TECHNOLOGY FOR HEALTH AND MEDICINE

Boutros-Pierre Mansourian
Former Director (ret.), Research Policy Coordination, WHO / HQ- Geneva, Switzerland

Keywords: Science, Technology, Biomedical Engineering, Genetic Engineering, Genome, Informatics, Pharmaceuticals, Instrumentation

Contents

Summary

This chapter discusses the inter-relationships between Science,Technology and Medicine, particularly in the context of Public Health.It emphasizes the role of Technology, taking the view that technological advances will ultimately be cost-effective, if used appropriately.

1. Introduction

Technological advances have led to many new diagnostic and therapeutic possibilities, many of which are costly. Imaging technologies, new materials for internal or external prosthesis, laser technology, biosensors, and silicon chips are examples. Information technology allows effective gathering and utilization of public health information, modern computing technology and the use of computational logic provides new opportunities for systems modeling and for the use of advanced decision support at all levels.

Inequities are easily created by such advances in science and technology. Deciding how and where to allocate resources to the new opportunities may be difficult. Human factors constitute important elements in identifying what health care is acceptable and in designing systems through which health care personnel provide acceptable health care services.

The general theme of Science, Technology and Medicine is introduced first, together with a description of global inequalities within S&T and within the health sector.

The issue of cost is also discussed, followed by an overview of major, promising avenues in technological development.

As in other aspects of Technology, health technologies become cheaper over time, thus improving their global accessibility and affordability (1).

2. Science, Technology and Medicine

It is well known that Science leads to Technological innovations, which feed back into further scientific development. At the core of this process, lies the capacity to exploit scientific methodology.

A number of critical issues can be identified in relation to methodologies for health development: (a) locating, utilizing and improving existing knowledge; (b) health measurement and monitoring; (c) 'knowledge-based' assessment of health; (d) health data interpretation; (e) modeling and simulation; (f) priority setting methodology.

All these issue are of top relevance to promote the R&D efforts required to improve health status and health care, particularly in under-privileged populations.

Contemporary technological advances have had important societal consequences, for example (a) increased reliance on brain work rather than physical work and (b) growing mobility of labor. Major industries have developed, which are bound to impact health, globally. Of particular significance, are those related to Biotechnology and to Informatics.

Health technologies can be categorized as (a) preventive, (b) diagnostic, (c) therapeutic, (d) rehabilitative, and (e) auxiliary. Key technology drivers for the next 10 years are thought to be: Genetic Engineering, Nanotechnology, Robotics, and Artificial Intelligence (AI).

Examples of the first can be found in drug design. The present cost of developing a new drug is of the order of 500 Mio. USD., and the time from conception to marketing is about 10 years. The goal is to reduce cost and time by 50-60%. To assist in this task, industry uses huge databases for millions of individual DNA sequences which are robotically tested, ultimately leading to the selection of a small number of active substances.

The second area, nanotechnology, is promised a brilliant future, with biochips reaching sizes smaller than one tenth of a micron. Computer chips are already as small as a quarter of a micron.

In the robotics area, surgical and minimally invasive techniques are presently in use and are amenable to generalization. Catheterizable robots are also susceptible to be used for extensive applications.

The relevance of AI to Public health is to assist the 'decision making' process, as has been the case in other sectors, 'Knowledge Engineering' and 'Computational Logic' techniques can prove useful. The task here is to measure health levels in a population, to have the capacity to analyze data, to distill information out of such data, then to synthesize the information to augment the knowledge base. The whole process should be able to improve the objectivity and rationality of decision making.

3. Science and Technology Disparities

Except for China and India as a whole (and possibly a few other countries), the gap (2) between high income (a proxy for the rich North) countries and low income (a class used as proxy for the poor South, not withstanding big variations between, say, Southeast Asia and Sub-Saharan Africa) countries is large and growing. An example of calculations is given by the following approximate ratios (per capita, rich vs. poor, OECD, World Bank and UNESCO data, ca. 2002)

GNP / cap. (PPP, USD)	30 : 1
Telephones (fixed and mobiles) per 1000	150 : 1
PCs / 1000	500 : 1
Patents	500 : 1
Publications	50 : 1
Energy use (Kg of oil equiv. / cap.)	10 : 1

(PPP = purchasing power parity, adjusted dollars).

