Who will consider these costs? The diffusion of robotic technology depends on fragmented, not centralized, decision making. Decisions to purchase robots are made not by payers but by hospitals, which compete with one another to attract surgeons and their patients. Hospitals, seeking surgical volume, find it difficult to resist surgeons' preferences, even without favorable direct reimbursement, and surgeons feel compelled to keep up with market demands so as not to lose patients.

Comparative-effectiveness research — often considered a corollary of regulatory cost containment — can play a critical role in this decentralized process. To date, there have been no large-scale randomized trials of robot-assisted surgery, and the limited observational evidence fails to show that the long-term outcomes of robot-assisted surgery are superior to those of conventional procedures.[1] Evidence from well-designed, large-scale, multicenter trials or comparably rigorous nonrandomized evaluations is needed to determine which patients benefit from open surgical approaches and which from robot-assisted approaches. Hospitals could use this information in response to pressure from technophile surgeons; surgeons could use it in discussing treatment options with patients; patients could use it to make treatment choices; and payers could use it in negotiating reimbursements. An efficient health care system must enhance the ability of medical professionals and their patients to make informed choices about the adoption and use of new technologies, even when insurers do not explicitly provide reimbursement for these new technologies.

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**1.** Hu JC, Gu X, Lipsitz SR, et al. Comparative effectiveness of minimally invasive vs open radical prostatectomy. JAMA 2009;302:1557-64.
**2.** Wilt TJ, MacDonald R, Rutks I, Shamliyan TA, Taylor BC, Kane RL. Systematic review: comparative effectiveness and harms of treatments for clinically localized prostate cancer. Ann Intern Med 2008;148:435-48. [Erratum, Ann Intern Med 2008;148:888.]
**3.** Healthcare Cost and Utilization Project. HCUPnet. Rockville, MD: Agency for Healthcare Research and Quality, 2010. (Accessed July 2, 2010, at http://hcupnet.ahrq.gov/.)
**4.** Altekruse SF, Kosary CL, Krapcho M, et al. SEER Cancer Statistics Review, 1975-2007, National Cancer Institute, Bethesda, MD. (Accessed July 20, 2010, at http://seer.cancer.gov/csr/1975_2007/.)
**5.** Nguyen PL, Lipsitz SR, Choueiri TK, et al. Time trends in the utilization of higher-cost treatments for prostate cancer: 2002-2007. Presented at the ASCO Genitourinary Cancers Symposium 2010, San Francisco, March 5–7, 2010.

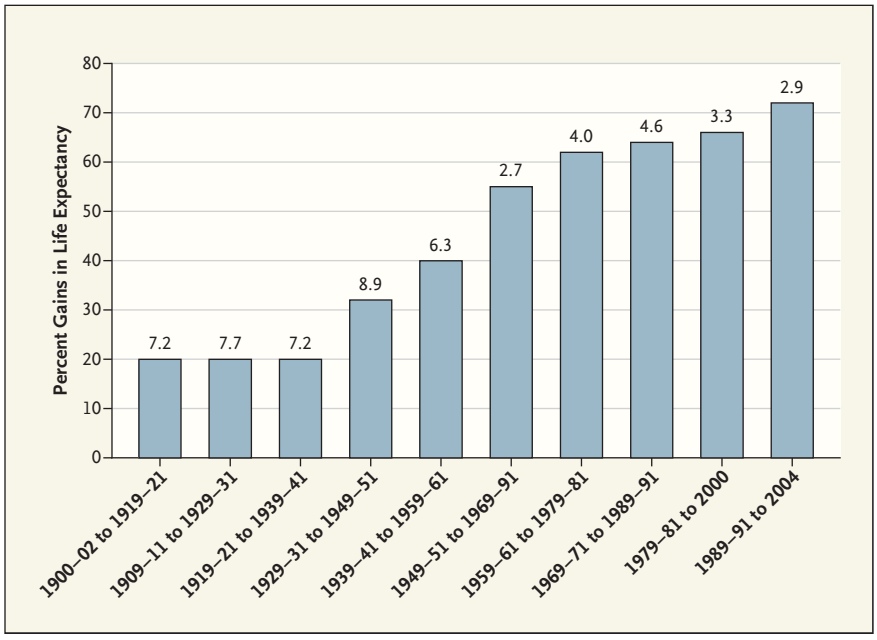


# New Priorities for Future Biomedical Innovations

Victor R. Fuchs, Ph.D.

