effects than other drugs have, and they cost patients less than psychotherapy does. Thus, patients take them for longer periods of time and get more effective doses. For roughly the same cost, treatment efficacy has improved. Berndt and colleagues estimate that this treatment substitution reduced spending per incremental remission probability by about 20 percent.

SSRIs also have led to significant treatment expansion. Numerous studies prior to the 1990s estimated that about half of persons who met a clinical definition of depression were not appropriately diagnosed by their physician, and many of those diagnosed did not receive clinically efficacious treatment. Manufacturers of SSRIs encouraged doctors to watch for depression, and the reduced stigma afforded by the new medications induced patients to seek help. As a result, diagnosis and treatment for depression doubled over the 1990s.

Treatment expansions have both costs and benefits. Treating an episode of depression costs up to $1,000, depending on the type of therapy followed. The health benefit of treatment is the reduced time spent depressed. Data suggest that effective treatment can reduce time spent depressed by about eight weeks. The quality-of-life improvement from reducing depressive symptoms has been estimated by several studies, with estimates ranging from 0.1 to as much as 0.6, on a scale where 1 is moving from death to perfect health. Using an intermediate value of 0.4, and again assuming that a year of life is worth $100,000, the reduction in time spent depressed is a benefit of about $6,000 (8/52 × 0.4 × $100,000). This is six times greater than the cost of treatment. In addition, there are gains from persons’ being able to work and produce more, which are not in this calculation. Thus, increasing rates of treatment among depressed patients is almost certainly well worth the cost.

**Cataracts.** Irving Shapiro and colleagues consider technological change in the treatment of cataracts from the late 1960s through the late 1990s. In the late 1960s a cataract operation was an intensive procedure. It involved three nights in a hospital (down from a week a few decades earlier) and substantial operating room and physician time. Complications were frequent, including glaucoma and infection. By the late 1990s cataract operations were routinely performed on outpatients in under half an hour, with many fewer complications. Postoperative visual quality has also improved.

The reduction in inputs needed for the operation has offset the increase in cost of each input. Even though hospital and surgeon fees have increased, so many fewer hospital days and surgical hours are needed to perform the operation that total operative costs for a cataract operation are essentially unchanged in real terms. With no
"Some of the increase in breast cancer treatment most likely reflects cases that would not have been detected in earlier years."

increase in spending over three decades and a large increase in visual quality and reduction in complication rates, the substitution of newer for older therapies is a clear case of technological change with positive net benefits.

There has also been treatment expansion for cataracts. People are operated on at much less severe measures of visual acuity now than in the past. A rough calculation suggests that treatment expansion is worth it socially. Medicare reimbursement for a cataract operation is about $2,000 to $3,000. The benefits of the operation are several years of improved vision. Estimates in the literature suggest a quality-of-life decrement from vision impairment associated with cataracts of about -0.2, on the same 0–1 scale described above. For a person with five years of remaining life expectancy, this amounts to one year of improved quality-adjusted life. Valuing this at $100,000 (assuming no productivity gains and no increase in longevity) gives a present value of about $95,000. This is much greater than the cost. One would need data on the age and life expectancy of cataract operation recipients to do this calculation precisely, but the treatment expansion effect almost certainly is beneficial.

**Breast cancer.** We have recently analyzed the costs and benefits of treatment changes for breast cancer over the period 1985–1996. This analysis is more preliminary than for the other conditions, so we stress our qualitative findings more than our quantitative ones.

Over time, several innovations in therapeutic treatment of breast cancer have been made. First, although much of the treatment for breast cancer itself has moved out of the hospital, chemotherapy regimens have become somewhat longer and more complex. Second, there have been many changes in supportive care—ranging from more frequent surgery for complications to more outpatient visits for drug treatments for such conditions as anemia and nausea.

Detection technology and public awareness of the benefits of screening also have advanced. As a result of these changes, overall cancer diagnosis and treatment rates have risen. Incidence rates rose 10 percent in the late 1980s and then fell somewhat in the 1990s, as increased early detection led to reduced rates of metastatic disease. Still, many more cancers were being treated at the end of the time period than the beginning. Some of this increase in treatment may reflect a true increase in cases, but it most likely reflects detection of
existing cases that would not have been detected in earlier years.

