at the University of Ibadan. "Invariably some participants will go before others in helping us to understand diseases, the treatments and the impact of those treatments. So, we owe those participants a debt of gratitude and we have a duty to protect them."





In 2000, Fogarty began a bioethics program designed to develop culturally relevant bioethics curricula for developing country scientists and support training to produce leaders who could advise on policy and help train the next generation. Since then, it's enabled hundreds of scientists and administrators to complete master's-level training in bioethics.

"What Fogarty has created with minimal funding and the impact that these programs have had is remarkable," said bioethics professor and Fogarty grantee Dr. Nancy Kass, of Johns Hopkins University.

Fogarty has worked in partnership with co-funders across NIH, including the NIH Clinical Center, which provides significant leadership and expertise, as well as online and in-person bioethics training courses geared to developing country researchers.

"Good ethical research requires a lot from top to bottom—from what questions to ask, how to design studies, how to do them, how to get them designed in a way that recognizes risks," said Dr. Christine Grady, chief of the bioethics department at the Clinical Center.



" My Fogarty training was a defining experience in my career...Fogarty gave me the opportunity of my life, professionally. It opened up my world completely, gave me another view and I fell in love with public health and research. "

Dr. Marcos Espinal

Director, Communicable Diseases,
Pan American Health Organization
Former Fogarty trainee



Many bioethicists agree that

regulation is necessary but not sufficient to ensure ethical research. Examination by an ethics committee or an Institutional Review Board (IRB) only goes so far. Training is geared to creating a culture of responsibility, so that ethical approaches are accepted by investigators, the teams that work with them and institutions that host them.

The review process is critical. "If the review is done incorrectly, you risk people getting harmed," said Dr. Joseph Millum, bioethicist at Fogarty. "If you do it inefficiently, you hold up the process of research." The IRB is further limited by its function, reviewing the protocol and the consent form, but not overseeing the actual research process.

Fogarty's program aims to produce bioethics leaders who can advise developing country institutions how to formulate and strengthen local bioethics guidelines, build well-informed review bodies capable of evaluating research proposals, and train others in the principles of ethical research conduct. Given the increasingly collaborative nature of research, it's also important to bring new voices with different perspectives to the global ethics conversation.

Fogarty's Dr. Barbara Sina, who has managed the program since its inception, said she's encouraged at the progress LMIC trainees have made. "Our ultimate goal is to develop research ethics capacity and expertise so that countries can create their own ethical oversight processes and participate equally in the global dialogue on research ethics."



Bioethics takes root in Nigeria

Examining the bioethics landscape in Nigeria today, it's difficult to imagine how recently it was a barren plain. Nigerian scientist Dr. Clement Adebamowo recalls a "perfect storm" of events that spurred him to develop a bioethics research training program at the University of Ibadan.

In 1996, a controversial drug trial conducted during a meningitis outbreak caused fatalities, triggering a backlash against researchers. Meanwhile, global outsourcing of clinical trials was growing in popularity, taking advantage of low-cost settings with little or no regulation. Finally, the "Out of Africa" theory of evolution was generating interest among researchers keen to conduct population studies that might determine the genetic basis of diseases.

Adebamowo began his bioethics training program with a Fogarty planning grant in 2004. He and his team developed web resources, conducted sensitivity and public awareness campaigns, and offered training to institutions to strengthen their research ethics committees. Once he received a full grant, he launched a master's degree program designed to serve as a bioethics resource for all of West Africa. The first class of master's students was drawn from nursing, biomedical research and public health. Coursework included classes on informed consent, research design, philosophy of bioethics, religion and ethics, and qualitative and quantitative research methods.

Eight of his faculty obtained master's degrees in bioethics through established Fogarty training programs in the U.S. and Canada. They in turn have provided instruction at Ibadan, mentoring 20 students through the master's program and more than 1,000 West African researchers through a short course. The "multiplier effect" is huge, Adebamowo observed. "For us in Nigeria, the Fogarty funding for bioethics changed the entire landscape. What we have now would have been impossible without the Fogarty funding," he said.



" For us in Nigeria, the Fogarty funding for bioethics changed the entire landscape. What we have now would have been impossible without the Fogarty funding. "

Dr. Clement Adebamowo
University of Ibadan

Fogarty bioethics grantee

In concert with his training efforts, Adebamowo also helped the health ministry transform Nigeria's national ethics system and drafted the country's first formal code for research ethics. His trainees held or assumed positions in state and federal institutions, creating a framework and resource as the code was implemented. His NIH funding provided credibility, he said, which was helpful as he re-established and chaired the national ethics committee, created a web-based research protocol tracking system, and initiated or strengthened 25 Institutional Review Boards across the country.

The cultural shift has been enormous and will have lasting impact, he said. "The most significant thing we've achieved is elevating the status of research ethics and helping researchers and Nigerians in general appreciate the value of ethical conduct of research," said Adebamowo. "We have more people who know that there is a way of doing research that is both scientifically appropriate and ethically sound. Those people will pass this down to their trainees, so over time a better research culture will develop."

Fogarty program develops bioethics expertise in Uganda



Ugandans were quick to participate in the master's-level bioethics programs Fogarty began supporting at institutions in the U.S., Canada and South Africa. When the trainees

returned home, they worked as a team to develop a national bioethics framework for Uganda, which is now the third largest destination for clinical trials in Africa.

"Fogarty trainees have been very active in developing the research ethics landscape in Uganda," said Dr. Julius Ecuru, of the Uganda National Council for Science and Technology (UNCST), the government agency that oversees research and development. With Fogarty support, he earned a diploma in research ethics from the University of Cape Town in 2005. He said the experience gave him the inspiration to help bring about many of the reforms in his country.

"We felt the guidelines must be driven by some kind of value judgment," Ecuru explained. "Every statement we put in there has an ethical justification of why it is there."

In the first decade of the Fogarty bioethics program, nine Ugandans from Makerere University traveled abroad for master's-level training. They studied the principles of ethics, international guidelines, research methodologies and other topics. They were also immersed in the practical application of coursework, by observing Institutional Review Boards (IRBs) in action and developing case studies relevant to the research issues they were facing at home. Throughout the process, they were mentored by experienced bioethicists.

Seven faculty members with substantial training returned to Uganda and formed the core leadership for bioethics in the country. In addition to helping shape national guidelines, they developed workshops and short courses to expand the number of experts in human research protection, responsible conduct of research, clinical ethics and research ethics. They also assisted in organizing national and regional conferences to share information and build capacity.

In 2014, Makerere had developed sufficient bioethics expertise to successfully compete for its own Fogarty bioethics grant, allowing the university to expand activities and establish a

bioethics master's degree program. Researchers no longer have to leave the country, or learn from a foreign trainer who comes in and teaches with examples from elsewhere, explained Dr. Joseph Ochieng, who was one of the first Ugandans to receive bioethics training. Ochieng, a professor at Makerere, received a master's in bioethics from the University of Toronto with Fogarty support, and continues to be heavily involved in bioethics.

"We are training individuals in the context of Uganda, in the context of where they live and practice, so they connect much better," Ochieng said, noting the approach also reduces brain drain and is cost-effective. "The only sustainable way you can do it adequately is by training locally. You can train more people with less funding."

Under the program, bioethics short courses have been presented to several hundred individuals, case studies specific to Uganda have been developed and online training tools are being produced, which will reduce costs and increase capacity. In addition to supporting trainees' participation in national and international research ethics conferences, the grant also helps fund the study of emerging issues such as genetics research in Africa.



"Strengthening research ethics has given us a good environment to support quality research," Ecuru said. "Our regulatory system should not be a hindrance to scientific progress. Rather, we want scientific progress that also ensures respect for human participants and causes less harm to participating communities."



“ Fogarty understands that global change starts within individual countries, and during its 50 years of existence, its unique, sustained focus on supporting people in their own countries to solve their own problems has been a critical piece of the architecture and development of global health.”

Dr. Peter Singer

University of Toronto
CEO of Grand Challenges Canada

Fogarty bioethics grantee



Advancing research through technology



Whether analyzing and comparing large data sets, tracking disease outbreaks or using text messages to communicate with study participants, global health scientists increasingly rely on information and communication technologies (ICT) to advance their research. ICT is a broad concept that encompasses computers, cellphones, broadband, videoconferencing and distance learning—and Fogarty grantees are at the forefront of the movement, working to adapt cutting-edge technologies to low-resource settings.

Since 1998, Fogarty has provided funding to catalyze implementation of ICT by supporting research and training in informatics, mobile health and electronic learning programs.



With computers, cellphones and other information and communications technology (ICT) becoming more widely available, Dr. Patty Garcia of the University of Cayetano Heredia applied for and received a Fogarty grant in 1999. That award enabled her to provide training for young Peruvian scientists in the use, development and application of informatics for health, linking them with ongoing research that uses new technologies.

Garcia created a range of options for emerging investigators, from diplomas to master's degrees to doctoral degrees, and also small grants for innovative, closely mentored research. Topics included improving home blood pressure monitors, using bioinformatics for cysticercosis control and incorporating electronic health records in the fight against tuberculosis.

To ensure broad access to the new bioinformatics curricula, both in Peru and other countries, many of the training materials were made available online. Having developed a critical mass of researchers with informatics expertise in Peru, additional Fogarty support allowed Garcia to create a hub to share that knowledge across the Andean region, with a focus on Colombia, Ecuador and Peru.

"We envision global health informatics as an umbrella for integrating health informatics and bioinformatics into clinical, biomedical and behavioral research issues that are vital to advancing the health of populations in our area and around the globe," Garcia said. "So, we are creating the critical mass to sustain and expand our progress. We are positioned as a leader in the field."



" I imagine Fogarty's training programs as a very rich soil. People, our trainees, are the seeds. The seeds, in a good soil, will grow into plants that eventually produce fruits—in the form of funding, scientific discoveries or even the ability to have research results influence policies that will improve public health. So, Fogarty plays a unique and crucial role by providing this fertile soil."

Dr. Patty Garcia

University of Cayetano Heredia
Lima, Peru

Fogarty grantee and former trainee



Fogarty's informatics program supported training for scientists to design information systems and apply computer-supported management and analysis to biomedical research. Informatics, the science of handling large volumes of

information, helps link physicians and researchers around the world so that they can share knowledge and collaborate on research.

Several of Fogarty's informatics projects expanded to form regional networks, leveraging tools and hard-earned lessons to benefit additional developing country researchers. A program in Brazil shared its materials with Mozambique, where Portuguese is also the national language. Researchers in Peru have built a Latin American training network, and a university in South Africa formed a consortium to strengthen biomedical informatics throughout the region.

