Innovations and Advances in Global Public Health

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Abstract:

Acceleration of innovations in science, technology - one of the major features of our time! Technology and innovation are the major drivers of social and economic development, and have a major impact on medicine in high/middle-income countries. Until recently, Global public health seems to have been far less influenced by this development in technology (vaccines are an exception!). Innovation and technology are part of powerful transitions that are occurring in health, globally. Crucial for global public health to fully embrace breakthroughs, as well as, to ensure access to existing technologies worldwide, in order to open up new/more effective strategies to meet UN Millennium Development Goals (MDGs). Key question is not whether global public health should embrace innovation, but how to deliver these innovations in context of huge disparities within and between countries.

Key words: Technology; MDGs; Global Health;

In 2000, following the adoption of the UN Millennium Declaration, eight development goals were established. All 189 United Nations member states (193 currently) committed to help achieve following MDGs by 2015: (1)

1. Eradicate extreme poverty and hunger
2. Achieve universal primary education
3. Promote gender equality and empower women
4. Reduce child mortality
5. Improve maternal health
6. Combat HIV/AIDS, Malaria and other diseases
7. Ensure environmental sustainability
8. Develop a global partnership for development

MDGs have become an international standard to assess trends in development in Global Health. Their adoption coincided with two important factors: a) Growing recognition of the role of science and technology in solving human health problems, and b) 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 global knowledge of medical technology continues to expand. This challenge offers new opportunities for promoting international cooperation in biomedical technology that is of relevance to global public health, particularly in developing countries.

What is in the pipeline?

The list of innovations that are in the pipeline is exhaustive – some major trends of technological development with potential impact on health include: (2)

A. Biotechnology & Genomics
B. Communication & Information Technology
C. Miniaturization and nanotechnology
A. **Biotechnology and genomics:**

New vaccines are in the pipeline, and equally important, the quality, stability, and delivery of existing vaccines may be significantly improved. New drugs, point-of-care diagnostics, biomarkers and complex genomic and epigenetic analytic tools will continue to be developed. (3, 4) The capability of biotechnology and genomics has the potential to provide a better understanding of the etiology, prevention and management of complex diseases such as cancer, dementia, heart disease and diabetes. (5)

**Biotechnology and global health:**

Biotechnology has emerged as one of the methods that can be used to address global health challenges and includes Molecular diagnostics; Recombinant vaccines and Drug delivery. (2)

i) **Molecular diagnostics:** Global health professionals who seek timely and accurate results are increasingly turning to the emerging molecular diagnostic technologies. These technologies offer positive identification of an organism’s nucleic acid in the cell, for a higher degree of diagnostic accuracy. In addition, their shorter time-to-result permits more rapid treatment of patient and limit spread. Research and development in molecular testing are moving ahead at a rapid pace, resulting in tests for an ever-broadening range of diseases.

ii) **Recombinant vaccines:** Genetic engineering has made it possible to produce single proteins of the pathogen in non-pathogenic microorganisms. This approach produces safer vaccines, since individual foreign proteins cannot cause disease. Recombinant vaccines might also prove cheaper than traditional vaccines due to innovative production methods and improved storage characteristics. Developing countries are emerging as key sources of new vaccines – In 1997, Hyderabad Shantha Biotech, launched a recombinant hepatitis B vaccine.

iii) **Drug delivery:** Can be introduced into the body in along with a biodegradable polymer that gradually releases its contents as it is broken down by the body. These 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 wide array of genomic and other biomedical opportunities for addressing MDGs in a developing country.

iv) **Other Examples:** Development of simple antibody-coated dipstick tests, such as those used to diagnose malaria and HIV, has increased relevance for developing world. With basic training, these tests can be used in clinics, which might not have access to clean water and electricity, much less advanced laboratory facilities. The refrigeration needed to store and transport conventional vaccines and drugs is costly. However, researchers have been able to dehydrate liquid vaccines and store them at room temperature for several months without affecting their potency.

B. **Communications & information technologies** is taking unforeseen directions. (6)

Wireless telephony & Internet is reaching people who until recently were deprived of information, while the speed at which information is spread has grown exponentially. (2)

**Example:** India added a staggering 227.27 million wireless subscribers in the 12 months between Mar 2010 and Mar 2011 averaging at 18.94 million/month and by now almost one billion. Mobile telephone has now reached well over half of the world’s population. Today, we
see this in poorest villages without toilets, electricity or clean water, where mobile phones are already having and will continue to have an impact. This has major implications for public health as mobile phones have already made disease surveillance and response faster and easier, and made telemedicine possible.

**Preterm Labor & MDGs**

Preterm labor and birth has always been a serious public health issue and is part of MDGs 4 & 5. (1) Advances in obstetrics have considerably eased the process of assessment of the stage of labor. However, it is still difficult to predict beginning of labor, and it can lead to premature birth. Moreover, infections caused by traditional examination may also lead to preterm births. Thus, there is an urgent need for an accurate and sanitary means of predicting the beginning of labor for patients under the risk of preterm labor.