Since 1900, life expectancy at birth has increased by an unprecedented 30 years in the United States and other developed countries. Before World War II, most of the gains resulted from improvements in nonmedical factors: nutrition, sanitation, housing, and public health measures. Since World War II, however, biomedical innovations (new drugs, devices, and procedures) have been the primary source of increases in longevity. These innovations have also been the most important reason why health care expenditures have grown 2.8% per year more rapidly than the rest of the economy over the past 30 years.[1] Will the future simply be a rerun of recent decades? Probably not. Current demographic, social, and economic forces will create new priorities for future biomedical innovations: more emphasis on improving quality of life and less on extending life, and more attention to value-enhancing innovations instead of pursuit of any medical advance regardless of its cost relative to its benefit.

Society may not pursue further gains in life expectancy as vigorously as we've done in the past, because there has been a dramatic shift in the age at which the increased years of life are realized (see bar graph). In the early decades of the 20th century, approximately 80% of the gains in life expectancy were realized before the age of 65 years and only 20% at 65 years or older. Now the situation is reversed — almost 80% of recent gains in life expectancy are realized at an age of 65 years or older. The main reason for the change is the sharp decline in rates of death at younger ages; thus, an ever-



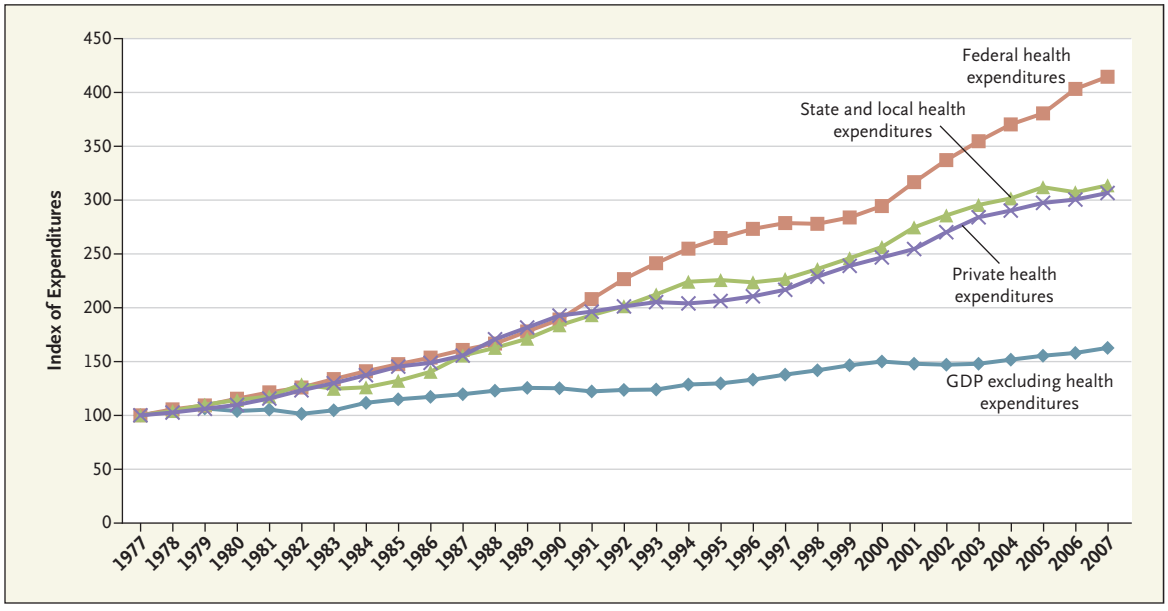

**Percent Gains in Life Expectancy Realized at 65 Years of Age or Older during Overlapping Periods.**
The value at the top of each bar is the number of years by which life expectancy increased during the period.

larger percentage of each birth cohort survives to at least 65 years of age. At the beginning of the 20th century, given the age-specific mortality rates of that time, only 41% of the birth cohort could expect to reach 65 years of age. By the end of the century, survivorship until 65 years had doubled, to more than 81%.[2] When survivorship to 65 years of age was low, gains in life expectancy meant keeping more Americans alive during their working years. Now, further gains in life expectancy will mostly mean keeping more Americans alive while they are retired and dependent on indirect transfers of funds from younger workers for much of their living expenses, health care, and social services. At 65 years of age or older, 4 of 5 men and 9 of 10 women are not in the labor force, and almost 4 of 10 have a physical or mental disability. Moreover, almost half of all patients in hospital beds are 65 years of age or older.[3] The U.S. entitlement programs for the elderly will be major contributors to huge federal deficits for the foreseeable future — deficits that are often invoked as reasons not to spend federal dollars providing health insurance to all Americans.