The arrival of broadband internet access in Africa and other developing countries has made distance learning and videoconferencing possible, creating opportunities for new collaborative teaching tools and resource sharing, greatly expanding the possibilities for research training.

As cellphones became ubiquitous throughout the developing world, Fogarty's grantees have studied ways to deploy them for disease surveillance, health program management, patient monitoring and global health research. They've also developed new software and hardware to turn cellphones into microscopes, diagnostic devices and training tools.





“ Something that’s unique about Fogarty is the group learning that goes on among its grantees because they convene us regularly. It isn’t just ‘here’s money, go away,’ it’s ‘here’s money, come and share what you’ve learned.’ And in my experience, that’s unique—that’s something that nobody else does.”

Dr. Bill Tierney
University of Texas at Austin
Fogarty informatics grantee

Until recently, clinicians and researchers working in sub-Saharan Africa relied on a paper-based system of medical records that was time-consuming and often inaccurate. In 1998, Dr. Bill Tierney, then of Indiana University, and his team used a Fogarty informatics grant to begin work on the first electronic medical record system in the region, the Mosoriot Medical Record System or MMRS, supporting Kenyan clinics. Tierney faced a number of challenges—establishing reliable computer service in an area with a meager supply of electricity and training local health workers who had little or no experience with computers were just a few.

MMRS, which was developed in Microsoft Access, allowed clinic staff to store data electronically and use it in ways they had never imagined. Staff could now identify villages where too few children had been vaccinated and take steps to rectify the situation. In another case, a rabies cluster was identified and the rabid animal was found and exterminated. The new system created efficiencies, too, reducing patient visit duration, enabling the clinic to double its patient load with no additional staff.

Tierney later went on to play an instrumental role in the creation of both the AMPATH system in Kenya and OpenMRS, a medical record system used in HIV/AIDS clinics in Tanzania and Uganda. Drawing on their experiences with MMRS, Tierney and a group of collaborators from other institutions chose tools that were freely available and open source when designing OpenMRS, guaranteeing that the overall project would remain low-cost and easy to update. Since then, OpenMRS has grown beyond expectation, having been implemented in more than a dozen other countries on three continents.

If it hadn’t been for the initial Fogarty funding, Tierney says the MMRS and its successors, AMPATH and OpenMRS, would never have been conceived.





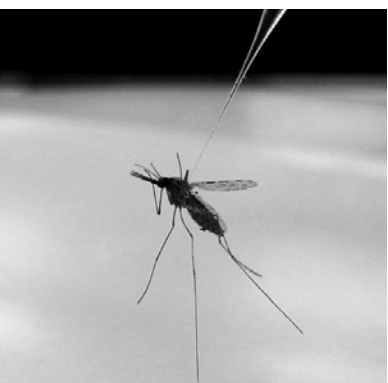
Constructing a multidisciplinary framework for research

An explosion of interest in global health on U.S. college and university campuses coincided with the 2005 launch of the Fogarty Framework program, designed to encourage multidisciplinary approaches required to tackle increasingly complex global health problems. Involving more than 30 U.S. and foreign universities, the program succeeded beyond all expectations, nudging faculty—who might never have crossed the quad to meet one another—to create new multidisciplinary curricula and harness previously untapped expertise. As a result, anthropologists, engineers, lawyers, business students, physicians and communicators all began collaborating on public health projects around the world.

“It was meant to be catalytic, and it was,” recalled Fogarty program director Dr. Flora Katz. “It was transformative at a time when money was coming into the field.”

Recipients call the program indispensable to their universities’ efforts to win more money from other sources and to provide students clamoring for global health training with foreign research experience.

Johns Hopkins, the oldest and largest U.S. university addressing global health issues, used its Framework grant not only to pull together faculty from a number of schools and departments on two different campuses, but also to develop courses for undergraduates. The program, which combined curricula from the schools of medicine, nursing and public health, awarded travel grants on



a competitive basis, with matching funds raised by the university's Center for Global Health.

When Hopkins received its Framework grant, public health had become the number one major among arts and sciences undergraduates. "The timing was perfect," says Center director Dr. Thomas C. Quinn. "It's one of the best grant mechanisms that Fogarty ever launched for universities," he said.

Framework support allowed the University of Virginia to develop 12 new courses across the campus. One of them, "Financing a Sustainable Future," teamed a professor of commerce with an infectious disease professor who went to Tanzania with a group of students from a variety of disciplines. They looked into establishing a business there for the production of HIV testing kits, which were prohibitively expensive to import. Working closely with Tanzanian students, the group created a business plan to build a factory and formed a foundation to raise seed money.

Program co-directors Dr. Rebecca Dillingham and Dr. Richard Guerrant said the Framework program not only advanced global health research, it also directly benefited individual students and faculty.

International collaboration literally bore fruit in one case, Dillingham recounted. As a result of coursework on urban agriculture in foreign



"I'm an anthropologist, so what's important to me when we train our students to get them ready to go overseas to do research, or when we bring international students to North Carolina for training, is that they really need the kind of interdisciplinary grounding that the Fogarty Framework program encouraged. Our trainees really need to understand the social and cultural context of the places where they're going to be doing their research."

Dr. Peggy Bentley
University of North Carolina
Fogarty Framework grantee

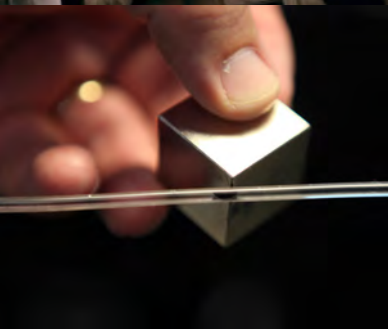


countries, students presented their findings to the city council and established a consortium to reduce the costs of locally grown food for all residents of Charlottesville, Virginia, where the University's main campus is located.



As for faculty, Guerrant said, "Just applying for the grant transformed our institutions. It really caused us to break out of our silos for our own good."

At the University of California, San Diego (UCSD), Framework support allowed students the opportunity to get practical experience with global health issues, particularly the cross-border spread of narcotics and sexually transmitted infections. More significantly, the funding helped spur creation of a joint doctoral program between UCSD and San Diego State University. "Global health is so popular as a field that students heard about it through the grapevine and were applying before the ink was even dry on the announcement," the UCSD's Dr. Steffanie Strathdee said.



Tufts University created a global health concentration in its Master of Public Health program, bringing together not only the medical, veterinary and engineering schools but also the renowned nutrition and diplomacy schools. It quickly became the most popular concentration, said program director Dr. Jeffrey K. Griffiths.

Tufts has partnerships with universities in Tanzania, Uganda and Kenya and uses an electronic library and other information technology to co-develop curricula. "We built capacity to share content and share discussion," said Griffiths. "Faculty had to change the way they taught, and students pushed the faculty to start using electronic means to get content up on the internet."

Fostering global health innovations

In a second phase of the Framework program, Fogarty provided funding to generate innovation in health products, processes and policies. Multidisciplinary teams identified critical health needs, then conducted research to develop and test solutions.

One project is tackling the problem of accurately diagnosing malaria in low-resource settings, so that appropriate treatment can be provided in a timely manner. A grant to Vanderbilt University is enabling a dozen American and Zambian research trainees to develop and deploy a new inexpensive, portable test for malaria. The scientists previously produced a related low-cost tool that primes blood samples for malaria testing, using magnets to attract molecules from the malaria parasite.

Harnessing excitement on campus

Capitalizing on the skyrocketing interest in global health on campuses across the U.S., the Consortium of Universities for Global Health (CUGH) was established in 2008. The following year, Fogarty co-hosted the group's inaugural meeting on the NIH campus. The rapidly growing Washington, D.C.-based organization now comprises more than 145 academic institutions and other organizations from around the world. Its annual meeting draws nearly 2,000 attendees to share expertise and form collaborations that translate knowledge into action.



Another growing problem is the spread of drug-resistant TB, which poses a serious threat in confined, crowded spaces such as hospitals, clinics, prisons and refugee camps. A Framework grant at Brigham and Women's Hospital in Boston is bringing together architects and engineers with infectious disease researchers and others to study new ways to slow the spread of TB.

The work is drawing inspiration from a previous project in Rwanda, where the nonprofit MASS Design Group constructed a new hospital specifically to minimize airborne TB spread. They located it on the top of a hill to maximize natural airflow, incorporated plenty of windows for cross-ventilation, changed the ward layout, added large fans and installed ultraviolet lights to deactivate TB bacteria.

Promising innovations resulting from the Framework program will be studied for effectiveness and practicality, with a view to scaling up those that have the potential for impact.

"Not all of the innovation projects will succeed," Katz acknowledged. "But it is our intention that, by going through this process, the participants will learn to think more creatively and gain experience bringing different disciplines to bear on a single problem."





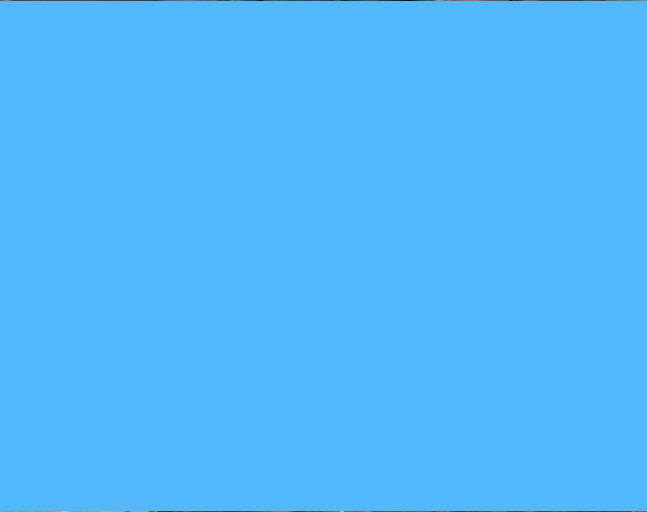
Cultivating the next generation of global health leaders

Fogarty Scholars and Fellows can be found in rural villages and urban capitals throughout the developing world, engaged in research to prevent HIV transmission, diagnose and treat heart disease, and study the causes of mental illness and other conditions. These motivated individuals are students, health scientists, medical doctors, nurses, dentists and veterinarians.

Since 2004, Fogarty has been offering one-year, mentored clinical research training overseas to pre-doctoral U.S. students in the health professions. In 2007, the program was expanded to include Fellows who are post-doctoral scientists already on a global health career path. Fogarty began a partnership with the Fulbright Program in 2010 to increase fellowship opportunities.

Originally supported by a single private donation, the program now receives funding from 17 NIH Institutes, Centers and Offices. There is broad recognition of the importance of providing support to bridge the gap between doctoral work and a solid career pathway in global health research.

