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DISCUSSION PAPER

New, Cheap, and Improved

Assessing the Promise of Reverse and Frugal Innovation to Address Noncommunicable Diseases

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Acronyms

ACE	angiotensin-converting enzyme
CFR	Council on Foreign Relations
DAH	development assistance for health
EPO	erythropoietin
HIV/AIDS	human immunodeficiency virus / acquired immunodeficiency syndrome
HPV	human papillomavirus
ICT	information-communication technology
NCD	noncommunicable disease
NGO	nongovernmental organization
OECD	Organization for Economic Cooperation and Development
PEPFAR	President's Emergency Plan for AIDS Relief
WHO	World Health Organization

Introduction

In Mexico, a company called MedicallHome provides phone-based health services to more than five million people. For a five-dollar monthly fee, subscribers can reach a physician twenty-four hours a day, seven days a week. Participating physicians make their diagnoses pursuant to standardized clinical protocols. The service averages ninety thousand calls per month. Two-thirds of those inquiries are resolved over the phone and without a doctor's visit.[1]

In India, Aravind Eye Care, a hospital chain, performed 280,000 eye surgeries in 2011 at a per-patient charge of less than 2 percent what it would cost the United Kingdom's National Health Service. Aravind Eye Care has built its high-volume, low-margin business by standardizing the entire process from screening and diagnosis camps to recruiting traditionally difficult-to-reach rural patients, to surgical procedures, recovery, and discharge.[2]

In Indonesia, rural health clinics are using the Lullaby baby warmer, a device that General Electric (GE) developed specifically for use in Indonesia and in India. It costs less than one-quarter of the version that GE sells in the United States and monitors a baby's pulse and weight in addition to warming the child. The Lullaby Warmer has proven popular and now sells in sixty-two countries, including Belgium, Italy, and Switzerland.

These anecdotes are some of the best-known examples of what proponents describe as a larger global trend of frugal and reverse innovation. The notion that health technologies, services, and delivery processes developed for low-income customers in low-resource settings (known as "frugal innovations") might also prove useful in other countries and higher-income settings (a process some call "reverse innovation") is not new. In recent years, however, frugal and reverse innovations have gained attention as potential strategies for increasing the quality and accessibility of care while slowing the growth in health-care costs and improving health outcomes at the patient and population levels. No health challenge is in greater need of such a strategy than noncommunicable diseases (NCDs).

Once perceived to be the problems of wealthy nations alone, cancer, diabetes, cardiovascular disease, and other NCDs are now on the rise in every region of the world. Developed and developing countries alike are straining to cope with the staggering economic and social costs of these chronic diseases. With these costs projected to continue to increase, the World Economic Forum has ranked NCDs as a greater threat to global economic development than fiscal crises, natural disasters, and transnational crime and corruption.[3]

In addressing this shared challenge, there may be much that high-income countries can learn from their low- and middle-income country counterparts, and vice versa. Developing countries are leading the way in experimenting with lower-cost chronic care models. Pharmaceutical, medical device, and information technology companies operating in these countries are working to develop more affordable, simplified point-of-care diagnostics, therapies, and information technologies usable in low-infrastructure settings.

There is a sizable literature on frugal and reverse innovation, particularly its use as a business strategy.[4] Several smaller-scale initiatives have been created to encourage the identification of these innovations in health care and foster their dissemination internationally.

Increased attention on innovation is welcome—particularly when it is in service of improving the economic opportunities of the world's poorest and increasing their access to much-needed health-care products and services. The trick will be, however, to ensure that the focus on reverse and frugal innovation goes beyond the latest buzzword and translates into real investments and results on the most pressing health challenges facing the poor. With this goal in mind, it is important to answer three practical questions regarding reverse and frugal innovation and NCDs:

- Are reverse and frugal innovations likely to be important for addressing the NCD challenges facing the poor in high- and low-income settings?
- Which pressing NCD challenges are reverse and frugal innovations best suited to help solve?
- What measures can donors, private companies, and nongovernmental organizations (NGOs) take to facilitate the use of reverse and frugal innovations to solve those problems?

The answers may contribute to the ongoing efforts of donors, investors, nongovernmental institutions, and governments to move frugal and reverse innovation out of the realm of promising anecdotes and into broader practice to tackle the global challenge of NCDs.

Defining Frugal and Reverse Innovation

As interest in frugal and reverse innovation has increased, researchers and practitioners have come to use the terms differently, obscuring their meaning.[5] This paper will use the terms as follows.

