Health Technology: Challenge to Public Health

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Health technology includes drugs, procedures, techniques, and equipment used by health professionals to provide health care, and the organizational and supporting systems within which care is delivered. Such new technology may comprehend new drugs, new medical devices and appliances, new medical activities and surgical procedures, health promotion and disease prevention activities, and organizational and supporting systems. To achieve maximal use of available resources and constant selection among alternatives offered, health technology assessment is indispensable as a scientific effort to determine the extent to which and under what conditions a specific technology is efficacious, effective, safe, and cost-effective. Since today the greatest benefit to patients must be achieved at the lowest cost, one of the ways to achieve this goal is to promote health technology assessment and thus build the healthcare infrastructure on more scientific and objective foundations.

Key words: biomedical enhancement; biomedical technology; health care quality, access and evaluation; quality assurance, health care; quality of health care

Health technology includes drugs, procedures, techniques, and equipment used by health professionals to provide health care, and the organizational and supporting systems within which care is delivered (1). Its universal use started early in the 19th century with the stethoscope, continued towards the end with the invention of sphygmomanometer and the discovery of X-rays, and proceeded at an astounding pace during the 20th century. Health technology has now become a pervasive part of all health care services, and new health technology items are being constantly developed and introduced to replace the old ones. Such new technology may comprehend the following areas.

New drugs that constitute a medical breakthrough, such as ceredase for the treatment of Gauchet’s disease; new antibiotics which are constantly produced; statin for the reduction of cholesterol or thrombolytic agents for use in myocardial infarction; and others.

Medical devices and appliances, ranging from relatively simple (splints and intrauterine devices) to more sophisticated ones (cardiac pacemakers, prostheses, artificial heart valves, intraocular lenses, and artificial joints).

Medical activities, diagnostic imaging using ultrasound, computerized tomography (CT) scanners, angiography, and magnetic resonance (MRI) or therapeutic activities (gene therapy, dialysis, rehabilitation of complex impairments, lithotripsy, and radiotherapy using linear accelerators).

Surgical procedures, such as cardiac surgery, laparoscopic surgery, and organ transplantation.

Health promotion and disease prevention activities, such as mass screening for colorectal and cervical cancer, mammography, early detection of high blood pressure, cessation of cigarette smoking, and prevention of traffic injuries.

Organizational and supporting systems, such as units for catheterization, specialized operating theaters, cancer centers, specialized rehabilitation institutions, and trauma centers.

Many of the new technologies are being introduced in ever-growing numbers, as illustrated by the rise in number of CT and MRI systems in some countries of Western Europe during the second half of the 1980s (Table 1) (2). Following the introduction of such new imaging equipment and procedures, the use of many dangerous, painful, and less informative methods was abandoned.
studies – such as pneumoencephalography, myelography, and intravenous cholangiography – has been reduced or totally eliminated. New procedures have been found to be more accurate, more sensitive, and more specific. Departments for diagnostic imaging have been brought under pressure to perform as many studies using the new health technology devices as possible, e.g., Israel, where the number of new imaging systems and studies performed using them visibly increased during 1990-1992 period (Table 2) (3). Furthermore, the new devices are very expensive to acquire and to operate. The expenditures on the acquisition and operation of an X-ray system with fluoroscopy in Israel are several-fold lower than the cost of more advanced imaging systems (Table 3) (3).

Table 2. Number of computerized tomography (CT) and magnetic resonance imaging (MRI) systems and studies using them in Israel in 1990 and 1992

<table>
<thead>
<tr>
<th>Procedure</th>
<th>1990</th>
<th>1992</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angiography:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>systems</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td>studies</td>
<td>2,100</td>
<td>3,500</td>
</tr>
<tr>
<td>CT:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>systems</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td>studies</td>
<td>200,000</td>
<td>380,000</td>
</tr>
<tr>
<td>MRI:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>systems</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>studies</td>
<td>5,500</td>
<td>11,000</td>
</tr>
</tbody>
</table>

Table 3. Expenditures on diagnostic imaging in Israel, 1995 (in US$)

<table>
<thead>
<tr>
<th>Imaging system</th>
<th>Capital cost of equipment</th>
<th>Cost of a single study</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-ray with fluoroscopy</td>
<td>350,000</td>
<td>100-150</td>
</tr>
<tr>
<td>Angiography</td>
<td>700,000</td>
<td>1,500</td>
</tr>
<tr>
<td>Computed tomography</td>
<td>750,000</td>
<td>220-250</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>1,000,000</td>
<td>1,500</td>
</tr>
</tbody>
</table>