The program has provided hundreds of early-career scientists the opportunity to participate in mentored research at top-ranked sites globally that have active NIH grants and a proven track record of scientific productivity. There are patient-oriented activities as well as epidemiologic and behavioral studies, operations research and health outcomes evaluations.





Exposure at this point in their careers is critical, said Fogarty director Dr. Roger I. Glass. “When young people go overseas to work in a low-resource setting, they get hooked on global health research. Their enthusiasm is contagious and it’s exciting to see leaders emerging from this program.”

The experience gives participants firsthand exposure to difficult issues on the ground, while providing the opportunity to forge relationships and scientific collaborations that can boost their career trajectory and lead to a lifetime of global health accomplishments.

Over the years, participants have published more than 500 articles in peer-reviewed journals and presented findings at numerous scientific meetings. Another measure of the program’s success is the growing number of alumni whose NIH applications have been funded. But perhaps the most meaningful outcome is the formation of international scientific collaborations that deepen over time and gain significance as today’s Scholars and Fellows become tomorrow’s global health leaders.

Accelerating disease diagnoses

As a medical student on a Fogarty Fellowship in Dar es Salaam, Tanzania, in 2005, Paul Drain watched AIDS patients die because they couldn’t afford needed medicines. After each day’s rounds, Drain would spend hours writing in a journal just to keep from feeling totally powerless.

Eight years later, on his second Fogarty-sponsored research experience, in South Africa, the drugs were available—at least for HIV patients. But

keeping patients alive after diagnosis still involves hurdles. The focus of his work today is developing easy, cheap ways around them.

“My group at Harvard has done several studies showing that when these patients leave the clinic, around 40 percent never come back,” Drain said. Many of those told to return for the HIV or TB test results, never do. Drain used his two-year Fogarty Fellowship to assess point-of-care diagnostics that can short-circuit such delays.

“Young people are thinking more globally than generations before,” Drain said. “Fogarty’s funding has allowed me and many other people to continue doing global work. Without their funding, a lot of this wouldn’t be possible.”





Studying water purity in India

Dr. Arti Kundu spends her days looking closely at dirty water. Trained in civil and environmental engineering—as well as public health—she applies problem-solving techniques to improve water quality and prevent disease around the world.

As a Fogarty Fellow, she investigated whether hands and drinking water in an Indian urban community were contaminated with *E. coli* bacteria and had any association with household diarrhea. Each year, diarrheal diseases kill about 10 percent of Indian children under the age of five.

“Today’s challenges in global health include providing clean water and enough food for people, and protecting vital ecosystems,” Kundu said. “I believe the mammoth task of improving health in developing countries can only be achieved through multidisciplinary research.”

Kundu is contributing to that varied approach with her engineering training and specialization in water. She has learned techniques for state-of-the-art molecular diagnoses and computer modeling of the physical, chemical and biological processes in the environment.

In her study, she discovered that source water from community pumps, municipal taps and commercial tankers was generally clean, but more than 65 percent of water in household storage vessels had fecal contamination. Additionally, she found a high correlation between gastrointestinal symptoms and the presence of *E. coli* on family members’ hands—especially the mothers’. Kundu shared her study results with affected households and visited local schools to teach the importance of handwashing and encourage each child with a gift of soap.

Kundu intends to apply for an NIH career development award to advance her multidisciplinary research. “I want to continue to make changes in society, reducing diarrheal diseases,” she said. “You feel very good when you can see you’re making an impact on peoples’ lives. I would like to keep doing that.”

Exploring natural products to discover new treatments and cures



Seaweed, mollusks and ants are just some of the diverse life forms being studied for their potential to treat infections, malaria, cancer or other diseases. Fogarty has been encouraging natural products discovery since 1993, when the Center helped found the International Cooperative Biodiversity Groups (ICBG) program in partnership with the National Science Foundation.

In addition to investing in biodiversity exploration for potential health applications, the projects also develop research capacity to support sustainable use of these resources, conservation knowledge and equitable partnerships among U.S. and low- and middle-income country research organizations.

In Fiji, a scientific team found a promising compound to fight malaria by studying how marine plants and animals defend themselves against infections. Under the project led by the Georgia Institute of Technology, scientists collected seaweed and other marine species to look for natural antibiotics. They also screened compounds from these organisms for biomedical properties and discovered that a type of red algae contained compounds called bromophycolides, one of which was found to have strong anti-malarial properties. Animal studies have begun to determine the compound's effectiveness and suitability as an antimalarial.

Fungal-farming ants are being studied in Brazil in a search for potential therapies for a range of conditions. Research teams from

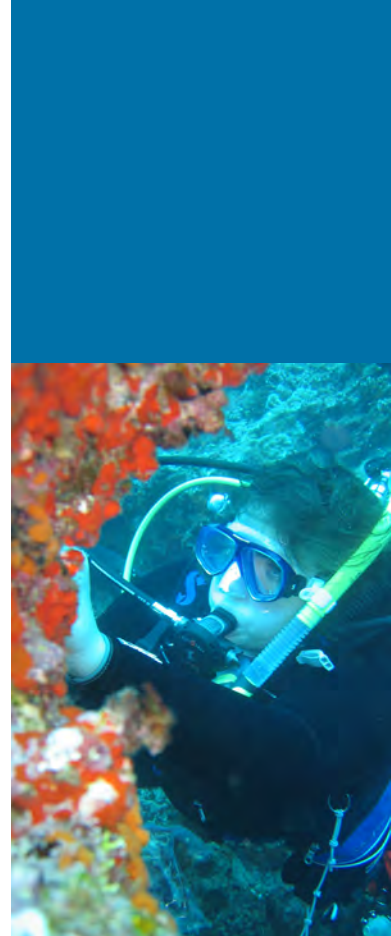


Harvard Medical School and the University of São Paulo are investigating symbiotic bacteria that live in specialized anatomical features of the ants, called crypts. The bacteria produce small molecules that act as antifungal agents, inhibiting invasive fungal pathogens but not the crop fungus that the ants rely on for nutrition. The researchers hope to identify the antifungal agents to develop treatments for invasive fungal diseases that affect humans and may be active against blood cancers, and protozoal parasite infections like Chagas disease and leishmaniasis.

In the Philippines, mollusks are the subject of a project seeking to discover therapies for bacterial infections, cancer, pain and other neurological conditions, and parasitic diseases such as toxoplasmosis and cryptosporidiosis. A team headed by grantees from the University of Utah, in collaboration with the University of the Philippines, is studying a variety of mollusks and their associated bacteria, which represent an unexplored trove of chemical diversity.

A potent new cancer toxin was discovered in a species of algae in Panama's coastal waters by grantee Dr. William Gerwick, of the University of California, San Diego. In addition to possibly leading to a new form of chemotherapy, the project is also preserving biodiversity resources for the future. Gerwick and his partners helped to successfully make the case for the island of Coiba—which houses diverse species including some that are endangered—to receive protected status as a UNESCO World Heritage Site.

“There is a very keen sense that we are doing something great in science but doing more than just science,” said Gerwick. “We are builders, not destroyers. We are attaching value to these life forms.”





Making implementation science a priority

An enduring challenge in global health is discovering how best to quickly adapt and implement research advances so they work effectively in low-resource settings. Implementation science—research to translate evidence-based findings into common practice—is a Fogarty priority and has been supported in projects across its portfolio of research and training programs. Sometimes referred to as the “know-do gap,” implementation science is the difference between what is known to work and what is done in practice.

Studying ways to prevent maternal deaths in Nigeria



Cultural practices—such as the tradition of early marriage for Nigerian girls—pose significant barriers to implementing programs that would improve maternal health. It’s not uncommon for rural Nigerian women to deliver an infant without medical care. Complications, such as hemorrhaging, can prove fatal before the woman can reach a hospital. In northern Nigeria, there are as many as 1,000 deaths for every 100,000 births.

To address this tragedy, Fogarty grantees Drs. Daniel Perlman and Malcolm Potts and their colleagues at the University of California, Berkeley, studied how best to implement a maternal health research program in partnership with their Nigerian counterparts at Ahmadu Bello University. As a first step, they introduced community-based use of misoprostol, a drug proven to safely prevent post-partum bleeding during

home births in other parts of Africa. They also determined that lack of electricity in remote areas seriously impaired the ability of hospitals to deliver care, leading to the development of solar energy systems that now power blood bank refrigerators, ultrasound machines, communications equipment and lights in operating rooms.

The research project also led to a partnership with village parent-teacher associations, schools and religious groups, with the goal of promoting the education of girls and increasing the age of marriage. One of the researchers discovered that many parents are open to the possibility of leaving their daughters in school and delaying matrimony when offered assistance with school fees, books and related expenses.

“Our research showed that school attendance could provide teenage girls with a socially acceptable alternative to early marriage,” said Perlman.

Researchers tackle fetal alcohol syndrome in Russia

Research on implementation identifies barriers to proven interventions and facilitates the creation of local strategies to overcome them. Bottlenecks may include cultural, behavioral, economic or management factors.

Often a collaborative process involving experts from a wide range of disciplines, implementation research in the global health field has helped clinicians to identify and solve problems more quickly, while improving the performance of programs using scientifically valid methods. It has also allowed program managers and policymakers to come to decisions based on evidence instead of assumptions, and has even helped managers and staff at health facilities better understand how their own programs work.

“Effective program implementation must be multidisciplinary,” said Fogarty Director Dr. Roger I. Glass. “We need to think with an open mind how to make programs work more effectively. In every realm of interventions, we have lots of knowledge that isn’t applied.”



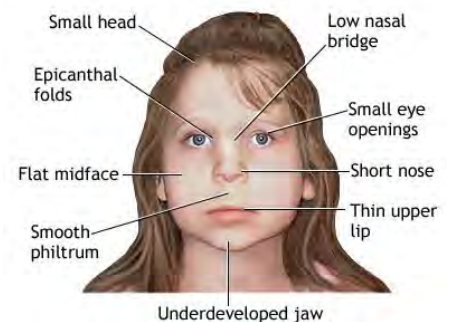
High alcohol consumption—common in Russia—is another barrier to implementing research findings that would improve health. Alcohol use poses an alarmingly high risk for pregnancies, and fetal alcohol

spectrum disorders are common in Russia. The leading cause of preventable mental retardation in the world, fetal alcohol syndrome can cause abnormal facial features, growth problems, difficulties with memory or learning, vision or hearing deficiencies and behavioral issues.

The first step for Fogarty grantee Dr. Tatiana Balachova, of the University of Oklahoma, was to assess the scale of the problem. “Alcohol consumption is widespread in Russia,” said Balachova. “It is a social norm and a part of everyday functioning that affects the society in many ways.”

