How Changes in Medical Technology Affect Health Care Costs
March 2007

Health expenditures continue to grow very rapidly in the U.S. Since 1970, health care spending has grown at an average annual rate of 9.8%, or about 2.5 percentage points faster than the economy as measured by the nominal gross domestic product (GDP). Annual spending on health care increased from $75 billion in 1970 to $2.0 trillion in 2005, and is estimated to reach $4 trillion in 2015. As a share of the economy, health care has more than doubled over the past 35 years, rising from 7.2% of GDP in 1970 to 16.0% of GDP in 2005, and is projected to be 20% of GDP in 2015. Health care spending per capita increased from $356 in 1970 to $6,697 in 2005, and is projected to rise to $12,320 in 2015.1

The particularly rapid increases in health insurance premiums over the last few years have focused the health policy community on the issues of cost containment and health insurance affordability. A key question from policymakers is why spending on health care consistently rises more rapidly than spending on other goods and services. Health care experts point to the development and diffusion of medical technology as primary factors in explaining the persistent difference between health spending and overall economic growth, with some arguing that new medical technology may account for about one-half or more of real long-term spending growth. This paper briefly describes what health policy analysts mean by medical technology and the mechanisms by which it affects the growth in health care costs.

What is Medical Technology?

Broadly speaking, the term “medical technology” can be used to refer to the procedures, equipment, and processes by which medical care is delivered. Examples of changes in technology would include new medical and surgical procedures (e.g., angioplasty, joint replacements), drugs (e.g., biologic agents), medical devices (e.g., CT scanners, implantable defibrillators), and new support systems (e.g., electronic medical records and transmission of information, telemedicine).2 There is very little in the field of medicine that does not use some type of medical technology and that has not been affected by new technology.

Heart disease and its consequence, heart attack, is the leading cause of death in the U.S. and a good example of how new technology has changed the treatment and prevention of a disease over time. In the 1970s, cardiac care units were introduced, lidocaine was used to manage irregular heartbeat, beta-blockers were used to lower blood pressure in the first 3 hours after a heart attack, “clot buster” drugs began to be widely used, and coronary artery bypass surgery became more prevalent. In the 1980s, blood-thinning agents were used after a heart attack to prevent reoccurrences, beta-blocker therapy evolved from short-term therapy immediately after a heart attack to maintenance therapy, and angioplasty (minimally invasive surgery) was used after heart attack patients were stable. In the 1990s, more effective drugs were introduced to inhibit clot formation, angioplasty was used for treatment and revascularization along with stents to keep blood vessels open, cardiac rehabilitation programs were implemented sooner, and implantable cardiac defibrillators were used in certain patients with irregular heartbeats. In the 2000s, better tests became available to diagnose heart attack, drug-eluting stents were used, and new drug strategies were developed (aspirin, ACE inhibitors, beta-blockers, statins) for long-term management of heart attack and potential heart
attack patients. From 1980-2000, the overall mortality rate from heart attack fell by almost half, from 345.2 to 186.0 per 100,000 persons.\textsuperscript{3}

Another example of how advances in technology have changed health outcomes over time is in the treatment of pre-term babies, for which very little could be done in 1950. But by 1990, changes in technology, including special ventilators, artificial pulmonary surfactant to help infant lungs develop, neonatal intensive care, and steroids for mother and/or baby, helped decrease mortality to one-third its 1950 level, with an overall increase in life expectancy of about 12 years per low-birthweight baby.\textsuperscript{4}

**How Does New Medical Technology Affect Health Care Spending and Costs?**

While a particular new technology may either increase or decrease health care spending, researchers generally agree that, taken together, advances in medical technology have contributed to rising overall U.S. health care spending. Rettig describes how new medical technology affects the costs of health care through the following “mechanisms of action”:\textsuperscript{5}

- Development of new treatments for previously untreatable terminal conditions, including long-term maintenance therapy for treatment of such diseases as diabetes, end-stage renal disease, and AIDS;
- Major advances in clinical ability to treat previously untreatable acute conditions, such as coronary artery bypass graft;
- Development of new procedures for discovering and treating secondary diseases within a disease, such as erythropoietin to treat anemia in dialysis patients;
- Expansion of the indications for a treatment over time, increasing the patient population to which the treatment is applied;
- On-going, incremental improvements in existing capabilities, which may improve quality;
- Clinical progress, through major advances or by the cumulative effect of incremental improvements, that extends the scope of medicine to conditions once regarded as beyond its boundaries, such as mental illness and substance abuse.

