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# Health Innovation Networks to Help Developing Countries Address Neglected Diseases

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\* The authors represent most of the participants from a meeting held in Bellagio during May 2004, as well as experts on global health and innovation systems who have advised on the development of the concepts that are presented.

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## Summary

There is a great unmet need for health technologies to address diseases of the poor in developing countries. At the same time, there is a rapidly growing capability to undertake health innovation\* in many developing countries (Innovative Developing Countries - IDCs). The more advanced IDCs have the greatest capacity to develop, manufacture, ensure safety, and market new health products and to develop, test and introduce new health policies or strategies. They are distinguished by their rapidly growing strength in health innovation as illustrated by increasing patenting and publishing activities; increasing investments in technology by both the public and private research based sectors; rapidly growing number of health technology companies†; and proactive health systems able to analyze, evaluate and adopt new practices and technologies.

This innovation capability provides a currently underleveraged opportunity to accelerate the development of new products, policies or strategies for diseases of the poor. We are therefore calling for the formation of an *Initiative for Health Product Innovation in Developing Countries*. Its primary mission will be to accelerate the translation of new knowledge into health innovations relevant to the diseases of the poor and to economic growth, taking into account national priorities and sensitivities. The Initiative could promote innovation, within and among IDCs, through programs to: (i) support research on health innovation systems; (ii) promote collaboration and coordination among countries to develop, disseminate and implement good practices and policies; and (iii) implement demonstration projects.

Such an Initiative would help maximize existing and growing investments by developing countries in health research, and complement global efforts to address health disparities and achieve the Millennium Development Goals.<sup>1</sup>

## Southern Needs, Northern Response and Global Strategies

Recent evidence shows that improved health is more than a consequence of development. It is a central input into economic and social development and poverty reduction. Good health, economic development and individual economic well being are intimately interdependent. The importance of investing in health cannot be overstated.<sup>2</sup> The magnitude of the health problems facing the poor in developing countries are immense.<sup>3,4</sup> Approximately 10 million children die each year with “under-nutrition as an underlying cause of child deaths associated with infectious diseases, the effects of multiple concurrent illnesses, and recognition that pneumonia and diarrhea remain the diseases that are most often associated with child deaths.”<sup>5</sup> In addition, global health experts are increasingly recognizing the growing relative importance of chronic diseases in the developing world where, in contrast to the infectious diseases that primarily affect children, the elderly are the most vulnerable. Chronic diseases are the world’s largest cause of

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\* We use the term ‘health innovation’ to include the development of new drugs, vaccines and diagnostics as well as new techniques in process engineering/manufacturing and new approaches/policies in health systems and services.

† Throughout this paper, we will refer to specific developing countries. These are illustrative and there are many additional countries with strengths in innovation.

death with 29 million deaths worldwide. The leading chronic diseases are cardiovascular disease, cancer, chronic respiratory disease, and diabetes.<sup>6</sup>

There are many interventions and strategies for improving health including strengthening health systems to improve the delivery of goods and services, education about desirable individual behavior, and introduction of water and sanitation systems. However, limitations of existing technologies, or the absence of appropriate technologies and other innovations, impede the achievement of desired health improvement goals. All health interventions draw upon innovations as essential tools to achieve the desired health improvement outcome. Such innovations include vaccines to prevent HIV, malaria, respiratory, and diarrhea (?? Please check) diseases; drugs to treat TB, malaria, cancers, and diabetes; other hardware such as weighing scales; software such as disease surveillance systems; and diagnostics and medical devices. These are a necessary part of a broader package of interventions including improvements in health delivery, surveillance, and policy formulation to improve the health of those most in need in the developing world.

Efforts to accelerate the development and distribution of health products for diseases of the poor have intensified over the past decade. Product development public private partnerships (PD-PPPs) have been established to develop new vaccines and drugs against HIV, malaria, TB , diarrhea and other infectious diseases, and related diagnostics and medical devices. These partnerships include the International AIDS Vaccine Initiative (IAVI), the International Partnership for Microbicides (IPM), the Medicines for Malaria Venture (MMV), the Malaria Vaccine Initiative (MVI), the Global Alliance for TB Drug Development (TB Alliance), the Aeras Global TB Vaccine Foundation, the Foundation for Innovative New Diagnostics (FIND), the Drugs for Neglected Diseases Initiative (DNDi) and the Institute for OneWorld Health. These initiatives have made significant progress, but are still relatively young and have therefore not yet achieved their intended goals.<sup>7</sup>

In addition to the PD PPPs, major global funds have been also established over the past five years to procure and distribute existing drugs and vaccines. These include the Vaccine Fund that works with the Global Alliance for Vaccines and Immunizations (GAVI) and the Global Fund to Fight AIDS, Tuberculosis and Malaria. Sustained and increasing support from donors will be needed for product development and procurement efforts to have their desired impact over the next decade. Access by the poor, either to existing or new products, depends upon numerous factors, but especially health delivery systems. The need for more attention, research and resources in this area was the subject of the annual Global Forum for Health Research, and the WHO-Mexico Ministerial Summit on Health Research, both held in Mexico City November 16-20, 2004.