In a survey, she and her team found more than half of non-pregnant women reported inconsistent birth control practices, with more than 70 percent of them admitting binge drinking. Even among women trying to conceive, 66 percent reported binge drinking.

Signs of fetal alcohol syndrome



Balachova and her colleagues used the information to create educational materials and online training programs for medical personnel and the general public. Her hope is interventions will ultimately be delivered routinely to large numbers of women in obstetrics clinics across Russia.

She faced cultural and institutional obstacles to implementing the programs, such as misconceptions that harm is only caused if parents are intoxicated at conception and the idea that “normal” women don’t drink and are not at risk. “There is a major lack of knowledge,” Balachova said. “We need to base our interventions on assessments, not assumptions.”





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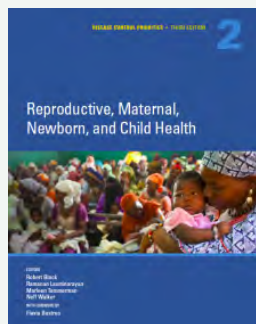
Training to meet the needs of the shifting disease burden



Growing urbanization, increasingly sedentary lifestyles, consumption of fast food and other factors mean people in developing countries are now facing many of the same health challenges as Americans. Successful programs have slowed deaths from AIDS, TB and malaria, but now populations are living long enough to develop diabetes, heart disease, dementia and other chronic, noncommunicable diseases (NCDs). Indeed, 80 percent of the world's NCD-related deaths now occur in developing nations, with the toll rising quickly.

Fogarty views NCD research and training as key priorities and has created a number of grant programs to support research and help develop the necessary skill set for NCD studies. Confronting the global chronic disease crisis will require a highly skilled and nimble research workforce that is poised to examine a wide range of risk factors and their interactions. The development of effective and locally appropriate interventions will require that these scientists be trained to think and work across multiple disciplines and diverse settings in response to local needs and research priorities. Given the burden of NCDs in the U.S. and other high-income countries as well as LMICs, this research is ripe for knowledge exchange, collaboration and team science.

Determining “best buys” in global health



To shed light on the complexities of infectious diseases and NCDs, Fogarty helped lead an effort that resulted in a landmark set of studies, known as the Disease Control Priorities Project 2. Published in 2006, the encyclopedic volumes quantified the global burden of disease by geographic region, assessed epidemiologic and demographic trends and projections, and computed the cost-effectiveness of interventions to manage, control

and prevent those diseases. “Best buys” in health were calculated by a comprehensive set of cost-effectiveness analyses addressing more than 300 conditions for which proven personal and community-based interventions were available.

Fogarty was secretariat for the project, an alliance that included the World Bank, World Health Organization, and the Population Reference Bureau, with funding from the Bill & Melinda Gates Foundation. The project, today managed by the University of Washington, has continued to release new data.

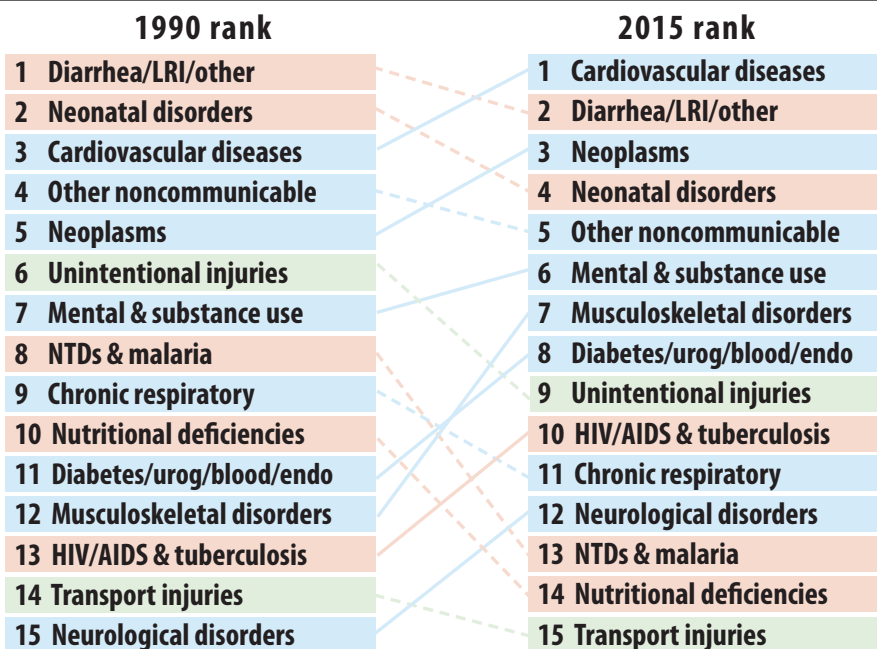


“With its mission to uplift science internationally, Fogarty is hugely important and has really had an impact on global health. Researchers in low- to middle-income countries struggle to secure funding to move forward in their careers, and often couldn’t do it without Fogarty.”

Dr. Michèle Ramsay
University of Witwatersrand

Global Burden of Disease Study

Both sexes, All ages, DALYs per 100,000



Communicable, maternal, neonatal, and nutritional diseases
 Non-communicable diseases
 Injuries

Institute for Health Metrics and Evaluation (IHME). GBD Compare Data Visualization. Seattle, WA: IHME, University of Washington, 2017. Available from <http://vizhub.healthdata.org/gbd-compare> (Accessed 3/17)

Fogarty is also studying how to leverage its long-standing investments in research and training on HIV / AIDS to now tackle NCDs, and address the interrelationships between infectious diseases and NCDs. For example, as access to antiretroviral therapy has increased and HIV-infected individuals are living longer, a new research agenda has emerged around HIV and NCD comorbidities. This includes epidemiological studies regarding the incidence and prevalence of comorbidities, the potential effects of antiretroviral therapy on pathogenesis, cost-effective ways to integrate HIV and NCD services that improve health outcomes, and prevention of NCDs in the HIV-positive population.

Training the next generation of scientists in NCDs

During a Fogarty Fellowship in Kenya in 2009, Dr. Gerald Bloomfield observed an epidemic of diabetes, heart failure and high blood pressure. He responded by creating a series of lectures that enhanced the capacity of local medical students, residents and technicians. As an assistant professor at Duke University, Bloomfield currently researches the epidemiology of heart failure and cardiovascular risk factors in sub-Saharan Africa. He also works closely with the National Heart, Lung and Blood Institute's Cardiovascular and Pulmonary Disease Center of Excellence at Moi University, located in Eldoret, Kenya, where he spends six months a year studying heart failure epidemiology, the cardiovascular effects of indoor air pollution and cardiovascular risk factors among HIV-positive patients. By demonstrating the burden of chronic, noncommunicable disease through epidemiology, Bloomfield hopes to use research evidence to influence policy change.



“There is no substitute for experience. While many trainees have ample passion and interest, the opportunity to directly experience the day-to-day of global health clinical research for one year is uncommon. Thanks to the Fogarty Fellows program, I have been able to add knowledge and experience to the passion I have for cardiovascular global health.”

Dr. Gerald Bloomfield

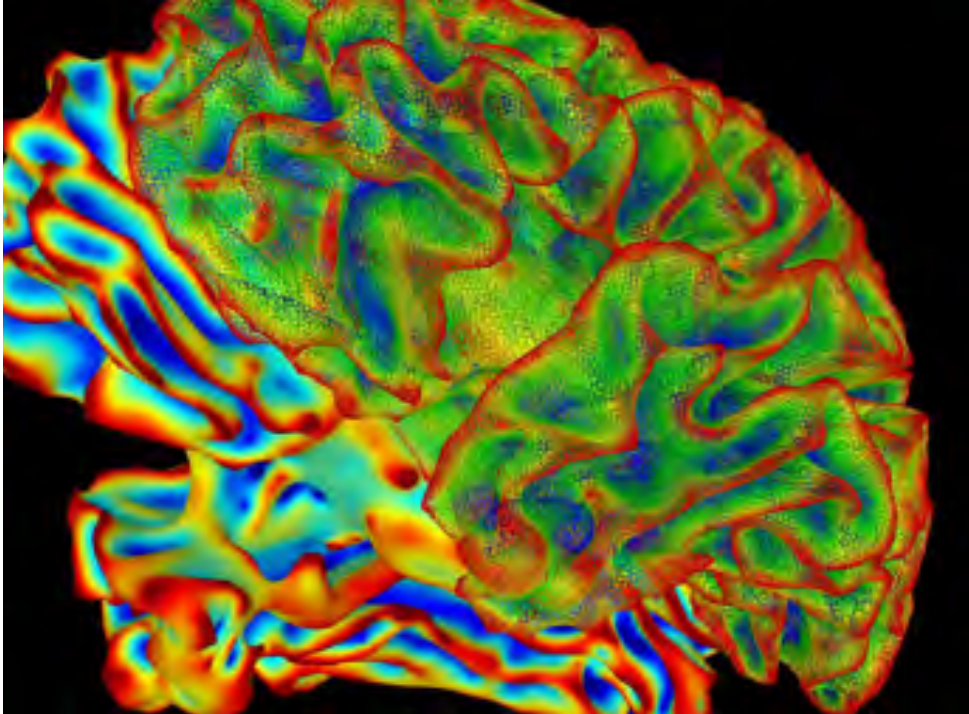
Fogarty Fellow in Kenya



Uniting to fight NCDs



To focus attention and funding on chronic, noncommunicable diseases, the world's major funding agencies have banded together to form the Global Alliance for Chronic Diseases (GACD). Fogarty helped start the partnership, which began in 2007 with four founding members and has grown to include the European Commission and research funding bodies in Argentina, Australia, Brazil, Canada, China, India, Japan, Mexico, South Africa, Thailand, the U.K. and the U.S. The GACD was established to facilitate collaborative funding activities for innovative, original research directed at the prevention and treatment of chronic diseases. In the first few years of its existence, GACD members invested more than \$100 million in joint research on hypertension, diabetes and lung disease.



Including brain disorders in the global health research agenda

The breadth and complexity of brain disorders make them some of the most difficult conditions to diagnose and treat, especially in the developing world, where there may only be one psychiatrist or neurologist in an entire country. These disorders occur throughout the lifespan—from infants starved of oxygen during difficult births, to children whose development is stunted due to malnutrition or exposure to infections or toxins, to adults who develop depression or dementia. Such mental and behavioral issues cause the world's largest burden of disability, according to the Institute for Health Metrics and Evaluation.