"Innovation" includes the development and deployment of new technologies, services, and processes, such as delivery, procurement, or human resource management improvements.

"Frugal innovation" includes the use of new technologies, services, and processes designed or adapted for impoverished patients or health-care providers in settings with limited infrastructure. These innovations may include lower-cost versions of existing technologies or services, less infrastructure-dependent versions of existing technologies or services, or new technologies, services, and processes developed for low-resource patients or providers in low-infrastructure settings. Examples would include technologies, services, and processes that function in settings without reliable energy grids, and with limited-skilled health workers and high heat, humidity, and dust.

"Reverse innovation" is the deployment of frugal innovation developed first for use in other markets. This is broader than the standard definition of reverse innovation, which generally refers to high-income-country adoption of technologies, services, or processes developed for low-income-country use. The broader definition captures the flow of low-cost, less resource-intensive innovation among developing countries ("South-to-South") as well as from developing countries to their wealthier counterparts ("South-to-North").

The terms frugal innovation and reverse innovation are relatively new, but the underlying commercial phenomenon is not. More than a century ago, Henry Ford's assembly line began producing its simple, affordable cars and I. M. Singer & Company began selling its sewing machines through franchisees. These innovations have been continually adapted, improved on, and combined with new insights to lower the cost and increase the accessibility of other products, processes, or services globally. Lean business strategies pioneered in Japan helped systematically wring waste out of auto and consumer product manufacturing and spur the country's export-driven economic recovery after World War II. *Jugaad* entrepreneurs working in India today are finding low-tech solutions to satisfy the poor's unmet needs for goods and services and building thriving businesses in doing so.

The basic concepts behind frugal and reverse innovation are also not new to global health. The "appropriate technology" movement began in the early 1970s as a reaction to an infrastructure- and capital-intensive, technology-driven model of international development that dominated aid initiatives at the World Bank and bilateral donor agencies. Appropriate technology was cheap, easy to operate and maintain, and designed for a specific context and people.[6] The World Health Organization (WHO) established an appropriate technology program. A nonprofit founded to pursue this strategy in reproductive health—the Program for Appropriate Technology for Health—later evolved into PATH, one of the most successful international NGOs working in global health.

Donors and nonprofits have long sought to leverage potential markets or dual uses in high-income countries to subsidize the development and delivery of global health technologies to the world's poorest. A common example would be a profitable travelers' market for a drug or vaccine for a developing world disease such as malaria or yellow fever.

The novelty and promise of frugal and reverse innovation is its marriage of the innovation and entrepreneurial energy of large-volume, low-margin business successes of the past with the social objectives and context-driven focus of the appropriate technology movement. To start, frugal innovation has focused on addressing the unmet needs of low-income people, not just the broader public. Frugal and reverse innovations have also generally been employed as commercial strategies with customers, rather than charities with beneficiaries. The possibility that the health needs of the poor will be a sustainable business opportunity—and not an unending humanitarian obligation—is important for attracting investment and aid to ensure those needs are met. As business practices, frugal and reverse innovations have had significant success in low-income customer segments of large emerging economies, particularly India. It remains unclear if that model can be adapted to low-income countries or be used to significantly alter health-care provision in high-income countries.

Why Frugal and Reverse Innovation Matter on NCDs

As defined by the WHO, NCDs are a broad category of diseases and conditions that cannot themselves be spread from person to person, although some are caused by viruses or bacteria that can.[7] Within this category, several subgroups of illnesses dominate. Cardiovascular diseases, cancers, and chronic respiratory illnesses are responsible for most of the deaths from NCDs globally. Rates of diabetes are increasing the fastest. Mental illness is a leading cause of disability worldwide and its sufferers are more likely to smoke cigarettes, be obese, and have multiple NCDs.[8] As a group, NCDs are the leading cause of death and disability in every region of the world other than sub-Saharan Africa, although rates are rising quickly there, too.

Because NCDs are a challenge in poor and wealthy countries alike, there is the possibility of identifying the technologies, services, or delivery strategies that prove effective and cost-efficient in preventing, diagnosing, or treating an NCD in one setting and implementing them in other places as well. These opportunities are important for three reasons.

First, it is essential to find new and cheaper ways to prevent NCDs, diagnose them earlier, and treat them more efficiently and effectively. The chronic nature of most of these diseases and conditions means patients are sick and suffer longer and also seek and require more medical care and hospitalization. The resulting social and economic costs are staggering.