### **Growing Capabilities of Developing Countries in Health Innovation**

One commonly identified impediment to effective health systems in developing countries is the difficulty of translating promising product concepts into affordable and accessible products. However, at least in some developing countries, this difficulty is beginning to be addressed. The rapidly growing health innovation capabilities of some developing countries represent a phenomenon that should complement the PD PPP efforts described above.

The concept of “health innovation systems” encompasses interlinked components including education, R&D, manufacture, domestic and export markets, intellectual property (IP) management, regulatory systems and the national policies that affect all of these (including public-private partnerships)<sup>8 9</sup>. An effective health innovation system, extending from concept research through delivery at the program and health systems level, depends upon the design and implementation of policies that recognize the dynamic linkages among all components of the system.

Developing countries themselves are building innovative capacity for new health technologies, products and services. Collectively they already invest at least \$2.5 billion per year in health research.<sup>10</sup> This compares with about \$200 million per year by various PD PPPs.<sup>11</sup> Public and private sectors in some developing countries are also working to build innovative capacities through the establishment of IP management systems, drug and vaccine manufacturing facilities, and regulatory capabilities.

Some developing countries are more scientifically advanced and have the greatest capacity to develop, manufacture, ensure safety, and market new health products. Innovation can occur in any locality, and this paper highlights recent dramatic progress in a few advanced “innovative developing countries.”<sup>12</sup>

Mashelkar has introduced a construct for understanding the special category of (??please check; I thought we don’t need the word ‘advanced’ here) IDCs (Table 1).<sup>13</sup> This modular construct adds nuance to the usual dichotomy between rich and poor countries. Countries could be arrayed along a continuous spectrum from higher to lower economic strength, and from higher to lower innovation capability. While economic strength is easily measured, and reasonably well-understood, innovation capability presents more difficulty.

**Table 1. Economic Strength and Innovation Capability (adapted from Mashelkar)**

		<i>Low</i>	<i>High</i>
		<b>Innovation Capability</b>	
<b>Economic Strength</b>	<i>High</i>	Natural Resource Rich Countries and small OECD countries	G8
	<i>Low</i>	Least Developed Countries and other non-IDC Developing Countries	Advanced IDCs

Advanced IDCs are the countries in the lower right quadrant.<sup>14</sup>  
Economic strength is measured by GDP per capita.

(then, who are the non-advanced IDCs? Or, We had better define clearly them before here)

Given the complex set of activities involved in the innovative process, measurement of “innovative capability” must be based on several indicators. Cross-country comparative data for a broad set of measures are limited. One often used measure of innovation is the number of US

patents issued.<sup>15</sup> Innovative efficiency, by extension, may be measured by the number of US patents per GDP/capita. Patents do not necessarily translate into products, and US patents represent only a subset of all innovation in a country. Thus, while instructive, this is an indirect measure of innovation capability. However, because of the global dominance of US markets, it has the advantage of creating a common yardstick against which to measure all countries.

Table 3 shows the top 25 countries in the world by rank order, analyzed for health related inventions only. Note that India and China are at 3<sup>rd</sup> and 4<sup>th</sup> places. Other developing countries on the list are Brazil, South Africa, Thailand, Malaysia, Indonesia and Argentina (in rank order).

Table 3. US patents, GDP per capita, and US Patents per GDP/capita, 2003

	Country	Country classification(*)	US Patents	GDP per capita	US patents per GDP per capita
1	United States	G8, OECD	50000 (est.)	36,006	1.389
2	Japan	G8, OECD	36889	31,407	1.175
3	<i>India</i>	<i>Advanced IDC</i>	<i>444</i>	<i>487</i>	<i>0.913</i>
4	<i>China</i>	<i>Advanced IDC</i>	<i>724</i>	<i>989</i>	<i>0.732</i>
5	Germany	G8, OECD	12960	24,051	0.539
6	Korea, Rep.	OECD	4246	10,006	0.424
7	France	G8, OECD	4906	24,061	0.204
8	Canada	G8, OECD	4368	22,777	0.192
9	United Kingdom	G8, OECD	4920	26,445	0.186
10	Italy	G8, OECD	2147	20,528	0.105
11	<i>Brazil</i>	<i>Advanced IDC</i>	<i>209</i>	<i>2,593</i>	<i>0.081</i>
12	Israel	HIE	1231	15,792	0.078
13	Sweden	OECD	1958	26,929	0.073
14	<i>South Africa</i>	<i>Advanced IDC</i>	<i>142</i>	<i>2,299</i>	<i>0.062</i>
15	Australia	OECD	1105	20,822	0.053
16	Switzerland	OECD	1917	36,687	0.052
17	Belgium	OECD	1055	23,749	0.044
18	Finland	OECD	945	25,295	0.037
19	Austria	OECD	657	19,749	0.033
20	<i>Thailand</i>	<i>Advanced IDC</i>	<i>64</i>	<i>2,060</i>	<i>0.031</i>
21	Singapore	HIE	564	20,886	0.027
22	<i>Malaysia</i>	<i>Advanced IDC</i>	<i>95</i>	<i>3,905</i>	<i>0.024</i>
23	<i>Indonesia</i>	<i>Advanced IDC</i>	<i>19</i>	<i>817</i>	<i>0.023</i>
24	<i>Argentina</i>	<i>Advanced IDC</i>	<i>64</i>	<i>2,797</i>	<i>0.023</i>
25	Mexico	OECD	129	6,320	0.020