That's why Fogarty launched an initiative in 2003, called Brain Disorders in the Developing World: Research Across the Lifespan Program, managed by Dr. Kathy Michels. The goal was to catalyze this field of research and develop badly needed expertise in low- and middle-income countries (LMICs). Since it began, more than 150 grants have been awarded, generating nearly 500 peer-reviewed articles and facilitating training of at least 150 scientists.

"Many people in developing countries suffer from conditions that affect their brains and devastate their lives, but we don't have much data documenting the underlying causes of the disorders and interventions that might be effective," said Fogarty Director Dr. Roger I. Glass. "By supporting research and training in countries where resources are limited, we hope to generate research capacity that could ultimately improve the lives of those suffering from the burden of these neurologic diseases."

Colombian family may hold clue to Alzheimer's cure



Dr. Francisco Lopera was a resident in neurology when the first patient with dementia walked into the San Vicente de Paul hospital in Medellin, Colombia in 1984. "He was 47 years old and he had

completely lost his memory over the past three or four years," Lopera recalled. "What was truly remarkable was, exactly the same thing had happened to his father and grandfather at the same age."

Over the next several years Lopera visited the man's family, where he identified several other cases with the same complex set of symptoms. He eventually found more patients in nine other mountain villages, as well as in Medellin itself. The families even had a name for the ailment: *la bobera*, "the idiocy." Nearly all of the cases of this heritable variant of early-onset Alzheimer's disease share a common ancestor. He was a 16th-century Spanish colonist who carried a particularly devastating genetic mutation to Antioquia province, where it spread through isolated villages. To date, Lopera and his colleagues have identified 5,000 patients in 25 families with the mutation.

In 1991, after Lopera, chief of the neurosciences program at the University of Antioquia, published a case study of this "founder" cohort, Dr. Kenneth Kosik of University of California, Santa Barbara got in contact. They began a collaboration that, with assistance from Fogarty's brain disorders program, has turned what Kosik calls the "natural laboratory" of Antioquia into a leading center for the study of Alzheimer's disease. The Lopera-Kosik collaboration, funded by Fogarty and the National Institute on Aging beginning in 2004, has taken on added significance in the last few years because of the unique characteristics of the Antioquia population, by far the world's largest occurrence of early-onset familial Alzheimer's.

Most Alzheimer's researchers believe that beta-amyloid protein accumulations in the brain cause the disease. But trials of drugs designed to attack amyloid in sick patients have in recent years failed to slow or reverse its symptoms. Lopera, a co-director of the Colombian trial, is hopeful that these

same drugs might be more successful if given to patients before they develop disease symptoms, by preventing the accumulation of the dangerous protein.

The Antioquia cohort presents a unique opportunity to study this hypothesis, because the carriers of the presenilin-1 mutation always develop early-onset disease. No such large, asymptomatic-yet-doomed group of Alzheimer's patients exists anywhere else in the world.

Kosik attributes much of what has been accomplished in Antioquia to Lopera's "tireless work" doing science, building relations and providing social services to affected families. "He will spend hours and days and weeks going from village to village to collect stories and histories, do neurological exams and make all this happen," says Kosik, who also praises Fogarty's role.



"Fogarty has made an enormous contribution," he says, because by strengthening local capacity it enabled a powerful platform for collaboration between foreign and local scientists.

"I can't emphasize how much that is the key to success of this project. We are not just going down there, taking genes, publishing papers and ignoring the people," Kosik said. "The Colombian researchers are not just collecting samples, they are thinking and designing experiments at the same level as we are."



Disease and malnutrition hamper intellectual development

During the past several decades, global improvements in health care have permitted more children to survive to adulthood, even as they bear the lasting effects of early disease and malnutrition. These can

Education may curb epilepsy linked to pig parasite

Three-quarters of people with epilepsy live in the developing world and a major cause is a tapeworm infection transmitted between humans and pigs—known as cysticercosis. Inside humans, the larvae can reach the brain and trigger severe headaches, stroke, hydrocephalus or epilepsy, which occurs in up to 70 percent of those infected.

Researchers investigated the problem in Burkina Faso, with support from Fogarty's brain disorders program and led by Dr. H el ene Carabin of the University of Oklahoma.

"Epilepsy is attributed to evil spirits," Carabin said. "People

with it cannot marry or work or share utensils with the family. Often, the family will build them a little hut, not too close. If they believed it is from a natural cause, then modern medicine would be sought, but if blamed on evil spirits, then they seek out spirit doctors."

Before testing their intervention, scientists gathered pilot data about the prevalence of cysticercosis, measuring antibodies in the blood of pigs and humans in three villages. Concentrations were highest in villages where pigs roamed freely and lowest in predominantly Muslim areas where pig farming was negligible.

The research team's main goal was to lock up the pigs. "Initially, we thought we'd focus on better pig management," Carabin said. "But when we talked to people, they said, 'well, this is all nice and good keeping pigs in pens, but there is nothing to feed them. We can barely feed ourselves. They need to find their own food.'"

The team produced educational materials conveying the importance of personal hygiene, cooking pork meat well, keeping pigs in pens and restricting animal access to human feces. Preliminary results confirm a very high prevalence of larval infection in pigs; human data are still being analyzed. Carabin, hopes the intervention successfully changes personal and village hygiene practices, lowers infection rates and ultimately is extended throughout Burkina Faso.



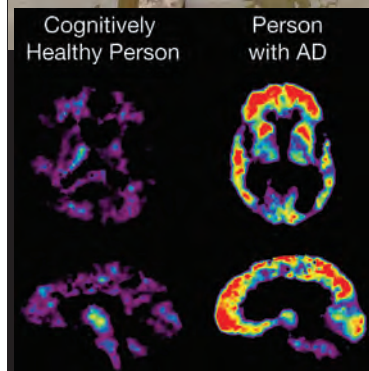
“ I think Fogarty is the bridge to global health. It was for me in my career, taking me from Johns Hopkins out into the world, out into Asia, giving me the opportunity to start my career here. I continue to benefit from the relationships I formed then. I’m incredibly grateful.”

Dr. Brian Hall
University of Macau
Fogarty Fellow



include lower cognitive ability and the development of chronic neurodegenerative disorders. Developmental disabilities have many causes, from genetic anomalies to poor nutrition, infectious diseases, environmental toxins and trauma. Some of these are particularly common in resource-poor countries. At the same time, very little data exist in developing countries on the epidemiology, natural history and pathogenesis of neurological problems and there is a severe lack of care available for them. Fogarty’s initiative specifically aims to support teams of researchers from both low- and high-resource institutions as they study brain disorders relevant to developing countries that occur at any stage of life. The projects are intended to provide scientific evidence and also help build the skills needed to research the nervous system and what can undermine it.

One grantee who collaborates with researchers on different continents is Dr. Richard Guerrant at the University of Virginia. His projects in Brazil and South Africa have shown how child malnutrition impairs cognition and can be prevented by low-cost interventions such as zinc supplementation and reducing the incidence of diarrhea. This type of research evidence, Guerrant noted, is essential for “driving future policy decisions.”



Cassava root causes cognitive damage in Congolese villages



In impoverished regions of sub-Saharan Africa, some villagers need sticks to walk because of neurological damage from the very food that keeps them from starvation—cassava. Toxins in

the tuber can cause sudden and irreversible paralysis and, researchers have learned, also undermine cognitive ability even without overt physical symptoms.

This problem has widespread public health implications because cassava, also known as yucca, manioc and tapioca, is a dietary staple for more than 600 million people globally. The cyanide it contains as a chemical defense against herbivores and insects is normally removed by processing through soaking, peeling and drying, but in stressed conditions such as drought, famine and armed conflict, people may eat partially processed cassava and risk neurological damage.

The one country with the highest prevalence of this paralysis is the Democratic Republic of Congo, where the condition is known as konzo and can affect up to 5 percent of people in some villages. A research team supported by Fogarty's brain program decided to investigate the extent of neurological damage from cassava as a first step toward finding interventions to reduce it.

The scientists enrolled preteens from villages with and without konzo and gave them standard cognitive and motor proficiency tests. All children in konzo-harboring villages—even without physical symptoms—showed poorer memory than children from konzo-free villages. Those in konzo villages additionally lagged in visual-spatial aptitude and in mental processing. These results suggest that even without physical manifestations from cassava toxins, some children suffer damage and the overall burden of cassava-related brain impact may have been underestimated. The team is also working on a biomarker to predict deficits in konzo patients and is investigating whether genetic susceptibility or dietary patterns can explain the spate of cases within families.

Fogarty's brain program covers conditions that strike at all ages, including adult onset neurodegenerative disorders and dementias. National Institute on Aging (NIA) Director Dr. Richard Hodes noted about 15 percent of the world's population will be over 65 in a few years.

"The challenges are going to be absolutely enormous, in particular those posed by age-related diseases," Hodes said. To maximize progress, he urged researchers to share their data widely and in interoperable forms.

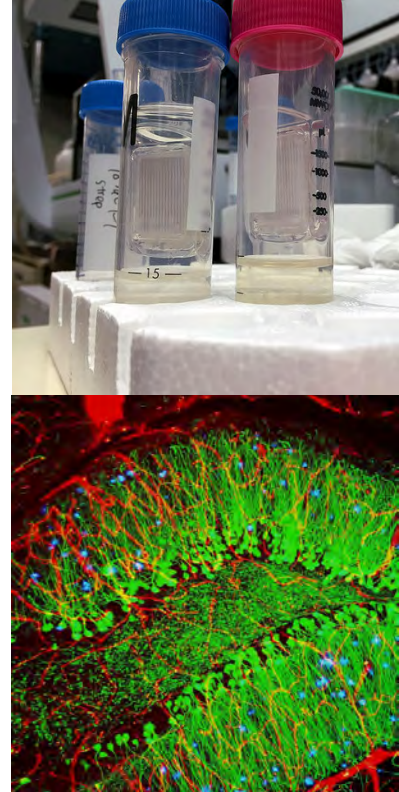
One new arena for brain researchers is HIV / AIDS, where antiretrovirals have dramatically extended patients' lives but little is known about the long-term neurological impact of either the virus or the drugs. Fogarty brain program projects include studies of cognition in children exposed to HIV at birth, and the link between HIV and cerebral malaria.

Researchers seeking low-cost interventions in developing countries have produced novel, inexpensive approaches relevant for developed countries as well. Dr. Benjamin Warf, a Fogarty grantee, in earlier research in Uganda devised a minimally invasive procedure for treating hydrocephalus. Now in use in

the U.S., this procedure has greatly reduced the number of patients receiving brain shunts, which carry a higher risk of infection.

