

The impact of medical technology on healthcare today

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Introduction

Rapidly changing medical technology and availability of high technology diagnostic and therapeutic equipment together with changing practice pattern of doctors has revolutionized the way health care is being delivered today.

Without doubt, medical technology is indispensable for people's health and better quality of life in some areas; and contributes billions of dollars to the economy.

Some would go so far to say that the practice of medicine these days is inherently dependent upon health technology. This is probably based on the observations that clinicians use a wide variety of technologies in diagnosing, treating and assessing the care of their patients.

Today's medical technology is more advanced, more effective, and in many cases, more costly than ever before. Furthermore there is an ever increasing demand for high technology diagnostic and therapeutic health care facilities and their availability may come into conflict with medical necessity, social justice and cost effectiveness.

There is increasing pressure on health care resources that is driving more explicit and public decisions regarding the best use of these resources. The complexity of modern technology and its high marginal cost suggest to us that testimonial reviews of new technologies are no longer sufficient.¹ Current trends in health care decision making favour a transition from a rationale based primarily on resources and opinion to a rationale derived from research.

In developing a new health care technology it is important to recognize its potential impact. The important question would be whether the new technology provides information that was not previously available and the new information may result in the cure of a common and otherwise fatal disease. Technology assessment helps physician by determining which technologies are most apt to benefit the patient, allowing the physician to recommend a prudent course of action. Technology assessment should encourage skepticism of new technology, causing the clinician to be more rigorous about accepting the latest invention. It will substantially contribute to better utilization of the scarce health care resources.²

Demands for increased productivity despite cuts in financial resources have renewed the discussion of cost effectiveness in medical care. Important parameters that should be considered include the incidence and prevalence of the disease, the cost and success of treatment, the cost and success of diagnosis, and the cost and success of preventive treatment. One fundamental issue of health care economics is the study of cost versus benefit analysis. It is often difficult to place a dollar value on a person's life, as is commonly done in the courtroom.

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Benefits

Any new technology, process, innovation or product will have a certain level of risk associated with it as, contrary to the wistful utterances of many politicians, there are no such thing as 'zero risk'. In fact there can be no innovation at all without an element of risk.

Medical technology industry's point of view is that they have to identify the appropriate hazards for a product or process, estimate the risks associated with them, reduce risks by appropriate risk control measures in an iterative process, taking care that we do not inadvertently introduce new risks by such actions, and consider the overall residual risks remaining after risk control measures have been implemented. The decision on the acceptability of that residual risk must take into account the benefit to the patient.

Most people inherently believe that the American healthcare system is safe and some countries use it as a yardstick. While this assumption is valid, it is also a fact that between 44,000 and 98,000 Americans die each year as a result of medical errors in hospitals, a number greater than the number of people killed annually from car accidents, breast cancer or AIDS. Recent studies have estimated that medication errors alone account for over 7,000 deaths annually.³ The total national cost (including lost income, disability and medical expenses) of preventable adverse medical events is running between \$17-\$29 billion dollars annually.⁴ Medical technology has in this instance help reduce morbidity and mortality from medial errors by providing electronic prescriptions that allow physicians to know if there is drug-drug or drug-food interaction. Some systems goes as far as providing information on physician profiling and disease management but also monitoring and assessing the care delivered to every member in the health plan.

Case examples

Three examples are provided to exemplify the complex issues of advances made in medical technology in the last few decades and to the extent in which their benefits have outweighed their cost.

Diagnosing and treating breast cancer

Despite the fact that breast cancers are being detected earlier, it has also been recognized that most breast cancers progress slowly and many occur in older women who may die from other causes before their cancer becomes symptomatic. It has been estimated that survival after breast cancer increased by four months during the period and average cost to treat breast cancer rose by about US\$20,000. This was observed from innovations in treatment from 1985 to 1996 using data from Medicare claims records in the US matched to the National Cancer Institute's Surveillance, Epidemiology and End Results program.⁵

Technology for heart attacks

Heart attack treatment is a compelling example of the benefits of new technology. Treatment of heart attack has changed to include the use of bypass surgery, clot dissolving drugs, angioplasty, angioplasty with stents and long-term drug therapies that reduce the chance of additional heart attacks. Spending on heart attack patients covered by Medicare in the US increased from \$3 billion in 1984 to \$5 billion in 1998, despite the fact that the number of heart attacks declined. These increased costs were due more to the use of intensive technologies rather than to the increase in the cost of treatment. In 1984 nearly 90% of heart attack patients were managed medically. By 1998 more than half of patients received surgical treatment. It is found that the use of new technology treatment helped to increase the average heart attack patient's life expectancy by one year. Around 70% of the survival improvement in heart attack mortality is a result of changes in technology. Technology increases spending, but apparently the health benefits more than justify the added costs.⁶

Telemedicine

Telemedicine is a system of health care delivery in which physicians examine distant patients through the use of telecommunications technology. The driving forces for Telemedicine advancement and adoption

have been as follows: (1) communications infrastructure development with network development and increase bandwidth availability, and (2) decreasing cost of data transmission with scientific advancement in digitalization of medical and non-medical requirement.