Whether a particular new technology will increase or reduce total health expenditures depends on several factors. One is its impact on the cost of treating an individual patient. Does the new technology supplement existing treatment, or is it a full or partial substitute for current approaches? Do these changes result in higher or lower health spending for each patient treated? In looking at the impact on cost per patient, consideration needs to be given to whether the direct costs of the new technology include any effect on the use or cost of other health care services such as hospital days or physician office visits.

A second factor is the level of use that a new technology achieves (i.e., how many times is the new technology used?). Does the new technology extend treatment to a broader population? -- examples would be innovations that address previously untreatable illness, diagnose new populations for existing treatments, or extend existing treatments to new conditions. New technologies can also reduce utilization - - for example, new screening or diagnosis capacity that allows more targeted treatment. There also are temporal aspects to evaluating the impact of new
technologies on costs. Some innovations, such as a new vaccine, may cost more immediately but may lead to savings down the road if the vaccine results in fewer people seeking more expensive treatment. New technologies also can extend life expectancy, which affects both the type and amount of health care that people use in their lifetime.

Evaluating the impact of new innovation can be complicated. For example, a case study that focuses on a single technology or disease may show cost savings based on the costs and benefits of the new technology if it replaces a more expensive technology and provides health improvements, while an analysis of health care system-wide costs may show cost increases if the new technology results in greater utilization than the old. A specific example is anesthesia, where substantial innovations have occurred in recent years. Better anesthetic agents and practices have reduced the burden of surgery on patients, producing faster patient recoveries, shorter hospital stays, and fewer medical errors. These changes reduce the cost per patient compared to surgery in the absence of these changes. At the same time, these innovations also make it possible to perform surgeries on patients who previously would have been considered too frail to undergo the surgery; this adds to the amount of health care that is delivered system-wide, thus perhaps increasing total health care spending.

It is not possible to directly measure the impact of new medical technology on total health care spending; innovation in the health care sector occurs continuously, and the impacts of different changes interrelate. The size of the health sector (16% of gross domestic product in 2005) and its diversity (thousands of procedures, products, and interventions) also render direct measurement impractical. Economists have used indirect approaches to try to estimate the impact of new technology on the cost of health care. In an often-cited article, Newhouse estimates the impact of medical technology on health care spending by first estimating the impact of factors that can reasonably be accounted for (e.g., spread of insurance, increasing per capita income, aging of the population, supplier-induced demand, low medical sector productivity gains). He concludes that the factors listed above account for well under half of the growth in real medical spending, and that the bulk of the unexplained residual increase should be attributed to technological change – what he calls "the enhanced capabilities of medicine."

What Factors Affect the Growth of New Medical Technology?

Many factors influence innovation in medical care. Consumer demand for better health is a prime factor. Research shows that the use of medical care rises with income: as people and the nation become wealthier, they provide a fertile market for new medical innovations. Consumers want medical care that will help them achieve and maintain good health, and advances in medical technology are perceived as ways to promote those goals. Consumer demand is affected by the increased public awareness of medical technology through the media, the Internet, and direct-to-consumer advertising.

Health insurance systems that provide payment for new innovations also encourage medical advances. Medical treatments can be very expensive, and their cost would be beyond the reach of many people unless their risk of needing health care could be pooled through insurance (either public or private). The presence of health insurance provides some assurance to researchers and medical suppliers that patients will have
the resources to pay for new medical products, thus encouraging research and development. At the same time, the promise of better health through improvements in medicine may increase the demand for health insurance by consumers looking for ways to assure access to the type of medical care that they want.

The continuing flow of new medical technology results from other factors including the desire by professionals to find better ways to treat their patients and the level of investment in basic science and research. Direct providers of care may incorporate new technology because they want to improve the care they offer their patients, but they also may feel the need to offer the “latest and best” as they compete with other providers for patients. Health care professionals, like people in other occupations, also may be motivated by professional goals (e.g., peer recognition, tenure, prestige) to find ways to improve practice. Commercial interests (such as pharmaceutical companies and medical device makers) are willing to invest large amounts in research and development because they have found strong consumer interest in, and financial reimbursement for, many of the new products they produce. In addition, public and private investments in basic science research lead directly and indirectly to advancements in medical practice; these investments in basic science are not necessarily motivated by an interest in creating new products but by the desire to increase human understanding.