In another example of two-way benefit, a study in Latin America compared treatment of traumatic brain injury using the expensive high-tech equipment common in the U.S. with its own practice of clinician monitoring, and found no difference in patient outcome. “It has caused us to rethink our care and ask what really, truly is important,” said Dr. Randall Chesnut of the University of Washington. “By corroborating across borders, we can come to a better understanding of what we do.”

The grants also expand research capacity. Chesnut’s project, for example, involves 13 intensive care units in Latin America where many former trainees are conducting their own research and training programs. With Fogarty brain program awards, “you’re making researchers as you’re doing research,” he said. “It’s a bit like building the bridge as you’re driving across it. We need to integrate the idea that research is not what you read in a journal, it’s what you do in the educational process and in the machinery of medicine.”





Protecting the environment and ensuring worker safety

Pesticides contaminate drinking water supplies, air pollution causes asthma and lung diseases, and unregulated mining harms workers and produces toxic runoff. These are everyday occurrences in much of the world and cause untold harm to human health. To help address them, Fogarty

has been supporting research and training in environmental and occupational health issues since 1995.

Fogarty began by making grants to individual institutions, supporting activities in more than 30 countries to improve work safety and protect the environment. Through the International Training and Research in Environmental and Occupational Health (ITREOH) program, grants funded training for hundreds of scientists, clinicians, epidemiologists, toxicologists, engineers, industrial hygienists, chemists and allied health workers from developing countries and emerging democracies.

With a critical mass of expertise in place, in 2012 Fogarty launched a new program to develop regional hubs so that scientists can collaborate, share findings and leverage resources. Partners include the National Cancer Institute and the National Institute of Environmental Health Sciences at NIH, and the National Institute for Occupational Safety and Health at the CDC, the International Development Research Centre in Canada, and the Global Alliance for Clean Cookstoves. This initiative is developing regional hubs so that scientists can collaborate, share findings and leverage resources. Seven GEOHealth Hubs are being funded to strengthen research collaborations, accelerate scientific infrastructure development, enhance research training and curricula, support research, and inform nationally relevant policies.

Neurotoxins related to mining and agriculture and their impact on

Making cooking safer with cleaner burning stoves



Simply preparing the family meal poses a deadly health hazard in much of the developing world. Household cooking and heating fires contribute to almost 2 million deaths annually, with women and children most affected by breathing in toxic smoke for hours a day.

Fogarty has been leading NIH efforts and participating in interagency partnerships to help solve the problem. It's surprisingly complicated, with numerous devices being developed that use a variety of fuels, but with little evidence they actually improve air quality or benefit health. The NIH has joined the Global Alliance for Clean Cookstoves as it works to make safer solutions available, and is funding a large multi-country trial to see if stoves that run on liquefied petroleum gas improve air quality sufficiently to provide measurable health benefits.

In addition, Fogarty has organized several indoor air pollution workshops to examine the latest research and train scientists in various aspects of the issues involved, including how to accurately measure stove emissions.

maternal and child health throughout the Caribbean are being examined from a hub based in Suriname. Meanwhile, scientists at a center in Thailand are investigating pesticides commonly used in agriculture across Southeast Asia, to see if they act as endocrine disrupters, which increase the risk of metabolic syndrome and associated diseases such as diabetes, stroke and heart disease.

A collaboration in India is focusing on air pollution and developing the scientific expertise to study the unique characteristics of exposures in that country, while a center in Bangladesh is addressing household air pollution, climate change and hazards in the the garment worker industry. A partnership based in Peru is working with the neighboring countries of Ecuador, Bolivia and Chile to build regional scientific capacity and support research on air pollution and climate change.

A hub based in Ethiopia is developing spokes in Kenya, Rwanda and Uganda to study air pollution, climate change and occupational health related to temperature. Finally, a center in Ghana is leading research and training in West Africa to address health threats from electronic waste, gold mining and transportation-related ambient air pollution.



Reducing death and disability from trauma and injury



Traffic accidents, drownings, agricultural injuries, burns, falls, poisonings and other types of injuries together claim more than 5 million lives each year. Yet, there is little relevant research or scientific expertise in developing countries where 90 percent of these fatalities occur.

In 2005, Fogarty began a trauma and injury research training program that funded more than a dozen projects in six world regions. In addition to spurring discoveries that resulted in over 100 publications, about 300 individuals received long-term training. The program fills a gap in low-resource settings where life poses hazardous situations on a daily basis. For example, pedestrians on unsafe, overcrowded and badly maintained roads are at greater risk of being hit by cars, buses or other vehicles. People living in poorly constructed homes without safety devices are more susceptible to burns and falls. In addition, many countries have inadequate health care and lack infrastructure such as paved roads and emergency response systems.

A number of the Fogarty projects involve road safety, such as one in Egypt, led by Dr. Jon Mark Hirshon of the University of Maryland, Baltimore. Hirshon has trained hundreds of health professionals across the Middle East region in initial evaluation and management of trauma patients, and injury epidemiology. His work guiding assessment of injury-related death and disability in Cairo is helping public health officials plan and implement





appropriate and cost-effective prevention strategies. Issues include the time it takes for the injured

to reach hospitals, the ability of emergency personnel to triage injuries, as well as populations with an ingrained belief in fate.

Despite expressing little faith that injuries can be prevented and a high reliance on fate, surveys revealed that young, educated Egyptians are ready for, and would benefit from, injury prevention programs, Hirshon has discovered. "As in much of the Middle East," he said, "there is work underway in Egypt to create a shift in thinking of accidents as random and unavoidable to preventable, predictable and avoidable."

Another global cause of deaths and disfiguring injuries is agricultural work, which leaves farmers with everything from back pain to deep cuts, contusions, broken and even lost limbs, especially as heavy machinery is replacing hand tools. In China, a Fogarty project supported training for nearly 100 researchers who studied various risk factors for agricultural injuries related to alcohol consumption, sleep patterns, pesticide exposure and others. The need is great—a study in rural China found that more than 590,000 farmers die from injuries every year and 3.5 million workers are permanently disabled.



"Fogarty's been great to me. I met so many people at orientation who introduced me to the next person and the next person. The opportunity to be involved, to be invited into this community has been amazing. I appreciate the chance that Fogarty has given me to develop my own skill set and help turn my passion for global health research into a career."

Dr. Cameron E. Gaskill

Surgical resident,
University of Washington

Fogarty Fellow

Lowering tobacco consumption through research



Global efforts to curb smoking and secondhand exposure have increased, but so has the problem, with one person dying every six seconds because of tobacco use, according to WHO data. Alarming, new usage patterns are emerging, with women, young people and developing country populations taking up smoking at increasing rates.

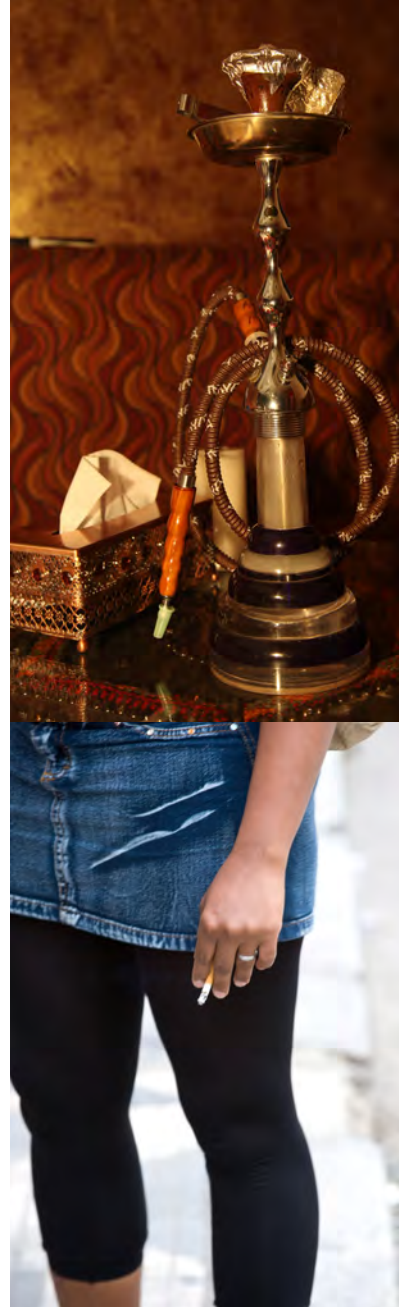
With tobacco use rising fastest in low- and middle-income countries (LMICs) that are least-equipped to tackle the associated health burdens from cancer and cardiovascular conditions, Fogarty established a new program to target the problem in 2002. The initiative has two distinct approaches—supporting observational intervention and policy research, as well as building capacity in fields such as epidemiology, behavior, prevention, treatment, implementation science and health services. Like many Fogarty programs, it encourages partnerships between LMIC and U.S. scientists, and emphasizes training and capacity building—the foundations of a robust research infrastructure.

“Our support has helped generate tobacco research capacity in many countries that had minimal or no quality data,” said Fogarty Director Dr. Roger I. Glass. “Establishing reliable epidemiological information is essential if countries are to develop a tobacco control program that will be cost-effective and have an impact on their at-risk populations.”



In its first decade of investments, Fogarty supported collaborations among investigators in more than 30 countries, trained at least 3,500 individuals and contributed to the publication of over 415 scientific papers. A number of program participants have reached leadership positions in their home countries, facilitating communication between researchers and policymakers and broadening recognition of the health burden from tobacco use. In Cambodia, for example, one grantee became an in-country WHO tobacco control representative and, in Laos, another became a finance ministry coordinator of the Southeast Asian Initiative on Tobacco Tax.

Projects have covered a wide range of topics, including study of behavioral, susceptibility and risk interventions. For instance, they counseled pregnant women in Argentina to avoid smoking, and successfully advocated for an indoor smoking ban in China. Other common topics have involved epidemiology and policy research, such as generating data on tobacco and cancer in Kenya. A few projects have examined economics, including strategies tobacco companies are using to promote products in Africa. One grant supported the world's first research demonstrating the dangers of consuming tobacco via waterpipes or hookahs. The findings are important for the U.S., where youth have increasingly adopted the practice with the mistaken belief it is a "cleaner" way to smoke.





Transforming African medical education



Medical education in sub-Saharan Africa is being revitalized and expanded through a U.S.-funded effort that is dramatically increasing enrollment, broadening curricula, upgrading internet access and incorporating cutting-edge skills training labs and other technologies.

Begun in 2010 with direct awards to African institutions in 12 countries, the Medical Education Partnership Initiative (MEPI) has empowered grantees to take ownership and responsibility to develop lasting resources that will improve the region's health care for decades to come. MEPI institutions have formed partnerships with other medical schools in their own countries, as well as with other MEPI grantees, creating a network that now includes representatives from some 40 member institutions, a quarter of sub-Saharan Africa's medical schools. Deans, faculty and other policymakers traveled frequently among sites to learn about successful programs they might also adopt and to relay their own experiences. Through these collaborations, they are leveraging resources and expertise so all can benefit from the lessons learned.