Similar patterns of development also occurred in other fields, such as cardiac surgery. The number of coronary artery bypass operations increased in Germany from 12,000 in 1985 to 29,000 in 1988, and in the Netherlands from 6,800 to 8,280 in respective years. The rate of these operations increased in Germany from 206 per million population in 1985 to 480 per million population in 1988, and in the Netherlands from 480 per million population to 583 per million population in respective years. The number of percutaneous transluminal coronary angioplasty also increased: in Germany from 2,556 in 1985 to 6,400 in 1988 (rate: 90-307 per million population), and in the Netherlands from 2,556 to 6,400 (rate: 190-428 per million population) in respective years (2).

There are wide variations in health technology use both within and across countries. In 1990, there were 3.5 MRI systems per million population in Switzerland, 1.7 in Germany, 1.3 in France, and 1.0 in the UK (Table 1). The rate of percutaneous transluminal coronary angioplasty per 100,000 population in 1990 was 57 in Belgium, 54 in the Netherlands, 48 in Germany, and 14 in the UK (4). Multiple factors, such as clinical policy (primarily), training, and values and interests of medical specialties, are responsible for these variations. The way in which countries manage the demand for health technology and the allocation of health care resources also plays an important role. For example, a regional health authority that has to decide whether to purchase an MRI system for a major clinical center or to install fluoroscopic radiography in several district hospitals may opt for the latter alternative. An all-payer Diagnosis Related Groups scheme, in which the acquisition of capital equipment is not part of a scheme, may promote duplication. Cultural variables and physicians’ attitudes may also play a role. In Denmark, liver and heart transplantation was not introduced until 1990, because criteria for brain death were not accepted until then (4). The use of new health technology enhances prestige and provides means of publishing research results, which may stimulate individual hospitals to seek non-governmental funding, donations mainly, for its purchase.

The capability of health care systems to provide necessary care greatly increased due to health technology development. If a new drug, device or operation can cure illness or prolong life – it is commendable to purchase and use it; if the quality of life can be improved by relief from pain and suffering, by improved functioning or better use of senses, it is also recommendable to purchase and use it. Most of the new technologies have been proven valuable and beneficial in this respect. However, at the same time, the expenditures for health care have increased, largely due to health technology. In Canada, the expenditure for health care increased from CAD22.7 billion in 1980 to CAD66.0 billion in 1991, with much of the increase attributed to health technology, whereas spending on drugs doubled from 1985 to 1990, and spending on devices increased from CAD2 billion in 1988 to CAD6 billion in 2000 (5).

Health Technology Assessment

Since resources are limited, even in rich and developed countries, a gap is created between technological potential and available resources. Hence, it is necessary to achieve maximal utilization of available resources and constant selection among alternatives. The aims should be halting the introduction of health technology of unproven advantage; regulating the diffusion and utilization of health technology with proven benefit; eliminating systems and facilities not absolutely necessary; and preventing the replacement of proven, less expensive diagnostic and therapeutic methods by new, more expensive ones that do not achieve better results.

At first the medical profession was free to select the items needed for use. It worked for some time, thanks to the sense of responsibility of the profession and its competence in applying the technology in an environment of social control overseen by peers. However, the growth of new technology and the enlarging volume of knowledge made it impossible for physicians to keep up with the progress. Inappropriate procedures and ineffective items of health technology crept into health services, largely based on opinions, not on evidence (6). A mechanism for assessing health technology and attaining the above-
mentioned goals was needed. Harvard School for Public Health initiated a conduct of systematic multidisciplinary assessment of health technology and, as a result, the Harvard Center for Evaluation of Clinical Procedures was established in 1973. The initiative was an act of provocation to the medical profession that considered it impossible for non-clinicians to assess medical care scientifically. Howard Hiatt, the leader of the group at Harvard, argued that the medical profession must work closely with other professionals in the assessment of health technology, since physicians alone would not be able to determine which practices were of unproven value and, also, that they would not be able to solve conflicts of interests between the individual and the society.