It started as a telecommunications augmentation to medical care but has now evolved into an integrative process of information technology and health care. It has the ability to see new and more productive interrelationships among medical professionals, patients, insurers, policy makers, businesses and the community at large. Full service telemedicine networks or systems provide a broad range of clinical services in various specialty areas, as well as continuing medical education and preventive health.

The multiple and emerging definitions of telemedicine reflect the fact that the current generation of telemedicine is evolving and the new uses for the technology are being discovered and implemented. The World Health Organization has fostered the inclusive concept of health telematics/telemedicine to refer to various 'health related activities, services and systems carried out over a distance by means of information and communications technology.'⁷

Some proponents have suggested that telemedicine will eliminate the problems related to the geography of medical care, and this attribute of telemedicine is emphasized in both professional literature and mass media reports.⁸ This suggests a potential for telemedicine in enhancing access to quality care. The degree to which telemedicine is accepted and adopted is therefore largely dependent on accessibility to telemedicine. On the other hand, if the technology represents a new and valued resource available only to the educated and those who can afford it, we should be concerned about creating another underclass lacking the ability to use it.

The concept of quality is multidimensional and complex, and has been narrowly defined in telemedicine research.⁹ There is strong and consistent evidence of general satisfaction with telemedicine among both providers and clients, regardless of whether satisfaction is measured in attitudinal or

behavioral terms.¹⁰ Most inadequacies are related to specific instances of failure in diagnostic accuracy and were fully attributable to the specific technology that was used, such as the lack of colour in dermatological images.¹¹

The emphasis on costs in telemedicine is receiving increased scrutiny owing to the ever rising costs of medical care, shifting patterns of care from the hospital to dispersed care networks, and expected growth in medical care demands by an aging population usually with limitations in mobility. The issue of cost is considered an important issue pertaining to acceptance of telemedicine by medical health care professionals, administrators and policy makers. Thus far, telemedicine's potential to contain the costs of medical care from the providers' perspective has not been demonstrated adequately. This has in part to do with the fact that the fast pace of technological changes has made it difficult to estimate true capital (fixed) costs or even operational (variable) costs. The cost savings of telemedicine compared with traditional alternatives depend on transportation costs, volume, time sensitivity of care and the cost of the alternative is difficult to quantify with certain accuracy. However, there is an agreement that advances in digital medical applications and lower-cost information technologies are improving the financial prospects for telemedicine.

Telemedicine is not only a technological innovation but a socio-cultural one as well. The essential nature of the usually specialist physician-patient encounter is changed from one of human to one of electronic contract and information exchange. Thus, telemedicine has social policy implications as well.

Possible causes of unnecessary usage and increase cost

The abundance of technology and specialists in the United States, compared with most other developed countries, has not assured better public health. The United States ranks tenth or below for indicators such as low birth weight percentage, neonatal mortality, years of potential life lost, and life expectancy at age 1, age 15 and age 40.¹²

Health professionals and laypersons alike tend to equate new medical technology with better-quality health care, assuming that newer is better. There is also an apparent assumption that more and newer technology must be superior to less and older technology. In a 1994 survey, 33% of Americans, 27% of Canadians, and 11% of Germans thought 'modern medicine can cure any illness with the access to advanced technology'.¹³ Therefore there is a problem of misconception.

Much of the scientific literature on diffusion of innovations focuses on the anticipated beneficial effects of new technology and methods to ensure its rapid adoption. Many new medical technologies are introduced and disseminated with only modest evaluation of efficacy, optimal indications, or impact on practice. Unfortunately, their use in routine care sometimes proves futile or even harmful. The adverse effects and consequences of new technology are often unanticipated.¹⁴

A host of factors unrelated to scientific evidence may promote the use of new tests and treatments, often in the absence of strong evidence of their benefit. These factors include direct-to-consumer advertising, aggressive marketing to health care providers, media hype of new technology, political pressure from advocacy organizations, legal decisions, and even legislative action.

The marketing of the new technology is often designed to maximize demand, and this has reached its extreme expression in direct-to-consumer advertising of prescription pharmaceuticals. Direct to consumer advertising are driving healthcare costs up.¹⁵

There are convincing evidence to suggest that ownership of imaging facilities leads to greater use of imaging.¹⁶ Other perverse financial incentives may result in additional forms of conflict of interest. Identifying more disease means more business.