In high-income countries, the health-care costs have escalated since their populations underwent the epidemiological transition from infectious to chronic diseases after World War II. Over the past sixty years, increases in health-care expenditure in Organization for Economic Cooperation and Development (OECD) countries have, on average, exceeded gross domestic product (GDP) growth by two percentage points annually.[9] The growth in health-care costs will only become more unsustainable as populations in high-income countries age, requiring more chronic care over longer periods of time. Advances in science and technology are offering new possibilities for treatment, especially for many cancers and diabetes, but the costs are often high and may increase inequalities in access.

In low- and middle-income countries, the costs of NCDs are compounded by the onset of these diseases in younger populations. More than 90 percent of the NCD deaths in people age fifty-nine or younger occur in low- and middle-income countries—a total of eight million lives lost in 2013. This heavy burden of NCDs in adult working-age populations has devastating implications, not only for households and health systems but for labor forces and economies as well. For these reasons, the World Economic Forum projects that NCDs will inflict $21.3 trillion in economic costs in low- and middle-income countries by 2030.[10]

Second, the possibility of generating frugal innovations for use in high-income markets is an important incentive for more private and donor-country investment in addressing NCDs in low- and middle-income countries. Sales or reimbursement in wealthy markets can subsidize private investments in new technologies, services, or delivery strategies in lower-income countries. The opportunity to lower the costs of health and welfare programs or improve their effectiveness may help motivate and justify donor aid to counter NCDs in developing countries.

Lastly, there are many NCD-related challenges for which proven and scalable solutions do not yet exist. This is especially true for population-based prevention of many major risks for NCDs, includ-

ing obesity, physical inactivity, high salt consumption, and poor diet. The more countries that seek to address these challenges, the greater is the likelihood that successful and cost-effective solutions will be identified and adapted for use elsewhere. With less established health infrastructure and fewer regulatory constraints, many low- and middle-income countries and their governments and entrepreneurs are freer to experiment and innovate.[11]

Effective Demand for Frugal and Reverse Innovation on NCDs

Although the intuitive appeal of frugal and reverse innovation as a cost-effective means of countering NCDs is enormous, the effective demand for such innovations may be less so. Cost-effective tools already exist to prevent, diagnose, and treat many NCDs in low- and middle-income countries, but there is insufficient local political will and donor support to promote their adoption. Many manufacturers and providers in high-income countries possess the ability to develop and deploy frugal innovation, but lack the incentive to do so in markets where cost is not the primary driver of health-care decisions. Many health-care technologies and services are heavily regulated, especially in high-income countries, which limits the feasibility of their cross-country adoption.

To increase the likelihood of success and reduce the potential for wasting scarce resources, investments in frugal and reverse innovation should target the priority NCD needs of the patients and health-care providers who are most likely to use frugal innovations. The following broad conclusions outline the effective demand for frugal and reverse innovation to address NCDs:

- The potential for reverse innovation is greater in South-to-South than in North-to-South collaborations.
- There are pockets of opportunity for frugal and reverse innovation in high-income countries, particularly on information-communication technology and peer-support networks.
- Frugal innovation will need more donor support before it plays a significant role in addressing priority NCD needs in low-income countries and emerging economies.

These findings are based on a data-driven assessment of NCD treatment and prevention needs, a literature review, and the discussions and insights generated at a recent Council on Foreign Relations (CFR) workshop of experts and institutions on reverse and frugal innovation and NCDs.

THE POTENTIAL FOR REVERSE INNOVATION IS GREATER SOUTH-TO-SOUTH

Reverse innovation is a process fueled by common global needs and barriers. New products, services, and processes that address the unmet needs of lower-income patients and providers in one country are adopted or replicated in another country grappling with similar challenges. NCD rates are rising worldwide, but there are important differences in the NCD-related challenges faced by the poor in low- and middle-income countries and those in high-income countries. These differences may limit the scope of reverse innovation as an approach for addressing NCDs.

The mix of NCDs that are most prevalent in low- and middle-income countries differs from that in their wealthier counterparts. Cardiovascular disease, chronic respiratory diseases, sense-organ (i.e., hearing and vision) diseases, skin diseases, and congenital abnormalities represent a greater proportion of NCD-related death and disability in poorer nations (table 1).[12] The burden of cancers is relatively lower in these countries.

