Reinventing global health: the role of science, technology, and innovation

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The Millennium Development Goals have become an international standard against which to assess trends in development and human well being. Their adoption in 2000 coincided with two important factors: the growing recognition of the role of science and technology in solving human problems, and the emergence of new infectious diseases. These developments have helped to define biomedical research as one of the most critical public policy issues facing the global community. The state of human health in much of the developing world continues to decline at a time when the world's fund of biomedical knowledge continues to expand. This challenge offers new opportunities for promoting international cooperation in biomedical research of relevance to developing countries as outlined in the report of the Millennium Project Task Force on Science, Technology and Innovation.[1] Addressing health challenges of the developing world will require new forms of international partnerships that take into account emerging opportunities in the globalisation of scientific knowledge.

Genomics and global health

Biotechnology has emerged as one of the methods that can be used to address health and other challenges in developing countries.[2] The realisation of this potential, however, depends on a diverse set of policy measures aimed at translating scientific discoveries into goods and services. These technologies include: molecular diagnostics; recombinant vaccines; vaccine and drug delivery; bioremediation (use of living organisms to degrade hazardous matter); sequencing pathogen genomes; female-controlled protection against sexually transmitted infections; bioinformatics; nutritionally enriched genetically modified crops; recombinant therapeutic proteins; and combinatorial chemistry.[3] Let us look at a few examples.

Molecular diagnostics are becoming a central element of the fight against disease. But many diagnostic methods in use in developing countries are cumbersome, time-consuming, and expensive. Although improvements in epidemiological surveillance and health systems to prevent disease are crucial, better diagnostic and treatment methods are also essential. Rapid and accurate diagnosis increases the chances of survival, prevents resources from being wasted on inappropriate treatments, and helps contain disease. Improved diagnostic methods would allow developing countries to better manage infectious diseases even if there was no cure and would provide much needed information for policy design and implementation.

The recent development of simple antibody-coated dipstick tests, such as those used to diagnose malaria and HIV, has increased the relevance of this technology for the developing world, since, with basic training, these tests can be used in community health clinics, which might not have access to clean water and electricity, much less advanced laboratory facilities.

Opportunities for international cooperation in the design of diagnostics are expanding as developing countries such as Brazil, China, Egypt, India, Kenya, and South Africa increase their activities in this area. For example, the Oswaldo Cruz Institute in Brazil has developed a commercial diagnostic kit for Chagas' disease based on recombinant *Trypanosoma cruzi* antigens.

Recombinant vaccines can play an important part in improving global health. Genetic engineering has made it possible to produce single proteins of the pathogen in non-pathogenic microorganisms. This approach produces safer vaccines, since the individual foreign proteins cannot cause the disease.

Recombinant vaccines might also prove cheaper than traditional vaccines due to innovative production methods and improved storage characteristics. A major roadblock in the development of recombinant vaccines is the long time it takes to run clinical trials and obtain regulatory approval, which has limited the number of products on the market. Nevertheless, developing countries are emerging as key sources of new vaccines. In 1997 Shantha Biotechnics, an Indian company, launched a recombinant hepatitis B vaccine, which it sells for US$0·40 per dose—a fraction of the $8–10 cost of the imported vaccine.

Closely related to advances in vaccines are improved methods of vaccine and drug delivery. Thousands of children die every year from vaccine-preventable diseases because the logistics of vaccine delivery pose major challenges. Refrigerated transport and storage are a major concern in all vaccine programmes. The need to hire trained medical personnel to deliver vaccinations also adds to their cost.

Injection-free and controlled-release delivery systems could help solve many of the problems associated with injections and complicated drug regimes. Scientists are exploring various alternatives to needle-based delivery of drugs and vaccines. The skin is an attractive route into the body because of its easy access. Needle-free injections propel the vaccine or drug through the skin and into the body with a high-speed jet of gas. Solutions, rubbing gels, and skin patches rely on simple diffusion to introduce agents into the body.

The refrigeration needed to store and transport conventional vaccines and drugs is costly. However, researchers have been able to dehydrate liquid vaccines and drugs and store them at room temperature for up to several months without affecting their potency. Injection devices for dried vaccines have been developed. Some involve the reconstitution of the dried substance into a liquid just before use.