An estimated $111 billion was spent on U.S. health research in 2005. The largest share was spent by Industry ($61 billion, or 55%), including the pharmaceutical industry ($35 billion, or 31%), the biotechnology industry ($16 billion, or 15%), and the medical technology industry ($10 billion, or 9%). Government spent $40 billion (36%), most of which was spent by the National Institutes of Health ($29 billion, or 26%), followed by other federal government agencies ($9 billion, or 8%), and state and local government ($3 billion, or 2%). Other Organizations (including universities, independent research institutes, voluntary health organizations, and philanthropic foundations) spent $10 billion (9%). About 5.5 cents of every health dollar was spent on health research in 2005, a decrease from 5.8 cents in 2004. It is not known how much of health research was spent specifically on medical technology, though by definition most of the Industry spending ($61 billion) was spent on medical technology. Medical technology industries spent greater shares of research and development as a percent of sales in 2002 than did other U.S. industries: 11.4% for the Medical Devices industry and 12.9% for Drugs and Medicine, compared to 5.6% for Telecommunications, 4.1% for Auto, 3.9% for Electrical/Electronics, 3.5% for All Companies, and 3.1% for Aerospace/Defense.

Policy Issues

Rising health care expenditures lead to the question of whether we are getting value for the money we spend. Compared to other high-income countries, the U.S. spends more, but this spending is not reflected in greater health care resources (such as hospital beds, physicians, nurses, MRIs, and CT scanners per capita) or better measures of health. However, studies have found that, on average, increases in medical spending as a result of advances in medical care have provided reasonable value. For example, Cutler et al. found that from 1960 to 2000, average life expectancy increased by 7 years, 3.5 years of which they attribute to improvements in health care. Comparing the value of a year of life (anywhere from $50,000 to $200,000) to the study’s finding that each year of increased life expectancy cost about $19,900 in health spending (after adjusting for inflation), the authors
concluded that the increased spending, on average, has been worth it.\textsuperscript{13}

No matter the value of advances in medical care, as the rapid growth in health care costs increasingly strains personal, corporate, and government budgets, policymakers and the public must consider the question of how much health care we can afford. Can the U.S. continue to spend an expanding share of GDP on health (from 7.2\% in 1970 to a projected 20\% by 2015)? If the answer is no, then society must consider ways to reduce future health spending growth. And since, as described earlier, the development and diffusion of new medical technology is a significant contributor to the rapid growth in health care spending, it is new technology that we would look to for cost savings.

Currently, most suggestions to slow the growth in new medical technology in the U.S. focus on cost-effectiveness analysis. Other approaches have problems: some used by other countries are not popular in the U.S. (rationing, regulation, budget-driven constraints), some have been tried and found not to have a significant impact on technology-driven costs (managed care, certificate-of-need approval), while others are expected to have only limited impact on health care spending (consumer-driven health care, pay-for-performance, information technology). Cost-effectiveness analysis involves non-biased, well-controlled studies of a technology’s benefits and costs, followed by dissemination of the findings so they can be applied in clinical practice. The method to control the use of inappropriate technology could be through coverage and reimbursement decisions, by using financial incentives for physician and patients to use cost-effective treatments. Use of the cost-effectiveness findings could be implemented at the health plan level\textsuperscript{14} or through a centralized, institutional process, such as Britain’s National Institute for Health and Clinical Excellence (NICE). If implemented at the national level, questions about the structure, placement, financing, and function of a centralized agency would have to be resolved.\textsuperscript{15} Other issues include whether money would be saved by reducing costly technology where marginal value is low and how to monitor the cost impact, and whether a cost containment approach would discourage technological innovation.


\textbf{2.} George B. Moseley III, \textit{Changing Conditions for Medical Technology in the Health Care Industry} (presented before the OGI School of Science and Engineering, Oregon Health and Science University, October 18, 2005), \url{http://cpd.ogi.edu/Seminars05/MoseleySeminarIndex.htm}.


\textbf{4.} David M. Cutler and Mark McClellan, "Is Technological Change in Medicine Worth It?" \textit{Health Affairs} 20(5) (September/October 2001): 11-29.
6. Several approaches have been used to study and quantify the impact of technology on health care costs, including:

- **The residual approach**, where the impact of changes in other factors (such as prices, income, population growth and demographic changes, and utilization) is quantified, and the residual not accounted for is attributed to changes in technology. The most widely-used approach, it circumvents the need to specify a direct measure of technology and captures the impact of general technologies applied in the health sector, such as information technology. However, it is only a rough, indirect estimate (and perhaps an overestimate) of the impact of technology on health spending because other factors that cannot be quantified (such as lifestyle, environment, education) will also be included along with technology. Examples of residual studies include (1) Newhouse (1992), described in the text of this report; and (2) Edgar A. Peden and Mark S. Freeland, "Insurance Effects on US Medical Spending (1960-1993)," *Health Economics* 7 (1998): 671-687, which found that nearly half (47%) of the 1960-1993 growth in real per capita U.S. medical spending and almost two-thirds (64%) of its 1983-1993 growth were due to increasing levels of insurance coverage (i.e., a decline in coinsurance levels paid by consumers). Because lower coinsurance levels and higher research spending are considered inducers of technology, the authors concluded that these results imply that about two-thirds (70%) of the 1960-1993 medical spending growth and about three-fourths (76%) of the 1983-1993 medical spending growth came from cost-increasing advances in medical technology.