TABLE 1. PROPORTION OF NCD BURDEN GLOBALLY, ALL AGES, BOTH SEXES, BY COUNTRY INCOME, 2013

	Low income	Lower-middle income	Upper-middle income	High income
Cancers	10.92	9.04	16.51	19.54
Cardiovascular and circulatory diseases	21.08	24.85	22.54	18.28
Chronic respiratory illnesses	7.33	10.55	6.85	5.88
Cirrhosis of liver	3.05	3.38	1.94	1.79
Diabetes, blood, and endocrine disorders	10.70	11.26	9.21	8.67
Digestive disorders	3.69	3.65	1.67	1.76
Mental behavioral disorders	13.45	11.07	12.80	11.93
Musculoskeletal disorders	8.04	7.60	12.16	14.30
Neurological disorders	5.01	5.74	4.88	8.45
Other NCDs	16.74	12.84	11.24	9.42

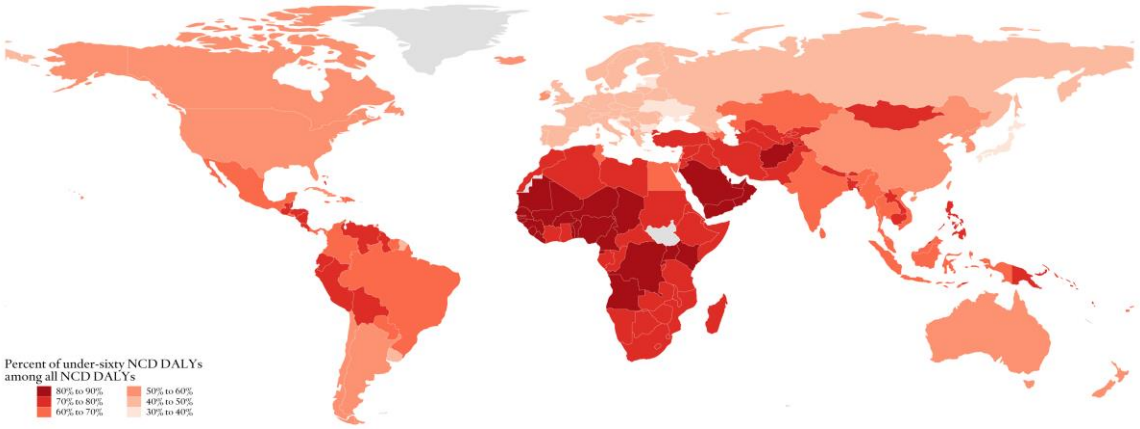
Data Source: Murray et al., Global Burden of Disease Study 2013, *Lancet* (2014).
Note: Due to rounding, the sum of the percentages listed in each column does not equal one hundred.

Within these broader disease groups, the particular NCDs that cause a large and disproportionate share of deaths in low- and middle-income countries include rheumatic, hypertensive, and ischemic heart diseases; asthma and chronic obstructive pulmonary disease; cerebrovascular disease; diabetes, stomach, and cervical cancers; and chronic kidney illnesses.[13] Low-cost and effective treatment and prevention tools already exist for all these diseases and are widely available in high-income countries, but not in many low- and middle-income countries.

Acute rheumatic fever is a leading cause of cardiovascular disease in sub-Saharan Africa, mostly affecting youth, and is generally caused by delayed or inadequate treatment of strep infections in children.[14] The principal medications for diabetes control—metformin and insulin—are long off patent, yet access remains limited in many low- and middle-income countries.[15] In wealthy countries, asthma is well managed with relatively inexpensive inhaled steroids and bronchodilators. Screening tests for *Helicobacter pylori* and treatment with antibiotics have dramatically cut stomach cancer deaths in high-income settings. Safe and highly effective vaccines exist for human papillomavirus (HPV), which causes the vast majority of cervical cancers.[16] Off-patent medications such as diuretics, calcium channel blockers, angiotensin-converting enzyme (ACE) inhibitors, and beta-blockers have helped reduce mortality from stroke and coronary heart disease by as much as two-thirds in many high-income countries, but are often unavailable in many developing countries.[17] Erythropoietin (EPO) and other erythropoiesis-stimulating agents are the primary means of treating chronic kidney disease, but are unavailable and unaffordable to most patients in low- and middle-income countries.