Funded by the President's Emergency Plan for AIDS Relief (PEPFAR) and NIH, MEPI is co-administered by Fogarty and the Health Resources and Services Administration. More than \$165 million has been invested, creating a movement and building a network of African health leaders. A new program, the Health-Professional Education Partnership Initiative (HEPI), will leverage achievements and lessons learned from MEPI with an additional \$37 million in funding over five years.



The critical shortage of physicians, researchers and health care workers across sub-Saharan Africa spurred MEPI's creation. While the region suffers 25 percent of the global burden of disease, it has only 3 percent of the world's health care workers, according to the World Health Organization. While serving as U.S. Global AIDS Coordinator with oversight of PEPFAR, Ambassador Eric Goosby was a strong proponent of the program and allocated much of the funding for MEPI's first phase.



Brain drain still takes a devastating toll on Africa's medical workforce, so MEPI funds supported research grants for faculty as both an enticement for them to remain in-country and also to ensure health care quality continues to improve as science evolves. That investment is already paying dividends. MEPI institutions currently receive support from about 150 NIH grants, double the level when the program began, reflecting their growing research capacity and ability to handle ethical review, manage financial programs, and compete in grant writing.

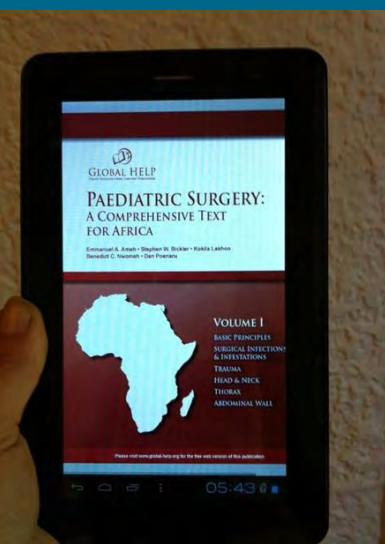
MEPI also expanded the subject matter included in curricula beyond infectious disease topics to include emergency medicine, mental health, surgery, cardiology, cancer, and maternal and child health. Developing expertise in these areas is critical to addressing current health challenges, as well as the rising tide of chronic illness sweeping the continent.

Another dramatic shift in MEPI institutions has been the adoption of information communication technologies (ICT) to enhance teaching methods and greatly improve students' access to electronic education materials and current journal articles. Some MEPI sites are supplying students and faculty with personal tablet computers loaded with medical books, national health guidelines and other valuable resources. Many are also deploying ICT to bring video recorded lectures, interactive procedure

BEFORE MEPI



AFTER MEPI



demonstrations and other e-learning materials to rural training sites. Because the need for health care workers is greatest outside urban areas, MEPI schools posted faculty and students at these remote locations to give them experience in community-based health care and offer local trainees quality mentorship.

In order to ensure the program's sustainability, participants were required to work in partnership with national education and finance ministers to encourage support and to align their goals with national health priorities.



There is growing interaction between MEPI and another major NIH initiative in Africa, intended to build expertise in genomics studies and support biorepositories and additional scientific infrastructure. The Human Heredity and Health in Africa (H3Africa) program, launched by NIH and the Wellcome Trust in 2010, has invested more than \$70 million so far.

Both H3Africa and MEPI were cultivated by the NIH Common Fund, the crosscutting NIH program intended to catalyze high-impact ventures that are broadly relevant to improving health. The expanding network of African researchers involved in the endeavors includes a number of alumni of Fogarty's research training programs.

"We are increasingly seeing synergies build in African research, as targeted training programs supported by Fogarty and other funders produce a cadre of scientists with excellent skills and knowledge who can then contribute to cutting-edge research across Africa," according to Fogarty Director Dr. Roger I. Glass.







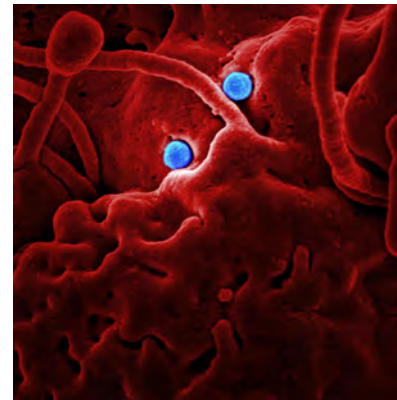
Modeling disease trends and predicting spread of outbreaks

To help guide policy decisions and disease outbreak responses, in 2000 Fogarty began building an in-house team of scientists to conduct research in the epidemiology and mathematical modeling of infectious diseases. Primary concentrations include cross-national studies of epidemiological patterns with special emphasis on influenza-associated disease, malaria and other vector-borne and vaccine-preventable diseases. Research outcomes have helped prompt changes in public health policies and practices to decrease disease burdens.

Leading an international collaboration to study flu

One of the group's first activities was to establish the MISMS project, originally called the Multinational Influenza Seasonal Mortality Study. Its aim is to advance understanding of flu virus transmission, vaccination practices, disease burden and evolution on a global scale through multinational collaborations.

The group's research findings have had significant policy implications. Assessments of the low effectiveness of vaccines among elderly populations have led to new strategies to optimize protection for vulnerable populations and decrease transmission. During the 2009 H1N1 influenza pandemic, MISMS scientists





were at the forefront, publishing key studies of the evolution of the virus in pigs, and research on the impact of the international trade of live swine on the spread of viruses. Other studies examined the role of tropical climates in the evolution and persistence of influenza viruses globally.

Investigating how malnutrition and disease impact child development

One in five children in developing countries experiences malnutrition, which is linked to

physical and cognitive impairment and greater risk of early death. Many children undergo repeated bouts of diarrheal disease, but the role this plays in their development is not well understood. To investigate these and other related issues, an international network of scientists, led by Fogarty and the Foundation for the NIH, was formed in 2009 to conduct an unprecedented study of early childhood health in eight countries on three continents.



Scientists hypothesize that childhood gut infections cause intestinal dysfunction that negatively impacts nutrient absorption, leading to stunted growth and cognitive deficits. They also suspect that repeated infections, combined with malnutrition, can undermine the effectiveness of vaccines. The \$45 million project, Etiology, Risk Factors and Interactions of Enteric Infections and Malnutrition and the Consequences for Child Health (MAL-ED), is funded by the Bill & Melinda Gates Foundation.



“ Modeling is a very cost-effective way of thinking about how to control an outbreak. It helps us to summarize our biological understanding, and suggests what key data we need to collect next. In RAPIDD, we were able to bring together preeminent researchers whose modeling work will impact policymaking long into the future.”

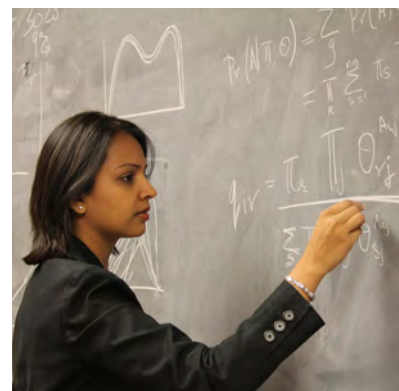
Dr. Bryan Grenfell
Princeton University
RAPIDD co-founder

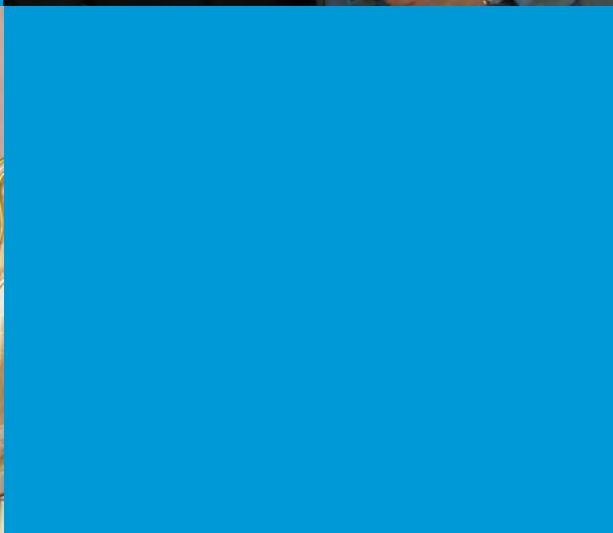
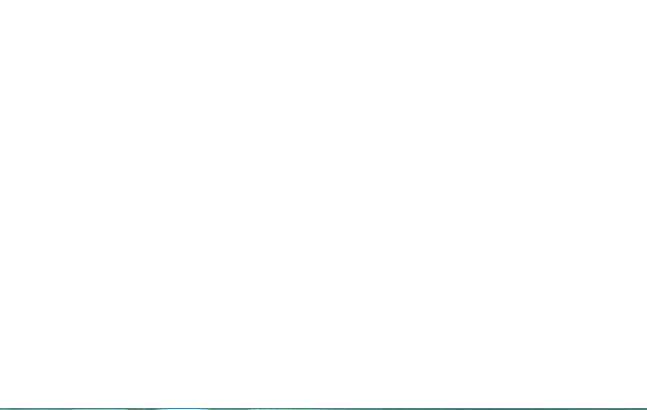


Disease modelers aim to inform policy decisions

Infectious disease outbreaks, such as Ebola and Zika, pose difficult decisions for policymakers who must decide how to most effectively deploy resources in response. Mathematical modeling can provide valuable clues in predicting how diseases might spread and how to best control them. To catalyze the field of infectious disease modeling, Fogarty formed the Research and Policy for Infectious Disease Dynamics (RAPIDD) group in 2008. Supported with funding from the Department of Homeland Security, RAPIDD researchers have published over 900 peer-reviewed papers and organized more than 100 workshops that have drawn at least 800 scientists from 40 countries. Another sign of the program’s success is that most of the group’s postdoctoral fellows have gone on to tenure-track faculty positions at top U.S. universities, where they are educating future generations of modelers to further strengthen the field.

RAPIDD is helping to narrow the gap between what modeling can do—provide information that allows scientists to compare strategies for tackling an outbreak and identify knowledge gaps—and the actionable data that policymakers seek.







Promoting science diplomacy for global health

Since its creation, Fogarty has served as a mini-State Department for the NIH, forging international partnerships between U.S. scientists and institutions and their counterparts abroad to advance research and training, as well as coordinating meetings for visiting heads of state, health ministers and others. Working closely with the State Department and the Office of Global Affairs at the Department of Health and Human Services, Fogarty has brokered hundreds of agreements between the U.S. and other countries.