(\*) G8: Group of 8; OECD: Organization for Economic Cooperation and Development; HIE: High-Income Economy (cf. World Bank); IDC: Innovative Developing Country



The productivity of advanced IDCs is a relatively new phenomenon which may contribute to the relative lack of attention it has received. Figure 1 shows the growth in numbers of US patents by inventors from several advanced IDCs\* from 1990 through 2003 where the words drug, vaccine, or pharmaceutical appear in the patent abstract.<sup>16</sup> The rate of patenting was relatively constant during the first half of the 1990s, but accelerated dramatically after 1996.

**Figure 1: Selected countries' inventors' US patents in drugs, or vaccines or pharmaceuticals**

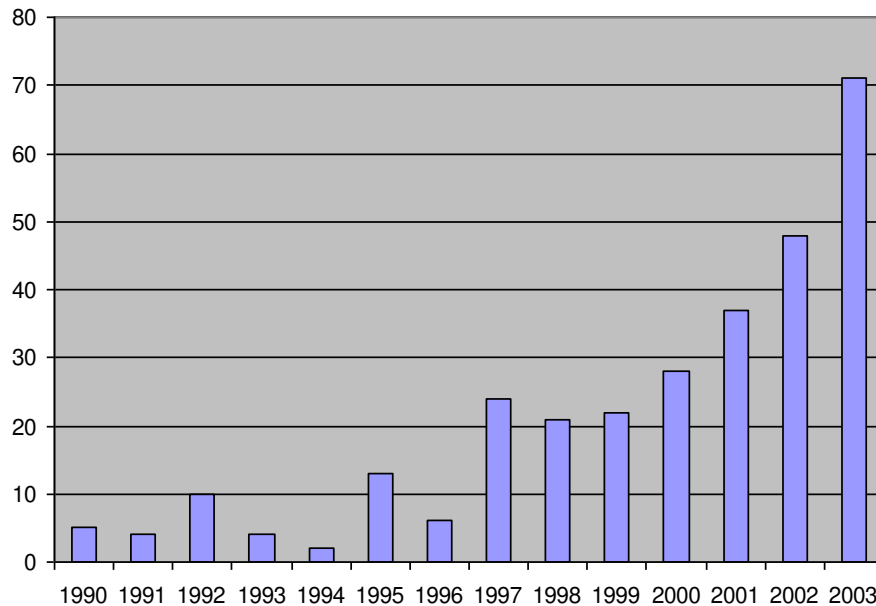


Figure 2 compares the two most active patenting IDCs, China and India, relative to Korea. Korea, has been an OECD country since 1995, and is often used as a benchmark for developing countries because its GDP per capita has grown exceptionally rapidly since 1960<sup>17</sup>.

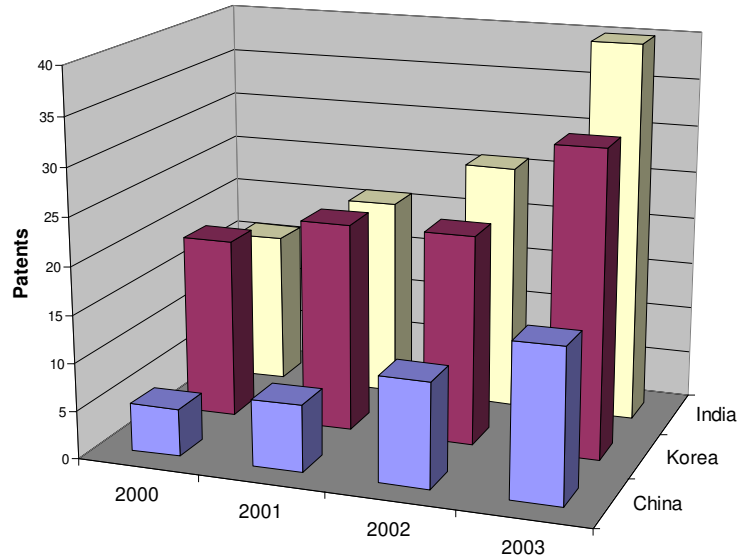
( I think here and in table 3 above, it would be good to consider using the category of low, middle (low middle and upper middle), high income countries than the OECD or not; because Korea, Mexico, and Turkey are OECD members but they are classified as the upper middle income country: by the WB definition of per capital GDP less than 10,000 as of year 2000). Below in this paper on the World Health Organization’ launch of the National Regulatory Network for Vaccines. It mention of the nine developing countries including Korea there)

\* Argentina, Brazil, China, India, Malaysia, Mexico, S. Africa, and Thailand.