The age groups affected by NCDs are also younger in low- and middle-income countries. In sub-Saharan Africa and parts of South Asia, 80 percent or more of the death and disability from NCDs arises in people fifty-nine years of age and younger.[18] In high-income countries, 13 percent of NCD deaths occur in this age cohort; in low-income countries, that proportion is three times higher (figure 1).[19] Overall, the WHO estimates that developing countries account for 90 percent of the nine million premature deaths from NCDs.[20]

FIGURE 1. PROPORTION OF DEATH AND DISABILITY FROM NCDS THAT ARISES BEFORE AGE SIXTY



Source: Council on Foreign Relations (2014), based on data from the Institute for Health Metrics and Evaluation's Global Burden of Disease Study (2010).

There are some significant differences in NCD-prevention needs among low- and middle-income countries as well. Table 2 lists the importance of the major behavioral and metabolic risks for NCDs. The numbers reflect the rank of that NCD risk factor among all health risks for that region. Diet is the leading health risk in most regions, but the driver in many low- and middle-income countries is different: inadequate access to fruits, vegetables, and legumes.[21] This shift in diet is especially prevalent in East and Southeast Asia and sub-Saharan Africa and is associated with diabetes, heart disease, certain cancers, and a surprisingly high number of deaths globally (2.7 million annually).[22] Household air pollution, caused by the burning of fuels indoors, is a leading health challenge in poor countries, whereas physical inactivity and obesity are not yet. Tobacco use, on the other hand, is a leading killer worldwide.

TABLE 2. THE REGIONAL IMPORTANCE OF MAJOR BEHAVIORAL AND METABOLIC RISKS FOR NCDS

	High-Income Asia-Pacific	Western Europe	Australia and New Zealand	High-Income North America	East and Southeast Asia	South Asia	North Africa and Middle East	East and Central Europe and Central Asia	Latin America and Caribbean	Sub-Saharan Africa	Oceania
Dietary risks	1	1	1	1	1	1	1	1	1	7	5
High blood pressure	2	3	4	4	2	4	2	2	2	6	6
Smoking	3	2	3	2	3	3	4	4	6	8	3
Household air pollution	24	24	24	24	4	2	16	3	11	2	4
Excessive alcohol	5	7	8	7	6	11	13	5	4	4	9
High body mass index	7	4	2	3	8	13	3	8	3	15	2
Ambient air pollution	8	9	16	10	7	7	7	9	16	13	21
Physical inactivity	4	5	5	6	9	12	6	6	7	17	7

Data Source: Institute for Health Metrics and Evaluation's Global Burden of Disease Study (2010).

The picture that emerges from assessing disease burden and health risks is that the expanding NCD crisis in low- and middle-income countries is driven by poverty, limited health-care systems, and inequitable access to the cheap and effective treatment and prevention tools already in wide use in wealthier settings. Most health systems in developing countries are built for acute care, not chronic or preventative care. Medicines are purchased out of pocket in many countries and are often unaffordable to the poor. Skilled health workers are in short supply. Government health spending tripled over the last twenty years in developing countries, but remains low. Health spending by all developing-country governments, representing 5.7 billion people, is less than is spent by the governments of Canada, France, Germany, and the United Kingdom, with a total population of 245 million.[23] With little access to preventative and diagnostic care, working-age people in developing countries are more likely to develop an NCD. Without access to chronic care and limited household resources to pay for medical treatment, these people are more likely to become disabled and die young as a result.

In this context, the priority needs for frugal innovations on NCDs are many. Cheaper point-of-care diagnostics that could be used by unskilled health workers or patients would help better identify chronic-care needs earlier in their disease progression when they are cheaper and more successfully treated. Standardized protocols for the pharmacologic treatment of hypertension and other NCDs with existing low-cost medicines would help ease their adoption and control rates in poor countries. A polypill, a combination of generic cardiovascular disease medications, could help improve patient adherence to treatment regimes and lower their cost. Identifying new ways to expand existing global health procurement and treatment platforms—such as the President's Emergency Plan for AIDS Relief (PEPFAR)—to include hypertension, diabetes, and chronic respiratory illness medicines would help ensure their quality, safety, and consistent supply. Developing basic mental health treatment packages for low-resource settings, including generic antidepressant and antipsychotic medications, would help their integration into primary-care platforms. Technical assistance and pilot funding can help policymakers adapt tobacco-control measures to local needs. More private-sector involvement and innovative partnerships with developing-country entrepreneurs might help generate cleaner, low-cost stoves that respond to local needs, tastes, and customs. Developing incentives for smallholder production, promoting urban gardens, and integrating nutrition and healthy-diet promotion into primary care could help slow the forces shifting diets in poor countries away from fruits, vegetables, and legumes.