Improved drug delivery can also help reduce the length and complexity of drug treatment regimens. Controlled-release drugs and vaccines can be introduced into the body in association with a biodegradable polymer that gradually releases its contents as it is broken down by the body. Sustained-release treatments would lower the number of doses a patient must receive, thereby increasing compliance and limiting the emergence of drug resistance.

These are only a few examples of the wide array of genomic and other biomedical opportunities for addressing developing country health problems. Much of the knowledge needed to pursue ambitious product development programmes is already available.

Strategic outlook

Transforming emerging knowledge into biomedical goods and services will require new institutional arrangements that take advantage of the globalisation of scientific research. Strategic partnerships between industrialised and developing countries are a critical aspect of such product development programmes. Efforts by institutions such as the Gates Foundation and the various vaccine development alliances are important in the fight against disease.

Another encouraging example of international cooperation is the recent development of a different method to synthesise a vaccine against the bacterium *Haemophilus influenzae* type B through a partnership between Cuba and Canada. Pharmaceutical companies produce only 100 million doses of vaccine a year, just 20% of the number required worldwide. With the new and cheaper method, Cuba alone could manufacture an extra 50 million doses a year.

Such approaches are being complemented by new alliances that involve developing countries, a demonstration of the growing globalisation of research and development.[4] For example, Brazil, India, and South Africa have been working together to identify areas for trilateral cooperation that include nanotechnology and efforts to prevent and treat HIV/AIDS. These efforts, however, are unlikely to make important contributions unless they are implemented in the context of long-term strategies that place science, technology, and innovation at the centre of efforts to improve human well-being. Such strategies will include measures such as improving the policy environment for research and development, building scientific infrastructure, investing in scientific human resource development, and spurring entrepreneurial activities.

Still Pictures

The first step in improving the application of science, technology, and innovation in development is to align government structures with research initiatives. This cannot be done without placing technological innovation at the centre of the development process. Governments can strengthen decision-making on health-related issues by appointing science and innovation advisers in the offices of presidents and prime ministers. Advice should be delivered through transparent and systematic processes that combine technical knowledge provided by institutions such as scientific, health, and engineering academies with wider democratic public consultations. International organisations such as WHO and the international financial institutions should expand the application of science and technology, promote technological innovation in developing countries, and adjust rule-making and standard-setting activities to better meet the interests of developing countries.

Infrastructure strengthening is a key aspect of economic development and human welfare and is considered essential for the delivery of medical services. In addition, infrastructure is an important part of the technological backbone of any country and a key vehicle for diffusing scientific and technical capabilities in society. Governments need to define infrastructure broadly to include biomedical research facilities in health and educational institutions. The construction

Panos Pictures

and maintenance of such facilities should be accorded the same priority as energy, transportation, telecommunication, sanitation, and water supply services.

Building human capacity, especially in scientific and technical specialties, is a long-term process that involves extensive political consideration. The first step in moving in this direction is for countries to review their educational and medical systems and identify opportunities for aligning the mandates of existing institutions with biomedical research priorities of the country. Priority should be given to strengthening and expanding institutions that create synergies between biomedical research, teaching, medical practice, and outreach. Countries should devote resources to helping more young people—especially women—receive higher education, paying special attention to the barriers that appear at the level of secondary education.

Creating links between knowledge generation and enterprise development is one of the most important challenges faced by developing countries. A range of approaches can be used to create and sustain enterprises, from taxation regimes and market-based instruments to consumption policies and promotion of close cooperation between business, academia, and government.

Conclusion

For many developing countries, the worsening state of citizens' health is probably their most critical challenge. Responding to the challenge will demand greater investments in institutional innovations that put to practical use the large body of science and technological knowledge available to humanity today.[5] Doing so will require developing countries to put science, technology, and innovation at the centre of their development strategies. Nothing short of a clear commitment to the role of technology in development will help developing countries benefit from the growing global body of scientific and technical knowledge. Biomedical research and the emerging genomic techniques are critical starting points.

Contributors

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Conflict of interest statement

We declare that we have no conflict of interest.

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