A diminished focus on developing innovations that increase life expectancy could and should be accompanied by greater pursuit of innovations, such as joint replacement, that improve the quality of life for both the elderly and the near-elderly. The potential market for quality-of-life enhancement among Americans 55 years of age or older is huge: 3 of 10 such Americans have difficulty stooping or bending, 1 of 10 has difficulty reaching or grasping, 4 of 10 usually sleep less than 7 to 8 hours in a 24-hour period, 15% have difficulty carrying 10 lb (4.5 kg), nearly one third have some hearing impairment, one fifth have lost all their natural teeth, and 1 of 4 has difficulty walking a quarter of a mile (0.4 km).[4]

Along with the shift in emphasis to developing future innovations that enhance quality of life, there is a growing need for a shift to value-conscious innovation instead of fostering the "progress at any price" attitude that has dominated biomedical innovation until now. The economy cannot continue to cope with the rapid increase in health care expenditures, an increase that is fueled in large part by innovations produced in an environment that ignores cost. The problem is not just federal health care expenditures. State and local governments, hard-pressed to meet their obligations under Medicaid and other health care programs, are forced to cut back support for education, repair of roads and bridges, and other critical expenditures. And the private sector is also under duress (see line graph). A rapid increase in the cost of employment-based health insurance is the major reason why the wages of the average worker have been relatively stagnant for three decades.[5]

To understand the differences between the present environment for biomedical innovations and a value-conscious one requires thinking of three effects of every innovation: its effect on the quality of care (including reductions in mortality and morbidity rates, relief of pain, and improvement of other types of care that patients desire), its effect on the cost of care (the resources used to develop it and provide it to patients, relative to those used for




**Indexes of Health Expenditures and the Gross Domestic Product (GDP) Excluding Health Expenditures, per Capita, Adjusted for Inflation, 1977–2007.**

The index value at 1977 was set at 100.

current practice), and its effect on the value of care (changes in quality relative to changes in cost). Until now, most biomedical innovations have been evaluated (if at all) only in terms of their effect on the quality of care. Cost is usually ignored, which means that value is ignored as well. There have been a few key innovations that increase quality of care and decrease the cost of care, resulting in unambiguously positive value; examples are antibiotics and diuretics. Most innovations, however, increase both quality of care and costs. Their effect on value depends on the relative sizes of these increases. In a value-conscious environment, some of the most popular innovations would meet a reasonable value standard, but many probably would not.

An additional important result of a value-conscious environment would be the encouragement of innovations whose main effect is to substantially decrease cost while holding quality constant or reducing it only slightly. Such innovations are common in other industries but rare in medicine. If some of the resources devoted to marginal advances in the quality of care were reallocated to the development of innovations that reduced the cost of care, the problem of paying for high-value advances in quality for the entire population would be much easier to address.

Despite passage of the Patient Protection and Affordable Care Act, there is still need for health care reform that will slow the rate of growth of expenditures. Regardless of whether that reform involves a much larger role for government or is more market-oriented, a shift in emphasis toward more value-conscious innovations is necessary and perhaps inevitable.

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**1.** Pauly MV. Competition and new technology. Health Aff (Millwood) 2005;24:1523-35.
**2.** United States life tables, 2004. Atlanta: Centers for Disease Control and Prevention, 2007.
**3.** Bureau of the Census. Statistical abstract of the United States, 2009. Washington, DC: Goverment Printing Office, 2009.
**4.** Schoenborn CA, Heyman KM. Health characteristics of adults age 55 years and over: United States, 2004-2007. Natl Health Stat Report 2009;16:1-31.
**5.** Emanuel EJ, Fuchs VR. Who really pays for health care? The myth of "shared responsibility." JAMA 2008;299:1057-9.