The priority needs for frugal innovation to address NCDs in high-income countries are to reduce the high cost of treatment, improve disease management (especially among the many patients with multiple NCDs), and implement population-based prevention for skyrocketing rates of obesity, physical inactivity, and excessive alcohol consumption. Frugal innovations of medical technologies for NCD diagnosis and treatment are still useful in this context, especially as stopgap or backup measures in remote settings, during power outages, and in transit while receiving ambulance services. These innovations seem unlikely to alter the overall cost structure of risk-adverse health systems where decision-making is driven by precedent, quality considerations, and fear of liability. Regulatory hurdles are a significant challenge to new medical technologies, especially those developed and manufactured in countries with still-nascent oversight. The acceptability of health-care-delivery innovations are limited in high-income countries by regulatory and licensing requirements that restrict who can provide services, the method of payment, and the context where that service must be performed.[24]

For these reasons, the portability of frugal innovation will be greater between low- and middle-income countries with more similar NCD challenges and fewer regulatory or legacy restrictions on the products, services, and processes deployed to address them. That said, there are important areas of possibility for reverse innovation between developed and developing countries, which should be explored.

REVERSE INNOVATION, INFORMATION-COMMUNICATION TECHNOLOGY, AND PEER-SUPPORT NETWORKS

Two areas are particularly promising for frugal and reverse innovation for NCDs in lower- and higher-income countries alike: information-communication technology (ICT)-enabled health care and patient-care management and support networks that use community health workers, peer-to-peer, or self-management strategies. In many settings, innovations in these areas will be used in combination.

ICT-enabled health care is the use of mobile phones, telephone networks, video conferencing, cloud computing, and other Internet and communication technologies to provide needed health services. For instance, the American Society for Clinical Pathology is working with Partners in Health, the Institute for Health Metrics and Evaluation, and other partners to provide cancer pathology services in African countries via a cloud-based network of pathologist volunteers and a web-based link to conventional computers or cell phones in those countries.

Such ICT-enabled health-care programs have the potential to achieve all three of the primary goals of health care: improved quality of care, increased access, and reduced cost. By remotely linking physicians directly to patients or through less-skilled health workers, patient access to high-quality health-care services can increase dramatically, especially in rural settings and for services that require a specialist. In turn, reducing the need for travel, in-patient visits, and brick-and-mortar facilities reduces health-care costs. Centralized, ICT-enabled health care allows for greater standardization and use of common protocols, which lowers costs and can improve patient outcomes.

One reason ICT-enabled health care and patient management networks are promising areas for reverse and frugal innovation is that the underlying infrastructure and equipment already exists in wealthy and poor countries alike. Mobile phones are nearly ubiquitous globally. In settings where patients lack reliable Internet access and smartphones, community health workers, nurses, or volunteers may be equipped with them.

The regulatory, accreditation, and licensing barriers to the use of ICT-enabled health care exist in high-income countries, but are proving navigable. It helps that the concept of telemedicine, or the remote provision of medical care by means of audiovisual technology, is not new. It has been used to provide radiological and pathology services for more than thirty years.[25] In 2012, nearly half of U.S. hospitals reported having active telemedicine programs in fields as diverse as dermatology, neurology, and intensive care.[26]

ICT has been a particularly important enabler in the emerging economies of Brazil, India, and South Africa, and companies are beginning to extend their programs internationally. Clickmedix, a U.S. company supported by a partnership of medical schools, multinational companies, and NGOs, is launching smartphone-based health-care services. These services have been piloted in fifteen countries ranging across the development spectrum from Bangladesh, Peru, and Uganda to China, Taiwan, and the United States, reaching more than seven hundred thousand patients.[27]

Care for chronic conditions invariably involves patients managing their own day-to-day care. This is especially challenging for patients with multiple NCDs, which is often the case in many high-income countries. Networks to support and involve patients in their chronic care have gained currency in both high- and low-income countries. These networks may involve community health workers, peer patients, or education-support self-management.