**Figure 2: US drug, vaccine, or pharmaceutical patents for China, Korea and India**



Citations of published articles are another proxy indicator of innovative capacity. A recent analysis by King<sup>18</sup> of highly cited publications from 1993-1997 and 1997-2001 also suggests a rapid increase in capabilities in advanced IDCs. Comparing the two periods of the study, several IDCs increased the number of highly cited papers significantly and either exceeded or equaled the average percent increase in highly cited papers of all countries that were analyzed (Table 4).

**Table 4. Numerical and Percent increases in the number of papers among the 1% most highly cited papers.**

Country	Numerical increase	Percent increase
Brazil	88	88
China	218	145
India	93	83
South Africa	30	59
Top 30 countries average	112	59

It is likely that for many of the IDCs, the impressive trends in patents and citations are a result of the recent and rapid increases in R&D investments, preceded by longer-term investments in science and engineering education. According to a 1998 study, Argentina, Brazil, India, Malaysia, Mexico, Panama, Peru, the Philippines, Thailand, and Turkey allocated approximately \$2.3 billion for health research for national needs.<sup>19</sup> This number could be compared with the

budgets of the UK Medical Research Council (\$0.3 billion) and the US National Institutes of Health (\$10 billion) in 1998.<sup>20</sup> Notably, this figure does not include China for which data were not available. In developed countries the public and private sectors invest comparable amounts in health research, whereas in most developing countries the majority of health research is supported by the government and conducted in public institutions.

Each of these countries, including China, is committed to double digit percent increases in health research funding.<sup>21, 22</sup> We estimate total allocations in 2004 at no less than \$3 billion. For the fiscal year beginning April 2005, the Indian government alone plans to increase spending in all R&D to \$3.3 billion, implying a minimum 15 percent increase in all major projects.<sup>23</sup> The private biotechnology industry in India projects investments of \$10 billion by 2010.<sup>24</sup> Some developing countries are aggressively creating high quality pharmaceutical and biotechnology industries on their own initiative.<sup>25, 26</sup>

Manufacturing and markets in developing countries are important components of innovation systems. There is limited but growing evidence that IDC firms, if well networked and set up efficiently, are able to achieve significant cost advantages in production.<sup>27</sup> For example, a recent study by the Organization of Pharmaceutical Producers of India found a cost advantage of up to 50 percent compared with the United States.<sup>28</sup> Further analysis is needed, and cost advantages may differ significantly between drug and vaccine manufacturers, but developing country cost-advantages arguably could lead to lower prices for products directed to the poor. South-South trade in low-cost products is an important aspect of access by the poor to both new and existing health interventions. By value, 67% of India's drug exports, 74% of Brazil's and 92% of Argentina's go to other developing countries, while 63% of Uganda's drug imports and 54% of Tanzania's drug imports by value come from other developing countries.<sup>29</sup>

By volume, India is now the fourth largest producer of pharmaceuticals in the world (13th by value), the country holds 8% of the global pharmaceutical market by volume (1% by value), and India has the largest number of manufacturing facilities approved by the US Food and Drug Administration (FDA) anywhere outside of the United States.<sup>30</sup> According to a recent analysis by the UK Department for International Development (DFID),<sup>31</sup> China is now the 10th largest pharmaceutical market after Mexico (9th), and the second largest producer of pharmaceutical ingredients in the world. For penicillin, vitamin C, terramycin, doxycycline and cephalosporin, China is the largest producer in the world. The Serum Institute of India is now the largest manufacturer of diphtheria-pertussis-tetanus (DPT) vaccine in the world.

According to the DFID study, 60% of UNICEF's vaccine requirements for the Expanded Programme on Immunization (EPI) are produced in just four countries: India, Indonesia, Cuba and Brazil. Thailand obtains 90% of its antiretroviral (ARV) ingredients from India, while the three South African producers of ARVs obtain 100% of their raw materials from India.

