PUBLIC HEALTH

Implementation Science

Researchers and funders need to use systems approaches that are beginning to translate research not only to the bedside but also to global health programs.

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We face a formidable gap between innovations in health (including vaccines, drugs, and strategies for care) and their delivery to communities in the developing world. As a result, nearly 14,000 people in sub-Saharan Africa and South Asia die daily from HIV, malaria, and diarrheal disease (*1*), even though scientific advances have enabled prevention, treatment, and, in some cases, elimination of these diseases in developed countries.

Many evidence-based innovations fail to produce results when transferred to communities in the global south, largely because their implementation is untested, unsuitable, or incomplete. For example, rigorous studies have shown that appropriate use of insecticide-treated bed nets can prevent malaria (*2*), yet, in 2002, fewer than 10% of children in 28 sub-Saharan African countries regularly slept with this protection (*3*). Newer studies have shown that malaria incidence is decreased by distribution of free nets, but further research is needed to promote cost-effective, sustained access—particularly for the poor living in rural areas (*4*).

The same is true of strategies to prevent mother-to-child transmission of HIV. Although interventions like prophylactic antiretroviral therapy and replacement feeding have worked well in hospitals and clinics, increasing coverage in rural areas (where women have limited access to clean water and formal health care) may require testing of novel approaches, such as self-administration of drugs (*5*, *6*). Similarly, the scale-up of male circumcision, which has been shown to protect against HIV transmission in recent clinical trials (*7*), will require development of safe, culturally acceptable, and accessible methods for surgery and care (*8*).

The Implementation Research Gap

Why is effective implementation, particularly in resource-poor countries, such an intractable problem? The reasons are complex. First, scientists have been slow to view implementation as a dynamic, adaptive, multiscale phenomenon that can be addressed through a research agenda. Although randomized, controlled experiments are the gold standard for testing safety and efficacy of pharmaceuticals, health delivery schemes are less likely to be subject to rigorous scientific analysis.

A doctor seeing a patient through Progresa, Mexico's incentive-based development program that targets the very poor. By improving children's growth and nutrition, it has especially benefited those who lack health care. Its success in improving health outcomes depends on rigorous, scientific studies that established the effectiveness of new strategies.

Second, people living in poverty face a bewildering constellation of social constraints and health threats that make prevention and treatment more difficult. They often have limited knowledge of preventive health practices and insufficient or sporadic access to quality care. Their health systems are underfinanced, underregulated, and crippled by health-worker shortages. Even for those with access to care, health is routinely undermined by heavy pathogen loads, environmental exposures, inadequate sanitation infrastructure, and socioeconomic barriers to behavior change. Faced with such challenges, it is not surprising that public-health professionals have found it difficult to successfully adapt, implement, and sustain new interventions.

Although a few rigorous studies of implementation could advance the delivery of health care in low-income countries, recent billion-dollar increases in budgets for global health have provided only limited support for studies needed to ensure maximum impact (*9*). Instead, planners often assume that clinical research findings can be immediately translated into public health impact, simply by issuing "one-size-fits-all" clinical guidelines or best practices without engaging in systematic study of how health outcomes vary across community settings.

A Framework for Research Translation

Realizing the need for a quantitative, scientific framework to guide health-care scale-up in developing countries, researchers in health, engineering, and business are building interest in implementation science (*10*–*14*). Unlike routine applied (or operations) research, which may identify and address barriers related to performance of specific projects, implementation science creates generalizable knowledge that can be applied across settings and contexts to answer central questions. Why do established programs lose effectiveness over days, weeks, or months? Why do tested programs sometimes exhibit unintended effects when transferred to a new setting? How can multiple interventions be effectively packaged to capture cost efficiencies and to reduce the splintering of health systems into disease-specific programs? Answering questions like these will require analysis of biological, social, and environmental factors that impact implementation, both to develop and test communitywide, multisector interventions that are not testable in clinical settings, and to identify how proven clinical interventions should be modified to achieve sustained health improvements in the "real world." A few innovative studies have begun to appear (*15*).

One example is the research program coordinated with implementation of Mexico's 1997 reform of health and social services. Before reform, food subsidies and health care were provided by the Mexican government, largely without gains in public health and welfare.