A basic difference between the "haves" and the "have nots" lies in the extent of scientific and technological development. Data derived from UNESCO and other sources point to a differential in R & D funding of the order of 100 : 1 per capita. Such disparity is reflected in output measures such as publications and patents.

These figures emphasize the need for strong pro-development policies, with appropriate economic and financial support. It may be worth recalling that the total amount of ODA (Official Donor Assistance) is a little more than 50 billion dollars / year (of which 12-15% for health), i.e., of the same order as the annual R&D expenditure of the pharmaceutics transnational corporations.

4. Health Disparities

Gaps can be assessed also by simple measures of health like mortality (3). For example, the World Health Organization (WHO) has proposed a compartmentalization of the world into five mortality regions:

- Group A countries have low level of mortality - both child and adult (male and female) - and include practically OECD countries and Central Europe.
- Group B countries have intermediate levels of both child and adult mortality and include most of Latin America, the Eastern Mediterranean, South East Asia and China.
- Group C countries have the same level of child mortality as group B, but much higher levels of adult male mortality. All are located in Eastern Europe and Central Asia.
- Group D countries, in Asia and Sub-Saharan Africa, have high levels of both child and adult mortality.
- Group E countries are all located in Sub-Saharan Africa and have extremely high levels of adult male mortality and - in most of them - extremely high levels of

female mortality (attributable in large part to AIDS).

WHO has also embarked on measuring health gaps in terms of "Disability Adjusted Life Years" (DALYs). DALY is a metric which combines information about mortality and disability into a single figure, expressed in the time domain. In other words, there are X DALYs lost due to a particular disease or risk factor.

At the turn of the century, about 20% of global DALYs lost were due to lower respirator infections, perinatal conditions, diarrhoeal diseases and HIV/AIDS. Projections for 2020 describe a different picture, with major causes of disease burden being *ischaemic* heart disease (5.9%) unipolar major depression (5.7%), motor vehicle accidents (5.1%) and cerebrovascular disease (4.4%).

In terms of risk factors, malnutrition has been shown to account for about 16% of the global disease burden and poor water supply, sanitation for about 7%.

All these calculations have been used, obviously, to portray differentials between countries, within countries, and across regions.

5. Global Costs of Health Technology

The following calculations are based on WHO and World Bank data, and on publications by Sachs (5) and Mansourian (8).

The World Bank and WHO have defined a minimum package to improve health in poor countries (4). It consists of two components: (a) Essential Public Health Interventions (EPHI) and (b) Essential Clinical Packages (ECP).

The first includes an expanded programme of immunization; school health including dewarming, micronutrient supplementation, and health education; information on health, nutrition and family planning; tobacco and alcohol control programs; monitoring and surveillance, vector control and programs for prevention of AIDS.

The second includes short-course chemotherapy for tuberculosis, management of the sick child, prenatal and delivery care, family planning, treatment of sexually *transmitted diseases and essential* care (such as pain control and management of minor trauma).

It has been calculated at the time (1993) that these measures could avert more than 15% of the disease burden in low income countries and more than 30% in middle income countries.

However, it has been reported (5) that in some of the world's poorest countries, "the average of many basic interventions is falling, not rising. In many countries, the percentage of mothers whose births were attended by trained mid wives or doctors is falling. Despite the importance of vaccination for child survival, levels of childhood vaccination stagnated or dropped in many poor countries in the 1990s"… In his report of the Commission on Macroeconomics and Health (CMH), Sachs calculates that the annual net financing gap (in USD 2002) for all recipient countries would be 22.1 billion USD in 2007 and 30.7 billion

USD in 2015.

One of the major estimated benefits would be that by 2010 around 8 million lives per year, in principle, could be saved by the essential interventions against infectious diseases and nutritional diseases recommended in the CMH report.

Looked at on a “per capita” basis, these costs are not excessive, since they translate into 34 USD per person per year (considering the average of 2000 USD in high income countries), of which nearly half could be covered by the (least developed) countries themselves. On balance, these calculations assume that low income countries could devote 5% of their GNP to health (vs. 10% approximately in high income countries).