“The Thai Public Health Ministry has clearly stated that their ambitious antiretroviral treatment programme would not exist without generic drugs, which would not have been possible without Indian [active pharmaceutical ingredient] supply. ...Similarly, data from the Brazilian firm, Farmanguinhos, which supplies approximately 40% of the total [Brazilian] Ministry of Health ARV demand, shows that approximately 74%

of total ARV purchases in 2002 and 94% of total ARV purchases in 2003 were supplied by Indian, Chinese and Korean firms.”<sup>32</sup>

A recent supplement of *Nature Biotechnology*, contains several papers emerging from a three-year seminal study by the Canadian Program on Genomic and Global Health at the University of Toronto.<sup>26</sup> The papers contain numerous examples of the growth of health innovation in developing countries. For example, the number of exhibitors from developing countries attending the US Biotechnology Industry Organization’s annual conference grew from 2 in 2001 to 97 in 2004. In late 2003, the Chinese firm Shenzhen SiBono GenTech became the first in the world to obtain a license for a recombinant gene therapy product. South Africa’s Council of Scientific and Industrial Research (CSIR) has isolated a hunger-suppressing steroidal glycoside (P57AS3) from an indigenous plant, *Hoodia gordonii*, and licensed the product to the British biotechnology firm, Phytopharm. The Synthetic Antigen Laboratory at the University of Havana played a leading role in developing the world’s first human vaccine with a synthetic antigen. The vaccine protects against *Haemophilus influenzae* infection, which often leads to pneumonia and meningitis in children under the age of 5. Made with a chemically produced antigen instead of fermented bacterial culture, it is much cheaper to produce and safer than vaccines coming from living organisms.

Despite these impressive developments affecting innovation capabilities in developing countries, many impediments remain. *The Economist*,<sup>33</sup> reporting on the University of Toronto study, summarized some of specific problems in IDC health innovation systems:

Brazil needs better links between academia and industry. Egypt's budding biotechnologists are short of cash from both government and private sources. India's regulatory system is slowing down product development. South Africa needs to do more to reverse its brain drain, and train more researchers to boost their ranks.

It is these impediments, and others, that an initiative focusing on innovation in developing countries will help to address. Networking among developing countries is needed to share information and good practices for better alignment of national innovation policies and national health priorities. Such an initiative will be essential if the growing health innovation capability of developing countries is to have an impact on public health.

### **Is health innovation in developing countries likely to strengthen the fight against diseases of the poor?**

There is as yet insufficient understanding of the detailed nature, dimensions, trajectory, and potential impact of the revolution of innovation in developing countries, of whether and how this revolution can best address the needs of the poor. Presumably, a significant portion of public sector investments by developing countries in health research is based on national health priorities. These financial allocations require more in depth analysis to understand how they are being used, but it is clear that these countries are allocating large and increasing sums thereby providing the opportunity to allocate increasing amounts to research on diseases of the poor.

As emphasized by a recent UN Commission,<sup>34</sup> the role of the private pharmaceutical industry in IDCs will be critical to success. Will it be possible to obtain their commitment, to a meaningful extent, to working on diseases of the poor? Most of the PD PPPs referred to earlier collaborate with pharmaceutical companies in developed countries, but none of these companies have prioritized diseases of the poor.<sup>35</sup> The amount of in-house funds spent on diseases of the poor is insignificant compared to what is spent on their lead candidates – for cardiovascular, cancer, chronic diseases.<sup>36</sup> Prioritizing the disease and health concerns of lucrative markets, for patients in the developed world, is understandable given all companies' drive to maximize return-on-investment.<sup>37, 38</sup>

In one documented case, a major US manufacturer declined to participate in a meningitis vaccine development program directed to Africa even though the public sector partner was willing to invest up to \$70 million in the effort.<sup>39</sup> The manufacturer concluded that the funds available did not exceed the opportunity cost of directing its resources (financial, facilities and personnel) away from the more lucrative US market. One of the conditions of participating in the meningitis program was that the price of the product not exceeded \$1.00.

According to the previously cited Indian private biotechnology investment projections, the R&D based private sectors in IDCs (as opposed to generics and material manufacture) are growing rapidly. It is critical to recognize that all of these companies are driven to maximize a return on investment. It is not surprising, then, that recent studies show that many of these companies are according priority to “diseases of the rich,” both locally and abroad.<sup>35</sup> For example, in the patent data cited above, for all IDCs in 2003 only 10 of 105 drug, vaccine, or pharmaceutical patents issued were for diseases that predominantly affect the poor (three antivirals, one anti-malarial, two antibiotics for drug-resistant bacteria, two vaccines, and one treatment for vaginal infections).

However, some IDC companies are considering business strategies that include diseases of the poor, and there are reasons to speculate that -- given their apparent cost and location advantages - they might be better placed to turn diseases of the poor into profitable business opportunities.<sup>40</sup> For example, the offer noted above by the meningitis program made good business sense to an Indian manufacturer after it was rejected by a US manufacturer. The University of Toronto study of health biotechnology innovation systems in 7 developing countries found that health biotechnology in IDCs was often focused on local health needs, including import substitution (with lower cost products), manufacturing process improvements, and novel invention.