Fogarty also conducts outreach to promote the economic and health benefits of science to foreign governments, encouraging ministers of health, education and finance to consider evidence for increasing investments in research and training. In recent years, a number of partnerships have been negotiated with other countries to support investigations that are jointly funded by both sides. In others, foreign governments have provided funding so their countries' scientists can gain experience working with experts on the NIH campus.

Fogarty also serves as the nexus for NIH engagement with international organizations such as the United Nations, World Health Organization, Global Alliance for Chronic Diseases and others. One of Fogarty's chief roles is to coordinate broad NIH input on health issues under consideration in intergovernmental discussions.

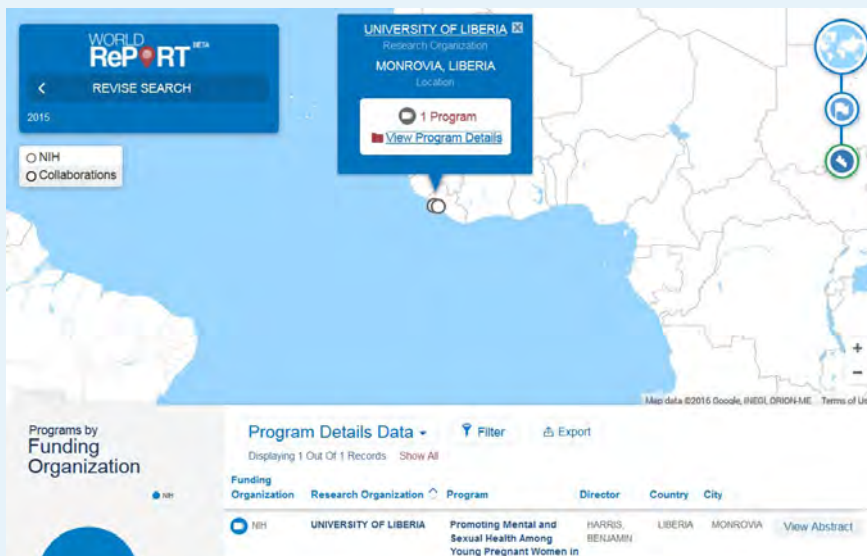




Notable partnerships formed with Fogarty's help include the Indo-U.S. Vaccine Action Program, which has for decades supported collaborations on lab research, epidemiological studies, field trials, vaccine quality control and delivery. Priority topics include dengue, enteric diseases, influenza, malaria and tuberculosis.

Another agreement facilitated by Fogarty is the South Africa-U.S. Program for Collaborative Biomedical Research, which supports U.S. and South African scientists to conduct research targeting HIV/AIDS, tuberculosis and HIV-related comorbidities and cancers. Scientists located at eight South African institutions are collaborating with investigators at more than 20 U.S.-based organizations, including NIH.

In the 1980s, Fogarty launched an Eastern European initiative to strengthen international collaborations and identify new openings to advance key areas of science at the end of the Cold War. U.S. researchers responded enthusiastically to opportunities to work with counterparts in Hungary, Poland and other Eastern bloc countries.



Fogarty helps produce resource to analyze global health funding

Fogarty helped NIH and other global funding partners to produce an online database and mapping tool of research projects funded globally. Known as World Report, the interactive, open-access site depicts investments and partnerships from some of the largest biomedical research funders. The project is intended to improve understanding of the research landscape, identify gaps in funding and areas where there might be a duplication of effort, and enable funders to synergize investments.

Studying global health science and policy

A tool for innovation and scholarship in global health science and policy



In 2012, Fogarty launched the Center for Global Health Studies (CGHS) as a physical and virtual space to support innovation and multidisciplinary scholarship and training to address pressing global health problems.

CGHS PROJECTS:

- Cut across the missions of multiple NIH Institutes and Centers and involve at least one NIH partner
- Engage collaborators from different sectors with unique expertise and resources
- Foster multidisciplinary and/or multisector approaches
- Produce concrete, implementable deliverables and recommendations for action
- Engage LMIC scientists, program implementers and/or policymakers

AREAS OF FOCUS:

Implementation science:



Projects develop new approaches and skills needed to better translate scientific evidence into health policy and practice. For example, the number of adolescents dying of AIDS is increasing even as the number of overall AIDS-related deaths are on the decline. To address this vulnerable population, CGHS has assembled a network of researchers, program implementers and policymakers to address the problem.

Projects develop new approaches and skills needed to better translate scientific evidence into health policy and practice. For example, the number of adolescents dying of AIDS is increasing even as the number of overall AIDS-related deaths are on the decline. To address this vulnerable population, CGHS has assembled a network of researchers, program implementers and



Scientific roadmaps:

Collaborations develop research agendas that tackle specific global health problems. For example, investments made in HIV, which have enabled millions of people living with HIV to live longer, healthier lives, are being undermined by the escalating epidemic of noncommunicable diseases (NCDs). To stimulate country-relevant research, CGHS has brought together researchers, implementers and government representatives to articulate practical goals, approaches, and a related research agenda to incorporate prevention, care and treatment for NCDs into HIV/AIDS platforms.



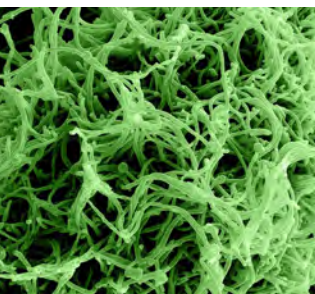
Scientific exchange and training:

Opportunities for U.S. and foreign investigators are offered, including mentored research projects, workshops, or short-term training institutes. For example, CGHS hosted the Global mHealth Research Training Institute at NIH in June 2016. The scenario-based training promoted multidisciplinary research, implementation science and novel research methodologies to a cohort of researchers from diverse fields.

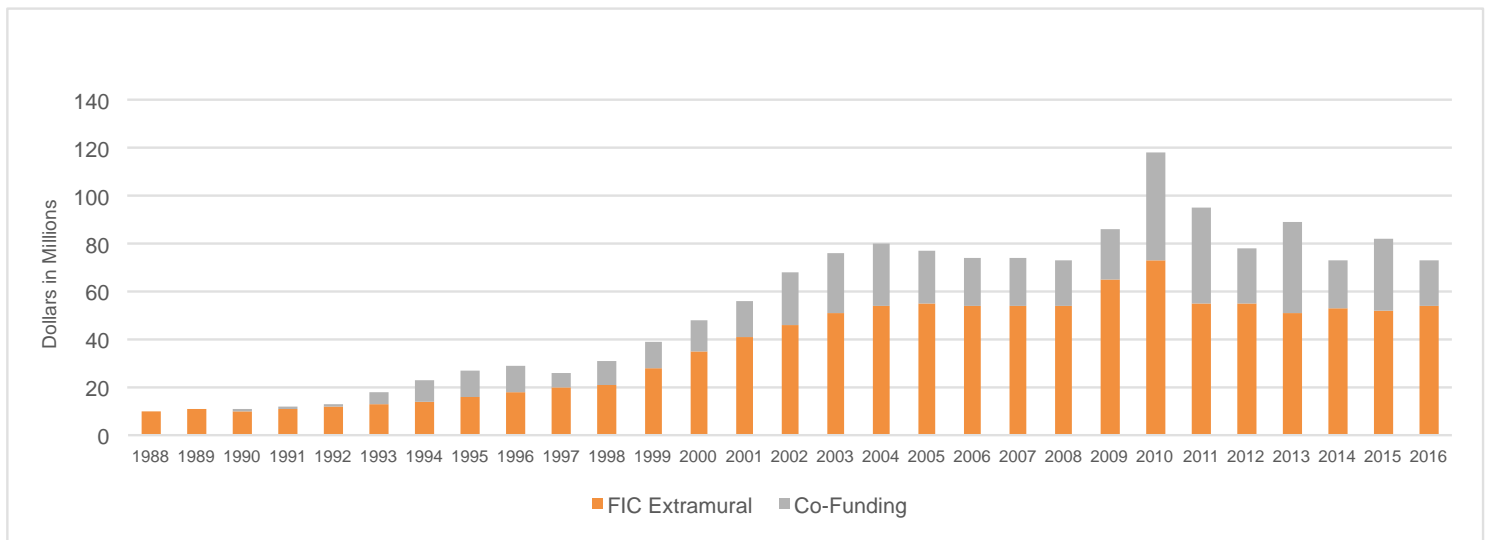


“We are often reminded in medicine that we can only do so much. But shortcomings are what drive our desire to do clinical research—to improve, to advance, to care—so that one day when someone is looking for a miracle, we can deliver.”

Dr. Jessica Manning
Fogarty Fellow in Mali



Expanding Fogarty's reach with NIH co-funding



Fogarty's extramural grants are leveraged with generous support—financial and otherwise—from many NIH Institutes and Centers, which greatly expands the reach and impact of Fogarty programs to advance science and build the next generation of global health leaders:

NIH Office of the Director

NIH Common Fund

Division of Program Coordination, Planning, and Strategic Initiatives (DPCPSI)

Office of AIDS Research (OAR)

Office of Behavioral and Social Sciences Research (OBSSR)

Office of Dietary Supplements (ODS)

Office of Research on Women's Health (ORWH)

National Cancer Institute (NCI)

National Eye Institute (NEI)

National Heart, Lung, and Blood Institute (NHLBI)

National Human Genome Research Institute (NHGRI)

National Institute on Aging (NIA)

National Institute on Alcohol Abuse and Alcoholism (NIAAA)

National Institute of Allergy and Infectious Diseases (NIAID)

National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)

National Institute of Biomedical Imaging and Bioengineering (NIBIB)

National Institute of Child Health and Human Development (NICHD)

National Institute on Deafness and Other Communication Disorders (NIDCD)

National Institute of Dental and Craniofacial Research (NIDCR)

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)

National Institute on Drug Abuse (NIDA)

National Institute of Environmental Health Sciences (NIEHS)

National Institute of General Medical Sciences (NIGMS)

National Institute of Mental Health (NIMH)

National Institute on Minority Health and Health Disparities (NIMHD)

National Institute of Neurological Disorders and Stroke (NINDS)

National Institute of Nursing Research (NINR)

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Clinical Center (CC)

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Center for Scientific Review (CSR)

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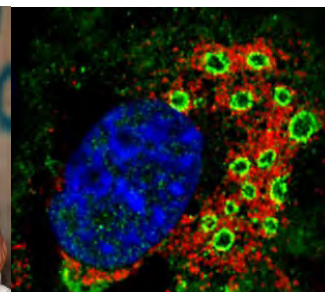
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