The proposals of the CMH have been partly implemented, for example, by the creation of a Global Fund to fight Aids, Tuberculosis and Malaria. The Global Fund has already in its 2-year existence, committed USD 3 billion for 310 grants in 129 countries (6). The three combined kill more than 6 million people each year.

There is another way to look at the technological cost equation. It may be observed (7) that high income countries, on average, are spending in excess of 10% of their GNP on health (i.e., > 2.500 USD billion per year meaning some 2500 per cap.).

The differential per capita, therefore, is roughly 40: 1. Most of this is due to technology (in the sense of products, services and infrastructure). The double burden of disease (communicable and non-communicable) needs no more emphasizing, and therefore people of low-income countries will be in need of, and expecting, modern health care. Hence the importance of affordable - up to date - “appropriate” technologies. One of the end-products of scientific and technological progress, by essence, is a decrease in cost (e.g., computer memory) and there is no reason why, if looked at on a longer time horizon, the reasoning could not apply to health.

-
-
-

Bibliography

1.Gunn S.W.A., Mansourian P.B., Davies A.M.,Piel A.,and Sayers B.McA., 2005,” *Understanding the Global Dimensions of Health* “, Springer, [a book compilation of learned essays on various aspects of international health].(with permission from the editors)

2. Mansourian, B., 2004,” *Health Science and Technology*: Gaps and Opoortunities “, Bull.Seanc.Acad.r.Sci.Outre-Mer, 48:475-486: an overview of worldwide disparities in S&T development in the light of modern trends.

3. World Health Reports, 2002, 2003: the authoritative WHO reference on the state of World Health.

4. World Development Report, 1993, "Investing in Health ", World Bank: A special study of the World Bank on World Health

5. Sachs, J.D., 2002: "Macroeconomics and Health: Investing in Health for Economic Development " [a report of the WHO Commission on Macroeconomics and Health, headed by Prof. J.Sachs].

6. www.theglobalfund.org: website for the global fund for Aids,Tuberculosis and Malaria.

7. World Development Report, 2002, 2003, World Bank: the authoritative annual report on world economic development.

8. Mansourian, B., 1995, ACHR News, Bulletin of the World Health Organisation, 73(2)259-264: a summary report on major issues discussed at the top WHO advisory body on Health Research.

9. www.forbes.com/huber: a provocative article on health economics.

10. Financial Times , November 2003 : (a report on Biotechnology)

11. Nebecker,F., 2002 "*Golden accomplishments in Biomedical Engineering*", special issue of EMB (entitled ' Charting the Milestones of Biomedical Engineering ' : a historical review. (courtesy of the Executive Office of IEEE)

12 WHO/FNU/FOS/95.12, 1995, World health Organisation: a special report on Food Safety.

Biographical Sketch

Dr. Boutros-Pierre Mansourian, (MB,ChB,MD,Mphil,PhD,DIC) is a medical graduate from the Universities of Cairo and Lausanne. He pursued his postgraduate training in the University of London (biomedical engineering, neurophysiology, and epidemiology) before joining WHO in 1969, with the Division of Research in Epidemiology and Communication Science. A few years later he was appointed to the Office of Science and Technology, an advisory unit to the Director General. He continued with that office (subsequently renamed Research, Promotion, and Development), serving as its Director from 1994 until retirement (1998). He published original work in a wide range of fields including neurophysiology, medical informatics, systems analysis (transfer function of the vestibulo-ocular control system), and epidemiology (digital filters and pattern recognition techniques in epidemiological variables). He served as Secretary of WHO's Advisory Committee on Health Research, and participated closely with that body in the formulation of research strategies and policy principles for the Organization during the 1980s and 1990s. In his co-ordinating roles he has been instrumental in promoting new methodologies such as remote sensing, systems modeling, and artificial intelligence in various WHO programmes.

Dr Mansourian is an elected member of the US Institute of Electrical and Electronics Engineers (1968), the Belgian Royal Academy of Overseas Sciences (1998), and the City and Guilds of London Institute (1999). He is also a member of the Royal Society of Medicine andthe New York Academy of Sciences.