Many IDC firms are now forming joint ventures with major international companies. Examples include an R&D partnership between Ranbaxy Laboratories (India) and GlaxoSmithKline for product identification<sup>41</sup> and, in Latin America, partnerships between Biomanguinhos/FIOCRUZ (Brazil) and Glaxo SmithKline for the production of *Haemophilus influenzae* vaccine, the Instituto Butantan (Brazil) and Aventis Pasteur for influenza vaccine, and the Instituto Finlay (Cuba) and Glaxo SmithKline for meningococcal group B vaccine.<sup>42</sup>

## **The Study of Health Innovation Systems**

Scholars who study innovation systems have, until very recently, paid little attention to health. However, Dhar and Rao have recently examined the development of the pharmaceutical industry in India.<sup>43</sup> Their analysis identified key determinants of innovation.

- *Support for R&D.* The government provided extensive subsidies for R&D including tax concessions, soft loans and exemptions from price controls. The government also provided extensive support of government research centers such as for the Council for Scientific and Industrial Research that actively engage in collaborative projects with private industry. Beginning in the 1990s, the government developed policies to stimulate local public-private R&D partnerships for product development<sup>44</sup>.
- *Manufacture.* Until 1994, government policy required firms that were not using high technology in production of bulk drugs or formulations to limit their foreign holdings to 40 percent to be considered Indian firms.
- *Intellectual property.* The Indian system recognized only process patents, excluding product patents for pharmaceuticals and agricultural chemicals from IP monopoly protection.
- *Domestic markets and exports.* This system allowed manufacturers to reverse engineer products that had been developed in the North -- both on and off patent -- for the domestic market. Patented products could then enter international commerce as soon as the relevant patents had expired.

The University of Toronto study<sup>45</sup> identified the following main features of innovation.

- *Government policy:* Support for R&D. Establishment and management of policies on intellectual property rights and drug regulation.
- *Public research institutes:* The growth of scientific institutions with highly trained staff, increasing number of paper published in international peer reviewed journals, capability to produce high quality products, formation of public-private partnerships, and development of products.
- *Industry:* The growth of private enterprise as reflected by increasing number of biotechnology firms, percent of the domestic market supplied by local firms, size of the domestic market, number of patents, and interest in public-private partnerships.
- *The general public:* The receptivity of the public to modern biomedical research particularly with respect to R&D involving genetics.

These findings, as well as those of Da Motta e Albuquerque and Cassiolato<sup>46</sup>, indicate that there are key determinants of health innovation systems in developing countries, and that strengthening these systems can help address national health priorities.

## A Framework for understanding Health Innovation Systems

In order better to understand health innovation systems in developing countries,<sup>9</sup> and maximize their ability to address diseases of the poor, we propose a framework with six determinants.<sup>8,47, 오류! 책갈피가 정의되어 있지 않습니다., 48, 49</sup>

- Creating capacity for and undertaking R&D
- Creating and sustaining capabilities to manufacture products to appropriate standards
- Promoting and sustaining domestic markets
- Promoting and sustaining export markets
- Creating and implementing systems for IP management
- Creating and implementing systems for drug, vaccine, diagnostic and device regulation

Table 5 shows these six determinants in a framework, distinguishing characteristics of health innovation systems in three categories, from less to more advanced IDCs and, for comparison, developed countries as well<sup>50</sup>. An essential aspect of this framework is that the six determinants are assumed to be dynamically linked such that progress in one is facilitated by and dependant upon progress in the others.<sup>51</sup> Similarly, the lack of progress in one can impede progress in the other five. Therefore, if a country wishes to shift from a less to a more advanced IDC category, it must make coordinated, dynamic progress in some or all of the determinants (in relation to their respective starting points).

For example, it will be difficult to create an export market without a satisfactory national drug regulatory system. Similarly, (and obviously) it will be difficult to develop new products from public or private R&D without a domestic ability for high quality manufacturing. Publicly funded research also depends on sound public-private partnerships -- which ideally protect the public interest -- to translate academic findings into high quality products.<sup>52, 53</sup> Finally, some argue that it will be difficult to attract significant private investments without a sophisticated intellectual property system to protect those investments and to achieve profitable returns.

Experience from non-profit product development partnerships shows that IP rights can be used by the public sector to help attract private sector interest, mobilize the necessary funds, and ensure affordability and access to essential new health products. There is therefore a need for special care in the development of national IP systems. The most appropriate IP system for IDCs at different stages of development, particularly when viewed with a focus on diseases of the poor, depends on the underlying circumstances in each country remains an open question for policy research. This point has been raised by many commentators, perhaps most notably by the UK Commission on IP Rights and the recent World Bank study.<sup>54</sup>