The formal process of health technology assessment started with the setting up of the Health Program of the Office of Technology of the U.S. Congress in the mid 1970s. During the 30 years of its existence, health technology assessment has expanded in terms of people involved and its importance, and has widened its scope. At present, health technology assessment is a scientific effort to determine the extent to which and under what conditions a specific technology is efficacious, effective, safe, and cost-effective.

Efficacy (“can it work?”) is the benefit of using technology for a particular problem under ideal conditions of use, e.g., within the protocol of a randomized, controlled clinical trial.

Effectiveness (“does it work?”) is the benefit of using a technology for a particular clinical problem under average conditions of use, e.g., routinely by a physician in a community hospital.

Safety answers the question whether or not the technology involves unreasonable risk or harm.

Cost-effectiveness determines whether there is a balanced relationship between the medical effect of the technology and its resource requirements, meaning, is it worth the money?

Thus, health technology assessment is a comprehensive multidisciplinary process that includes (a) testing for efficacy, safety, and effectiveness; (b) economic evaluation; (c) the choice of the best alternative for combining the optimal utilization of financial resources allocated to health care; and (d) attention to social, political, ethical, and legal implications that may be consequences of the use of a given technology.

The ongoing development of health technology, the pervasive role it plays in preventive, curative, and rehabilitative care, variations in its use, and the rise of healthcare costs attributed in large part to health technology use, all make a policy on health technology and health technology assessment crucial for all countries and represent a significant challenge to Public Health in the new millennium. Each country has its specific healthcare system, with its history, philosophy, values, and codes of ethics, and will establish a health technology policy consistent with these features. Whatever the form of a country’s health technology policy and health technology assessment, operationally it is possible to distinguish two aspects in health technology assessment: the regulatory and the advisory.

Regulatory Aspects

This aspect is concerned with the efficacy and safety of an individual item of health technology. In most countries, the government has the authority to regulate drugs, which have to undergo a rigorous process before their marketing, sale, and use are permitted. Once a drug has passed all the checkings for efficacy and safety, as well as economic evaluation, it has to conform to conditions laid down for marketing (who is allowed to buy and sell it), packaging, and labeling (including instructions and warnings). A similar regulating process exists in many countries for devices, but is less rigorous. There are devices, e.g., grafts, that must be tested before use (either by the treating physician or by an appointed committee of the treating facility), whereas there are others that can be purchased for immediate use with no control. This may have tragic consequences. In the 1970s, Dalton Shield, an intrauterine birth control device, was introduced in the USA without rigorous tests for safety and efficacy. In women who used it the unwanted pregnancy rate proved high and side effects common, including pelvic inflammatory disease and uterine perforation.

Advisory Aspects

The advisory aspect of health technology assessment is wider in scope. It aims to provide public health experts, clinicians, administrators, and decision makers with valid and timely information regarding the value of a given health technology. The dominant concerns are evidence of efficacy, effectiveness, and costs, as well as the level of distribution and use. This assessment addresses particularly health technology that is sophisticated and expensive.

In both aspects of health technology assessment, some countries accept the methodological principles...
of foreign testing centers, such as Food and Drug Administration in the USA (FDA) or National Institute for Clinical Excellence (NICE) in the UK, and adapt their findings to local conditions. This is a policy that saves effort and resources. However, it is not sufficient to complete health technology assessment. The dissemination and application of its findings in practice must be assured. There are several ways of implementing this, neither of them completely successful and hence used in various combinations.

**Dissemination and Practical Application of Health Technology Assessment**

**Application of Regulations**
The application of regulations limits entry of drugs and some devices to the market. However, this process does not apply to new procedures unless they incorporate new drugs and devices. Also, the efficacy and safety information generated by health technology assessment makes no reference to alternative methods for managing a condition, nor does it compare different technologies and hence is not sufficient for decision making by public health experts, clinicians and patients.

**Payment Policy**
Payment policy may also serve as an application method of health technology assessment findings. Fixed payments by Diagnosis Related Groups has led to some changes in inpatient care, such as reduced use of intensive care units; however, since the Diagnosis Related Groups scheme payments apply only to inpatient care, problems with the location and cost of technologies may move into the less constrained area of ambulatory care. Capitation payment of Health Maintenance Organizations has financial incentives to implement health technology assessment findings over a broad range of services.