- **The proxy approach**, where a proxy (such as research and development spending, or time) is used to measure the impact of technology. The usefulness of these studies depends on how good a substitute the proxy is for technology and how measurable it is. Examples include: (1) Albert A. Okunade and Vasudeva N.R. Murthy, "Technology as a "Major Driver" of Health Care Costs: a Cointegration Analysis of the Newhouse Conjecture," *Journal of Health Economics* 21 (2002): 147-159, which found that technological change, proxied by total research and development (R&D) spending and health R&D spending, is a statistically significant long-run driver of 1960-1997 rising real health care expenditures per capita; and (2) Livio Di Matteo, "The Macro Determinants of Health Expenditure in the United State and Canada: Assessing the Impact of Income, Age Distribution and Time," *Health Policy* 71(1) (January 2005): 23-42, which found that time, used as a proxy for technological change, accounted for about two-thirds of the 1975-2000 increases in real per capita health expenditures in the U.S. and Canada.

- **Case studies of specific technologies**, to determine their effects on the cost of treating a particular condition. While case studies can explain the impact of certain medical advances on health care costs, it is difficult to generalize from them to an aggregate or national level: (1) In an analysis of technological change at the disease level for 5 medical conditions, David M. Cutler and Mark McClellan, "Is Technological Change In Medicine Worth It?" *Health Affairs* 20(5) (September/October 2001): 11-29, found that the benefits of 4 of the 5 conditions studied (heart attacks, low-birthweight infants, depression, and cataracts) were greater than the costs; costs and benefits were about equal for the fifth condition (breast cancer). For example, in 1984 nearly 90% of heart attack patients were managed medically; by 1998, more than half of
patients received surgical treatment. Spending by Medicare on heart attack patients increased from $3 billion to $4.8 billion (a 3.4% annual change), despite a 0.8% annual decline in the number of heart attacks. From 1984-1998, the use of new technology helped to increase the average heart attack patient’s life expectancy by one year (valued at $70,000 per case), while treatment costs increased $10,000 per case (4.2% per year), for a net benefit of $60,000 per case; and (2) Laurence Baker et al., “The Relationship Between Technology Availability And Health Care Spending,” Health Affairs, Web Exclusive (November 5, 2003): W3-537-W3-551, studied the relationship between the supply of new technologies and health care utilization and spending at 3 levels (a particular technology, “category” spending on substitutable or complimentary technologies, and total health spending), using 10 diagnostic imaging, cardiac, cancer, and newborn care technologies. They found that more availability of the technologies was frequently associated with higher use and spending on the services. For example, a one unit increase in the number of freestanding MRI units per million people was associated with an increase of about $32,900 per million beneficiaries (commercial and Medicare) per month, or approximately $395,000 per year. Looking at “category” spending, they found an individual technology can increase or decrease spending on other technologies in the same category depending on whether they complement those technologies (e.g., an increase of one unit per million in availability of MRI equipment was associated with an increase of 0.33% in total diagnostic imaging spending) or substitute for those technologies (e.g., increases in the availability of cardiac services were typically associated with reductions in total spending on patients with cardiac diagnoses). For total health care spending, they found that greater availability of technologies was associated with higher total spending in the commercial population in all but 2 technologies studied, and these effects were larger than the technology-specific relationships.


Data for the medical technology industry, universities, state and local government, 
and philanthropic foundations is for 2004.


10. Kaiser Family Foundation, Health Care Spending in the United States and OECD 
Countries, January 2007, 

11. Gerard F. Anderson, Bianca K. Frogner, Roger A. Johns, and Uwe E. Reinhardt, 
“Health Care Spending And Use Of Information Technology In OECD Countries,” 

“U.S. Health System Performance: A National Scorecard,” Health Affairs, Web 
Exclusive (September 20, 2006): w459.

Spending in the United States, 1960-2000,” The New England Journal of Medicine, 
355(9) (August 31, 2006): 920-927. See also Jonathan S. Skinner, Douglas O. 
Staiger, and Elliott S. Fisher, “Is Technological Change In Medicine Always Worth It? 
The Case Of Acute Myocardial Infarction,” Health Affairs, Web Exclusive (February 7, 


15. Gail R. Wilensky, “Developing A Center For Comparative Effectiveness 
Information,” Health Affairs, Web Exclusive (November 7, 2006): w572-w585; Molly 
Joel Coye and Jason Kell, “How Hospitals Confront New Technology,” Health Affairs 
25(1) (January/February 2006): 163-173; and the NICE website: 

Source: Kaiser First Edition: 3/9/07