Community health-worker programs have long been used successfully to extend and monitor chronic care among vulnerable populations. Partners in Health used this strategy to provide chronic care for HIV/AIDS and drug-resistant tuberculosis in shantytowns in Haiti and in the highlands of Peru.[28] The Department of Public Health for King County and Seattle has used this model to support vulnerable patients with type 2 diabetes.[29]

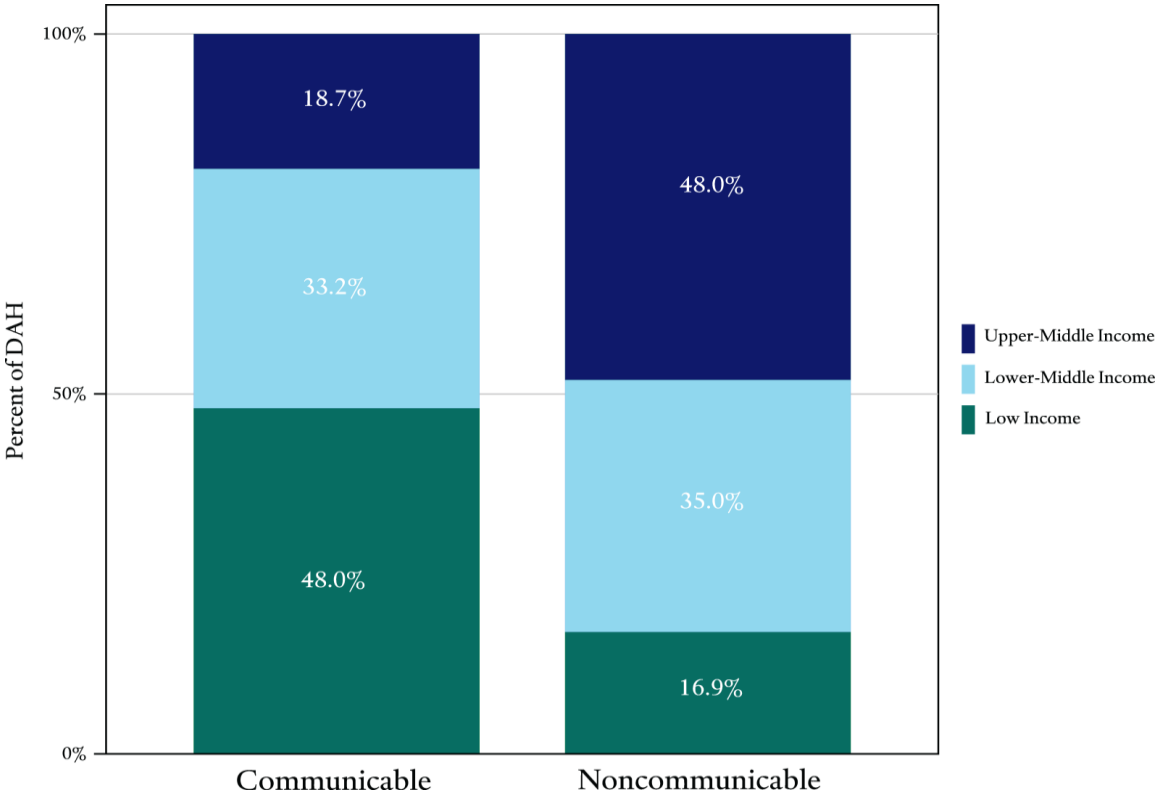
Peer networks, which link patients to volunteers with the same condition, were used extensively in international programs on HIV/AIDS, but are increasingly being used for diabetes management.[30] Education-supported patient self-management programs have existed for more than a decade in the United States, but are being adapted to support chronic care in low-resource settings in developing countries.[31] For example, an asthma self-management program in Tonga has demonstrated promising early results.[32]

FRUGAL INNOVATION IN LOW-INCOME COUNTRIES

Addressing the unmet NCD-related needs of the poor in low-income countries will be impossible without frugal innovations to extend and improve access to low-cost, quality care. However, it remains unclear whether needs could be met through an increase in frugal innovation alone. Innovations, even when low cost, must be funded, developed, and deployed. This requires resources. Outside of donor-funded global health initiatives, chronic- and preventative-care platforms are limited in low-income countries. Health spending by developing governments is increasing, but remains low especially in the poorest nations.[33] All the governments in sub-Saharan Africa together spend roughly as much on health annually ($33 billion) as the government of Poland ($31 billion).[34]

International donors have not yet risen to the NCDs challenge. The U.S. government currently has no dedicated NCD programs and devotes less than a tenth of 1 percent of its global health aid budget to NCDs.[35] Overall, NCDs received only 1.7 percent ($611 million) of global health aid in 2011 ($35.9 billion).[36] Most of that aid is not directed to low-income countries (figure 2). In contrast to aid for infectious diseases, which favors the poorest nations, less than one-fifth of international aid for NCDs targets low-income countries.[37] Most of that aid is dedicated to tobacco control and cancer treatment and prevention, rather than clinical prevention, diagnosis, or treatment of cardiovascular diseases, diabetes, and chronic respiratory illnesses.[38]

FIGURE 2. DISTRIBUTION OF DEVELOPMENT ASSISTANCE FOR HEATH (DAH) BY COUNTRY INCOME AND DISEASE TYPE



Data Source: Joseph Dieleman et al., "Tracking Development Assistance for Health From Source to Health Focus Areas, 1990–2014," *Journal of the American Medical Association*, forthcoming.