**Distribution of Particular Equipment**
Distribution of particular equipment is effective as long as the government provides the equipment. The distribution policy may be based on accumulating research evidence, which indicates that the greater the volume of performance of a provider, the better the outcome for patients (13, 14). The distribution method may be combined with requirements for licenses for new facilities or services. The granting of license could be based on the benefit to the public healthcare system, the ratio of beds or services in a given catchment area, and the running cost of the new service and its effect on the total, public healthcare expenditure. This could lead to the decision to approve the use of new, expensive health technology according to specified criteria (Table 4) (15). It is also possible to confine certain procedures to specific institutions, e.g., pediatric oncology to be done only in institutions having at least 50 new pediatric patients annually and fulfilling some other criteria concerning radiotherapy, immunology, and pathology. It could also be decided that only specific hospitals be allowed to perform surgery for congenital heart disease (15). Many objections to such policy may arise. Teaching hospitals may claim that they cannot be prevented from treating their patients with the most advanced technology. Another problem is how does one prevent peripheral-sited hospitals being regarded as second rate, how can one endow these hospitals with sufficient prestige? To implement an appropriate health technology policy, one must have a clear idea of what objectives one wishes to achieve and belief in both the idea and the ultimate success of the policy, and to firmly and persistently explain the policy.

**Professional Regulation**
Professional regulation is another form of applying the findings of health technology assessment. In this case, the control mechanism lies with professional medical societies (Colleges of Physicians or Surgeons in some countries), in peer review or audit activities, or with special boards of physicians. All these have an important impact at the level of clinical practice.

**Regulation by Health Insurance**
Regulation by health insurance depends on the benefit package of the insurance, which is legally defined in its program. However, the entitlements were usually expressed only broadly. Beyond these broad expressions, decisions were made implicitly: the services offered were those that physicians of the program deemed appropriate. As problems of cost and the quality became more demanding, insurance programs had to begin making such decisions more explicitly. Thus, they have defined so-called “service baskets”, i.e., drugs and services to which insured members are entitled. A unique aspect of an Health Maintenance Organization (or a service provided by the state, e.g., a National Health Service) is the integration of the insurance and the provider functions and permits more direct control over the content of care provision. Health Maintenance Organization or National Health Service may issue clinical practice guidelines or directions for use of new technology, such as clinical indications that justify the use, or the approval process to go through before a medication or a procedure can be applied.

**Role of Consumers**
The role of consumers is important in the application of health technology assessment findings, but it is not known how they use the information on findings of health technology assessment. Patients appreciate that certain lifestyles confer risk for heart disease but their propensity to change their behavior or comply with treatment is not great, and it seems that they,

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**Table 4. Government approval for acquisition and use of expensive health technology in Israel, 1995**

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<thead>
<tr>
<th>Health technology</th>
<th>Conditions/criteria</th>
<th>Acquisition rate/population</th>
</tr>
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<tbody>
<tr>
<td>Computerized tomography</td>
<td>hospitals of 300+ beds</td>
<td>1:200,000</td>
</tr>
<tr>
<td>Magnetic resonance imaging</td>
<td>hospitals of 400+ beds and departments of neurology and neurosurgery</td>
<td>1:750,000</td>
</tr>
<tr>
<td>Cardiac catheterization</td>
<td>hospitals of 300+ beds and a coronary intensive care unit</td>
<td>1:200,000</td>
</tr>
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</table>
as well as some physicians, have unrealistic expectations of the efficacy and benefits of cardiac surgery (16). Therefore, both consumers and providers should be educated on the limits of medical care and technology, as well as on the matters of its effectiveness and even cost-effectiveness.

**Health Technology Assessment and Quality of Care Improvement**

Health technology assessment and quality of care improvement are closely related, though they address different aspects of health care (17). The aims of health technology are to promote efficaciousness and cost-effectiveness of a particular technology, to protect people from ineffective health interventions, and to enhance safety. Improvement in quality of care is concerned with application of health technology assessments and findings in the most competent and least wasteful way.

**Conclusion**

Health technology poses a serious challenge to public health, which faces issues of equity, equal accessibility, and cost effectiveness of health care. In most countries, resources for health care are shrinking and the costs of delivering care are increasing. On the other hand, the greatest benefit to patients must be achieved at the lowest cost. One of the ways to achieve this goal is to promote health technology assessment and thus build healthcare infrastructure on more scientific and objective foundations.

**References**


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