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Frustrated with poor outcomes, the government worked with scientists to develop a multisector antipoverty program, *Progresa*, to help increase the uptake of existing nutrition and health services.

The new initiative provided conditional financial incentives for poor rural families, on the basis of their use of prenatal, child health, and nutritional services provided by local clinics. Because researchers were involved in the initial design, they were able to build a prospective, cluster-randomized experiment into the program's roll-out, revealing statistically significant improvements in child development as a result of the new initiative (*16*). Because these and other quantitative studies showed sustained effectiveness (*17*), conditional cash transfers have enjoyed continuous support of the Mexican government, despite radical changes in political leadership. Similar programs are being adopted by policy-makers throughout Latin America.

The West African Onchocerciasis Control Programme (OCP) is another example of how rigorous implementation research can amplify the public health impact of proven interventions. This decades-long initiative has used established vector elimination methods and communitywide drug treatment campaigns to control the nematode parasite that causes river blindness. However, the program is unique in that it has, from the beginning, integrated mathematical modeling into every aspect of implementation and ongoing operation (*18*). Modeling of strategies has enabled the OCP to package together tested interventions, without direct experimentation. It has also helped optimize interventions to match field conditions and has enabled scientists to better understand parasite transmission and host-vector interactions.

Many implementation experiments—particularly cluster-randomized trials and agent-based models that compare the population-level health impacts of different delivery strategies—can be coupled with the planning and roll-out of new programs by health ministries, making the cost of research marginal. They can also be used to model the potential gains of health-system designs, policies, and multisector interventions that cannot be tested experimentally. These approaches all require the involvement of scientists in early planning to ensure that research questions are incorporated into program design.

Identifying New Research Opportunities

Opportunities for learning about implementation are particularly promising for initiatives like the Global Fund to Fight AIDS, Tuberculosis, and Malaria; the U.S. President's Emergency Plan for AIDS Relief (PEPFAR); and the President's Malaria Initiative. To date, these programs have focused on trial-and-error optimization of health services, using descriptive studies, process evaluations, and monitoring to measure program outputs. More recently, they have expanded to include targeted evaluations, which use comparison groups to infer the likely impacts of interventions on community health. Among the questions they need to address are those relating to behavior change and HIV prevention; the effectiveness of orphan care services; the risk of drug resistance in the scale-up of antiretroviral and antimalarial therapy; and the packaging together of interventions for HIV/AIDS, tuberculosis, and malaria. Questions that focus on health-care providers and systems include how pay-for-performance schemes impact quality and cost of care, and how agent-based modeling of clinic and hospital operations can inform development of human resources for health.

Implementation Science for Global Health

There are three additional imperatives facing the research community. First, we must advance theoretical models and new analytic methods that apply to resource-poor settings. This may include, for example, developing frameworks for implementation that rely on existing social networks and markets for sustained health-care delivery, rather than the training of health workers—a limited resource in most developing countries. Multiple disciplines, from systems science and computer simulation to public health and behavioral economics, need to be integrated.

The World Health Organization's Special Programme for Research and Training in Tropical Diseases (TDR) has begun to address this need, through support of collaborative research grants in implementation research (*19*). For example, with funds from the ExxonMobil Foundation, TDR researchers are currently testing the impacts of health-care franchising (based on a micro-enterprise business model) on access to antimalarial drugs in Kenyan villages (*20*, *21*). Programs like these should be expanded. The U.S. National Institutes of Health is actively soliciting international research proposals for its ongoing initiative in Dissemination and Implementation Research in Health (*22*).

Second, we need to train a generation of researchers who can effectively bridge the implementation gap. This will require new curricula and interdisciplinary, systems-oriented approaches. Because some features of implementation are context-specific, it also calls for strengthening of research institutions in low-income countries.

A final imperative is for researchers to collaborate with developing country governments, nongovernmental organizations (NGOs), and communities. For example, the George Washington University School of Public Health and Health Services recently announced a partnership with the Elizabeth Glaser Pediatric AIDS Foundation, to help capture opportunities to integrate research into the delivery of HIV/AIDS prevention and treatment services supported by the foundation (*23*).

Although implementation experiments and computational modeling may be more complex—in terms of study design and data analysis—than the monitoring and observational studies currently funded by donors, any inconvenience is outweighed by the profound ability of scientifically rigorous findings to focus limited health resources and to save more lives.

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