Without increased donor support for NCDs, or expanding existing global health programs to include priority needs, the effective demand for frugal innovation on NCDs in low-income countries is likely to be quite limited.

Recommendations for Facilitating Frugal and Reverse Innovation

Frugal and reverse innovations have significant potential to transform the international response to NCDs, lowering the cost of preventative, diagnostic, and chronic care, improving its quality, and expanding its access among poor and impoverished communities. Achieving that potential requires assessing soberly the limitations of frugal and reverse innovation in the NCD context and channeling resources to those innovations most likely to address the pressing NCD challenges of the poor and to the health-care providers most likely to deploy them. The following strategies would help facilitate these innovations.

Use incentives to channel and target frugal and reverse innovations to priority NCDs. Bilateral and philanthropic donors should come together to use their collective purchasing power to stimulate private-sector investment and harness their skills in the development of important health technologies and scaling up of manufacturing and delivery. The advanced market commitment, for example, is a contractual commitment that donors have used to attract and subsidize the provision of products that meet the defined technical specifications and requirements of their most likely adopters.[39] The National Cancer Institute is using modest phased innovation awards to encourage the adaptation, application, and validation of existing or emerging technologies in low- and middle-income countries.[40] More such programs are needed on other priority NCD challenges.

Foster targeted peer networks to identify and spread reverse and frugal innovations to their most likely adopters. The fundamental challenge of innovation is to link people, ideas, and resources. Entrepreneurs, health workers, and government officials who generate new products, services, or process solutions to address an unmet local NCD have limited time and incentive to publicize that innovation internationally. Curated networks and conferences can provide opportunities for mentorship and connect innovators and researchers to their peers and donors and investors. The networks should prioritize South-to-South collaboration and channel interest to priority needs. Here, too, financial incentives such as Grand Challenge programs can help generate and maintain interest in participation. Innovations in Healthcare at Duke University, formerly the International Partnership for Innovative Healthcare Delivery, is doing excellent early work in this space and deserves support.

Use cost-effectiveness assessment to drive adoption of reverse and frugal innovation. Health-care spending per capita has risen 70 percent in OECD countries since the early 1990s. With rising rates of chronic disease and aging populations threatening to drive these costs even higher, many high-income countries are turning to cost-effectiveness analyses to make decisions on health technologies and services. The Bill & Melinda Gates Foundation is funding projects by the UK National Institute for Health and Care Excellence and the Tufts Center for Health Decision Science to adapt and extend these programs for use in global health programs in low- and middle-income countries. These programs should be expanded to include potential frugal innovations for NCDs, which help promote their local adoption.

Expand donor platforms to address NCDs. NCDs are increasing in the same countries and populations that U.S. and international initiatives target for other global health concerns. A recent CFR-sponsored Independent Task Force assessed the forty-nine countries in which the U.S. government devoted five million dollars or more in aid for health in 2013, determining that NCDs accounted for 3.5 times more premature deaths than HIV/AIDS and 1.6 times as many premature deaths as malaria, tuberculosis, and HIV/AIDS combined. If the United States and donors are interested in the welfare of these countries and populations, the global health treatment and procurement platforms should be expanded to include NCDs. Until that occurs, prospects are limited for reverse and frugal innovation targeting NCDs in these countries and for the patients with chronic diseases who need them.

Conclusion

The promise of frugal and reverse innovation is real, but should not be oversold as the solution to the unsustainably rising rates of NCDs in high- and low-income settings. Many cost-effective tools already exist to address NCDs in low- and middle-income countries and need not be reinvented, but frugal and reverse innovations can help expand timely access to those tools in low-resource settings. Political dysfunction, path dependency, and a lack of structural incentives for cost cutting keep health care expensive in developed countries, but frugal and reverse innovations can expand access and the quality of care to vulnerable and remote populations. Important initiatives exist to promote frugal and reverse innovation in health, but more is needed. These recommendations and strategies suggest a feasible way forward. The time to act is now.

About the Author

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