**Table 5. Categories of health innovation systems in IDCs and developed countries by six determinants.**

	<b>Manufacture</b>	<b>Domestic Market</b>	<b>Export Market</b>	<b>R&amp;D</b>	<b>IP System</b>	<b>Drug Regulatory System</b>
<b>Category 1</b> <b>Less Advanced IDCs</b>	Assembly of imported components	Small market	Very little except as toll manufacturer	Very little	Very limited understanding of IP; no IP protection	Very limited
<b>Category 2</b> <b>Learning IDCs</b>	Production on license or by copy with significant cost-advantages over Northern products	Growing domestic market of increasing interest to foreign companies; some import substitution; significant share of imports come from other developing countries	Growing trade; companies learning how to establish export markets; significant share of exports go to other developing countries	Local government and foreign donor-funded R&D to understand technology either to produce on license or to copy	Patents allowed for local inventors, but foreign inventors and investors still not interested because of lack of markets and IP protection; few local public-private partnerships (PPPs)	Limited services without enforcement capabilities
<b>Category 3</b> <b>Advanced IDCs</b>	Manufacture of domestically developed high technology products with significant cost-advantages over Northern products; growing source of outsourcing	Rapidly growing domestic market of interest to foreign companies	Increasing exports make significant contribution to GNP; significant share of exports go to other developing countries	Scientifically advanced; funded predominantly by local government, and carried out predominantly by local public research institutions; capable of innovation	Advanced IP system, but poorly enforced; moderate experience with technology management in local PPPs	Advanced capabilities but not at highest level because of need to strengthen capabilities as appropriate
<b>Developed countries with a drug or vaccine industry.</b>	Highest capabilities to produce high technology drugs and vaccines	Highly profitable market in both the public and private sectors generating profits to support, in part, advanced research	Global companies	Generous support for health research from basic to applied. Large research investment by private companies including large pharmaceutical manufacturers and biotechnology companies	Sophisticated system of IP protection, and management of technology in local PPPs (e.g., university-industry R&D agreements)	A sophisticated agency to oversee the regulatory approval of drugs and vaccines. In addition, the government oversees clinical trials and production facilities and enforces rules and regulations.



## **A Network to Strengthen Developing Country Capabilities**

In the complex field of new health product innovation, national governments, public and private sector product development efforts, and other related initiatives need to develop a coherent strategy for product development by addressing each of the determinants discussed above. Some advanced IDCs may be able to address, and will address, all the determinants themselves. However, in other cases strategies involving coordination and learning among countries may be the best route. South-South information exchanges could help countries learn from one another to maximize the effectiveness of their health innovation systems to both achieve economic development and to address national health priorities, including diseases of the poor.

Developing countries with innovation capabilities could take on an important role of leading the global advocacy for health product innovation by sharing experiences, shaping priorities, developing workable strategies, conducting collaborative programs, and facilitating public-private collaborations. Such efforts would complement other initiatives including the PD PPPs which are primarily headquartered in developed countries (with numerous collaborative relationships in IDCs).<sup>55</sup>

A South-South based initiative could help to promote research on health innovation systems (a heretofore neglected field), support the dissemination of information about effective innovations system policies among IDCs, promote the conduct of demonstration projects of innovation system policies concerning one or more of the determinants, and provide a forum for IDCs to exchange information about health innovation systems. There is a need to mobilize relevant institutions in developing countries that are concerned with health innovation including R&D centers, technology and IP management centers, drug and vaccine manufacturers, sources of financing, regulatory bodies, and government institutions and non-governmental organizations that are concerned with access to health products and services.

As a mechanism to help strengthen health innovation systems in developing countries, this is consistent with key recommendations of previous studies that have examined the potential role of developing countries in health product innovation. The Evans Commission of 1990 highlighted that, in addition to addressing their own health needs, developing countries could contribute to the solution of global health problems.<sup>56</sup> The UK Commission on Intellectual Property Rights has examined the issue of the participation of developing countries in health product innovation.<sup>57</sup> The Commission's report notes, "[Of important promise] might be a network of the public-private partnerships in developing countries, taking advantage of the concentration of research resources in public sector institutions but also the opportunity to build research capacity in the private sector." It then goes on to recommend:

*Public funding for research on health problems in developing countries should be increased. This additional funding should seek to exploit and develop existing capacities in developing countries for this kind of research, and promote new capacity, both in the public and private sectors.*

There are efforts underway to link and mobilize innovation in developing countries. For example, the Global Forum for Health Research (GFHR) supports an annual meeting to bring together key individuals and organizations concerned with research on priority health problems in developing countries<sup>58</sup> while the WHO-hosted Tropical Disease Research Special Programme has been a leader in this effort, and an ‘incubator’ of PD-PPPs.<sup>59</sup> The Global Research Alliance (GRA), composed of nine research institutes in developed and developing countries, seeks to facilitate and promote research in a number of development areas including health.<sup>60</sup> The Research Agency Collaborative for Global Health (REACH) is an emerging initiative to facilitate coordination and collaboration among national medical research agencies in both developed and developing countries.<sup>61</sup> This year, the World Health Organization, along with nine developing countries, created and launched the National Regulatory Network for Vaccines. The participating countries are Brazil, China, Cuba, India, Indonesia, Russia, South Africa, South Korea and Thailand.