For monitoring preterm difficulties, we only need to monitor the first stage of labor because after first phase, a premature delivery cannot be prevented. Therefore, we need to measure cervical diameter continuously over the range of 0–4 cm.

Current monitoring devices for cervical dilation are all limited to hospital usage and performed by trained examiners. This means that pregnant woman cannot measure the cervical dilation outside hospital. New technology is able to give accurate information that indicates the progress of labor. Symptoms used as indicators of start of labor:

- degree of softening of the cervix,
- frequency of contractions, and
- the degree of dilation of the cervix.

Softening of the cervix can be tested by experienced examiners with fingers. This is rather a late symptom which takes place after the cervix starts to dilate, and it cannot be tested by the pregnant woman herself. As for the frequency of contractions - pregnant woman has to pass through the whole contraction phase and count the frequency of all the contractions; which makes it impractical to indicate when labor begins. Cervical dilation is a good indicator of the beginning of labor since it is an important precursor to delivery.

**Remote cervical dilation monitoring system:** (Fig.1 US Patents 8100840 and 7819825) (7)

This system is attached to cervix of the pregnant female by her doctor and consists of an EM device in a non-reactive plastic tube. The sensor stretches as the cervix dilates. A healthcare provider can pull out the whole unit easily when the monitoring is over and the delivery starts. This circuit determines the diameter of the dilated cervix and transmits the value of the diameter.
in centimeters through RF to a small wireless unit carried by the pregnant female like a ‘mobile phone’. Wireless unit is worn on a belt or attached to clothing. The main component of EM sensor is a solenoid coil.

Wireless unit designed automatically dials medical data processing center at a predetermined interval and can be adjusted remotely. Once the contact with the center established, cervical dilation data and other information sent to the center which monitors progress of cervical dilation; provides basic instructions to patient via mobile phone. If needed, the center also gets in touch with healthcare provider and the clinic of the pregnant female, who may then advise the patient as appropriate.

Miniaturization and nanotechnology:

Miniaturization and nanotechnology may revolutionize medical practice (8 – 11), including in resource-poor environments. (12 – 14) For example, small and simple imaging instruments have the potential to increase greatly access to obstetrical monitoring, thereby reducing maternal mortality and poor pregnancy outcomes, as well as absorbing some health-worker shortages. (2)

Point-of-care diagnostics, ‘labs on a chip’, energy conversion and water disinfection with nanotechnology may all soon have their place in public health. (12 – 14)

Impact of Technology

Everything we do in global public health will be affected by developments in science and technology: From disease surveillance to human resources, disease prevention, education, supply-chain management, good governance and community empowerment.

Technological innovation can be a game changer - consider a new vaccine or antiretroviral therapy. In addition, technological innovation is already leading to major social change, be it in relation to poor farmers gaining access through mobile phones, to market prices of agricultural commodities. Some of the most urgent questions for both debate and action include the following questions: 

Who sets the agenda?

One who makes technology or those who need it? In general, technological discovery has been driven by scientists, whereas management innovation has been incentivized by the need to find cost effective solutions to delivery problems. (2) Technological innovation has come from high-income countries, but increasingly, emerging economies are both at the source of innovation, and the first users. (15) We now see ‘reverse innovation’, with India and China now bringing new technologies to both high- and low-income countries at affordable costs. (16) In 1997, Hyderabad based - Shantha Biotech, launched a recombinant hepatitis B vaccine - sells for US$ 0.40 per dose—a fraction of $8–10 cost of imported vaccine. It is urgent for global health community to engage in a dialogue with technological and other innovators to formulate an agenda that addresses priorities for global public health & MDGs. (2)

Conclusion

A few technologies are being utilized but there is a tremendous amount, yet to be explored, that can be brought to global health to achieve MDGs. New global health concept is better equipped to fully utilize potential of innovation and technology because of stronger integration of population and individual health, and interdisciplinary approaches.
REFERENCES

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Graduated in medicine from Madras Medical College, in dentistry from KGMC, Lucknow and MPH in Healthcare Administration from University of Minnesota. After completing fellowship at UTMB Galveston, Texas, joined University of Minnesota as a faculty member and Director of Women’s health research.

Currently, serving as the Director of Clinical Laboratories and faculty at Oklahoma State University, teaching graduate courses - Global Health; Relief and Development in Global Health; International Health Systems and Translational Medicine; and as the President of American Association of Physicians of Indian Origin (AAPI-Tulsa).

Served as senior consultant to Minnesota State Health Technology Advisory Committee; reviewer for National Institutes of Health (NIH) and the American Journal for Obstetrics & Gynecology.

Recently, served as senior health advisor to the United States department of State in Iraq and awarded “Expeditionary Service Award” by Secretary Hillary Clinton. Also, received Sony’s South Asian Excellence Award - “Scientist of the Year” in 2008.

Awarded 6 patents for developing diagnostic tools to prevent preterm births and cancer. Published 42 scientific papers and invited to present at more than 100 national and international meetings including recent Global Healthcare Summit (Ahmedabad, India January 3-5, 2014) and the 101st Indian Science Congress (Jammu, February 2-5, 2014).