Inappropriate screening by well meaning clinicians are sometimes prompted to undertake screening tests in asymptomatic patients whom they perceive to have a high risk of a serious disease. In some cases, diagnostic

tests themselves carry iatrogenic risks, regardless of subsequent treatments.¹⁷

Physicians sometimes request unnecessary tests or treatments in order to avoid medico-legal liability for a missed diagnosis or treatment opportunity. In other situations, having a low tolerance for ambiguity by doctor or patient similarly may lead to unnecessary investigation and treatment. The analysis suggests that defensive medicine is not merely a problem of increased cost, but also one of reduced quality-of-care.¹⁸

Newer diagnostic technologies are able to detect ever smaller or milder abnormalities that aggravate the problem. Many of the small abnormalities detected with new imaging techniques are often clinically irrelevant. Spinal MRI exemplifies the problem of discovering more and more abnormalities with most having no clinical relevance.^{19,20} An Institute of Medicine study concluded that lumbar spine surgery is overused and misused in United States, and the wide use of imaging studies may be a driver of this excess use.²¹

Nevertheless, even clinically important abnormalities are detected at much earlier stages than was previously possible. Because of this, their outcomes superficially appear to be improved, when in fact much of the improvement is due to lead time bias and length bias. Higher rates of detection create the impression of higher disease incidence and prevalence, which along with seemingly improved treatment efficacy, lead to ever more frequent testing and treatment. This cycle affects both individual patients and large populations of patients for whom resources are unnecessarily wasted. Such interventions may also lead to unnecessary iatrogenic illness.²²

Researchers may help by better exposing the natural history of increasingly mild disorders detected by advanced technology. Better evaluation of the benefits and harms of treating such mild disease will also facilitate future screening and diagnostic decisions.

While cost-reducing technology has blossomed in other sectors of the economy, the health care arena remains untouched by these advances in efficiency. Research toward new technology usually aims to lessen

expenses, although medical discoveries by research scientists can sometimes increase costs. For example, previously incurable diseases that were ignored as hopeless cases have become curable thanks to advances in medical technology.

Patients themselves often do not recognize unnecessary medical care, and patient request for unnecessary care are common in day-to-day practice. Patients often equate laboratory testing and imaging with high quality care and assume that the only reason for not performing such tests is financial. In some studies, inappropriate diagnostic tests were most likely to be done among patients with the strongest perception of need.²³

How to choose

Physicians and patients alike must recognize that newer and more is not the same as better. Innovators, researchers and early adopters of new technology should be alert to unanticipated adverse effects. Early studies of a new technology are often vulnerable to biases and limitations in application of results.²⁴ For new medications, pre-marketing evaluation is quite vigorous but this is less true of devices and procedures. For those new technologies, post-marketing surveillance has been relatively informal and poorly organized and better surveillance may help to identify problems at an earlier stage of technology dissemination.

The decision to implement a new medical technology requires that it not only increases survival or quality of life, but also economically sound. It is not easy as the fast pace of technological changes have made it difficult to estimate true capital (fixed) costs or even operational (variable) costs. The increasing costs and improved technologies that distinguish the health care industry force policymakers to question whether the process of implementing new technologies operates at the most efficient level.

The adoption of technology does not necessarily need to be complex or expensive. Many times, leveraging existing technology can produce easily measured

returns in the form of improved productivity and other cost savings. These types of projects which provide the organizations with quick 'wins' are limited only by the ability to imagine new and better uses for the technology.²⁵

Important points to consider when performing a cost-effectiveness study are what perspective to take; comparing the technology with the next best strategy; including both effectiveness and costs; the distinction between describing and valuing the quality of life; intangibles such as the value of information, and the incremental cost-effectiveness ration.²⁶

Physicians can help by acquiring a more complete understanding of the predictive value of diagnostic tests. Diagnostic testing should only be undertaken to answer very specific questions in order to avoid a shotgun approach. These high selective approaches are more likely to avoid test complications, false-positive results, costs and anxiety.

Ethics

The ethical issues on medical technology or innovations are profound and their controversies are enormous. In the old days, ethics and medicine were not often in conflict. The physician intervened to save lives when he could, but his main limitation was technology. Nowadays, however, we have the technology to keep life going for an indeterminate period, blurring distinctions between life and death.

However, it is equally true that we have always been confronted with the same objective: to do the best that we can to preserve life given the limited resources while the demands are unlimited.

Many ethical issues have been raised since and an example includes a recent study on the use of invasive procedures among Medicaid patients in the US with acute myocardial infarction. In the study, factors other than age, race, sex, income, coexistent illness and location of care, account for lower use of invasive procedures among Medicaid patients. The influence of Medicaid on medical practice and process of care thus deserves investigation.²⁷

It is of the author's belief that it is not the advance of medical technology by itself that creates these conflicts but the lack of a basic framework to guide us, based on time-tested rules, in making ethical decisions.

Conclusion

The growth in health care technology is ubiquitous and has far reaching consequences both for users and providers. Technological assessment with respect to this benefit and cost aspects has been evaluated, but still requires much work in detail. Future progress depends on today's investment in research, development, and education. We cannot leave such urgent issues to determine themselves but rather must actively collaborate to ensure a stable healthcare system.

Technology is moving forward so rapidly that the rest of the world (developing countries) may not be able catch up. Will peoples still have fast access to innovative medial technologies in the future?

Despite the high costs and complexity of medical technology, the use of new technology continues to spread. The benefits of medical advancements outweigh their drawbacks. Expensive technology is a bargain if it can improve quality of life, preserve economic productivity and prevent the high cost of disability.

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