Some new efforts have been created for, and led exclusively by, developing countries themselves. Each of these could be an important contributor to an international network promoting health product innovation in developing countries:

- The Asia Pacific Economic Commission (APEC) is developing a comprehensive Strategic Plan for its Life Sciences Innovation Forum that addresses the issues raised in this paper.<sup>62</sup>
- India-Brazil-South Africa Dialogue Forum (IBSA), established in June 2003, includes a focus on intellectual property and access to medicine, traditional medicine, and research and development of vaccines and pharmaceutical products to address national health priorities.
- Technology Network for HIV/AIDS, announced during the 2004 Bangkok meeting on HIV/AIDS, includes Brazil, China, Nigeria, Russia, Thailand and Ukraine (and possibly South Africa and India in the near future). The Network will support research and South-South technology transfer on antiretroviral drugs and drug formulations, and the development of an HIV vaccine.
- Developing Country Vaccine Manufacturers’ Association, established in 2000.<sup>63</sup>
- The Third World Academy of Sciences, whose goal is “to promote scientific capacity and excellence for sustainable development in the South.”

However, something more comprehensive seems to be needed. The new initiative for health innovation systems in developing countries could help promote:

- research on health innovation systems;
- information sharing among IDCs;
- information dissemination on effective policies and practices;
- demonstration projects; and
- capacity building to support all the above points.

A major goal would be to help formulate policies in several areas including financing, capacity building in each of the determinants, and the formulation of laws and government regulations to promote health innovation.

### *Innovation systems research*

There is a real need to encourage studies focusing on diseases of the poor. There is a need for innovation system theorists and global health practitioners to develop a more sophisticated literature on health innovation in developing countries. Methodologies for country, product and company case studies, derived from innovation systems theory, need to be applied to health innovation. This work would evaluate best policies and practices for consideration by IDCs. Another important product of this work would be the development of sustainable and consistent networks for information collection, analysis and sharing.

### *Information dissemination*

There is a need to ensure the widest possible dissemination of best practices and policies identified through research and forum activities (see below) by, for example, codifying the output of innovation research into briefs for policy makers and practitioners.

### *Demonstration projects*

There is a need to support demonstration projects to test implement of proposed policies and practices in real life situations, and to determine how best practices and policies may vary depending on local conditions.

### *A Forum for IDCs*

These activities could be addressed to improve the efficiency and effectiveness of health innovation systems in IDCs through a forum that would bring together diverse institutions and individuals, including scientists, policy makers, and leaders from international development and the private sector. Forum participants would:

- discuss specific innovation determinants and share experiences related to innovation in health products, drawing on the health innovation research activities;
- develop consensus on best practices and policies; and
- advance policy initiatives to improve the efficiency and effectiveness of health product innovation.

In 2003, The WHO Commission on Macroeconomics and Health called for an expanded outlay in 2007 of approximately \$1.5 billion per year in R&D through a new Global Health Research Fund (GHRF).<sup>56</sup> These funds would be in addition to those already allocated to existing channels such as the WHO-based research programs on tropical diseases and human reproduction, and the PD PPPs. The report states, “A key goal of the GHRF would be to build long-term research capacity in developing countries themselves. The GHRF would provide vital funding for research groups in low-income countries.”<sup>56</sup> Unfortunately, developed countries have not implemented this recommendation perhaps, in part, due to a lack of appreciation of how rapidly capabilities for innovation in developing countries are growing.

Arguably, those closest to the needs of the poor are the communities, scientists, policy makers, and institutions – public and private – in the countries where the challenges of poverty reside.

As persuasively argued by Lucas,<sup>64</sup> it is essential to devise ways in which programs in developed countries can become better integrated with the scientific and technological institutions in developing countries that have been rapidly expanding their ability to undertake health innovation and are becoming part of the global knowledge economy. Solutions depend on sophisticated global partnerships and collaborations to share knowledge and good practices in innovation policies to enable developing countries to drive and own agendas and harness their available capabilities to achieve the most effective ends including the improved health for the poor, and the generation of wealth.

## **Conclusion**

To address global health disparities, the global community must harness the potential of national and regional health innovation systems throughout the world, with a particular focus on the development of technologies and techniques that are relevant to developing countries.<sup>65</sup> This means making full use of abilities, energy and resources in both developed and developing countries. Advanced IDCs should assume a leadership position in health innovation, both because of their increasing capacity to address global health problems, and because they are literally closer to the legitimate voices of those living in poverty. A new focus on health innovation systems in developing countries should capture the imagination of those in leadership positions and many others who share the belief that all people, especially the disadvantaged, should be able to share equitably in the benefits of modern health innovation.

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