This increased detection may or may not be valuable. While breast cancer is often fatal if untreated, most breast cancers progress slowly, and many occur in older women who may die of other causes before their cancer becomes symptomatic. As a result, there is considerable professional uncertainty about the appropriateness of breast cancer screening in women above age sixty-five or seventy.²⁴

To measure the benefits of these diagnostic and therapeutic changes, we calculate survival for women as a whole as a result of reduced breast cancer mortality. This effectively combines the treatment substitution and treatment expansion effects. In the breast cancer case, we do not feel sufficiently sure of our ability to separate the two. We express these population-based survival improvements on a per case basis to compare with per case treatment costs.

The data we used are from Medicare claims records matched to the National Cancer Institute’s Surveillance, Epidemiology, and End Results (SEER) program. The SEER data contain mortality information along with stage of cancer at diagnosis, which allows us to control to a considerable degree for the severity of the detected disease.

We estimated that survival after breast cancer increased by four months over this time period.²⁵ The benefits of this additional survival are $75,000 per year: the $100,000 health benefits less the $25,000 of basic medical and nonmedical costs (the women we analyzed were elderly, and few were working). In present value, the increase in survival is worth about $20,000. Since the average case of breast cancer costs about $20,000 more to treat in 1996 than in 1985, technological change was neither beneficial nor harmful on net.

There are uncertainties in this calculation that could make technological change valuable or not. For example, we did not account for quality of life, which many believe has improved over this time period. On the other hand, we did not factor in screening costs. These uncertainties could tip the balance one way or the other, but the magnitudes are unlikely to reach the level of the other conditions we have analyzed.

**Summary.** In most of the cases we analyzed, technological innovations in medicine are on net positive. Technology often leads to more spending, but outcomes improve by even more. In one case, breast cancer, there is no clear result. Outcomes are slightly better, but costs have increased substantially, and the two are roughly equal orders of magnitude.

These results can be understood by recognizing the two ways that medical innovation affects patients. Treatment substitution is clear in all of our examples. Among those already treated, innovation
changes how people are treated. Per case costs may rise or fall with this substitution; our examples show both scenarios. But outcomes are usually better. Thus, treatment substitution appears generally worthwhile.

Treatment expansion is a notable feature of three of our cases: depression, cataracts, and breast cancer. Treatment expansion is generally cost increasing, since no therapy other than routine physician visits was provided prior to the diagnosis. Treatment expansion may or may not be worth it, depending on how valuable the treatment is in the marginal patients. Some of the greatest successes of the medical care system, and some of its greatest failures, are in this treatment expansion effect. To date, treatment expansion has received relatively little study by researchers.

**Policy Implications**

- **Is technological change as a whole worth it?** While we have considered a range of diseases, we have not considered enough to draw firm conclusions. Most importantly, we have not yet analyzed any chronic diseases such as diabetes, asthma, and congestive heart failure. Further, the conditions we have chosen may not be random among acute diseases. Thus, generalizing from our results is not easy.

  But we can say more. Consider the facts given in the introduction to this paper. Between 1950 and 1990, the present value of per person medical spending increased by $35,000, and life expectancy increased by seven years. Valuing these years at $100,000 per year, the present value of the increase in longevity is about $130,000. Thus, the increase medical spending as a whole is worth it if medical spending explains more than a quarter ($35,000/$130,000 = 27 percent) of increases in longevity.

  We have highlighted two conditions where medical technology greatly reduced mortality: care for low-birthweight infants and treatment of acute heart attacks. Our heart attack analysis was for only the recent time period, but other data suggest medical benefits for a longer period of time. If one takes just the medical component of reduced mortality for low-birthweight infants and ischemic heart disease, medical care explains about one-quarter of overall mortality reduction.

  Thus, medical care is certainly worth it if any of the additional increase in longevity results from improved medical care, or if medical care improves quality of life. We have shown examples where it clearly does. Thus, we conclude that medical care as a whole is clearly worth the cost increase, although we cannot present a specific rate-of-return evaluation.

- **Policies toward medical spending increases.** Medical care
“Policies that eliminate waste and increase the incremental value of treatment may also retard technological progress.”

costs are high, and much evidence documents waste in the provision of medical services. Responding to such concerns, the public and private sectors have periodically focused on the need to reduce spending. In the public sector, cost constraints were central to the Clinton administration’s Health Security Act and to various proposals for Medicare reform in recent years. In the private sector, the focus on cost containment drove much of the move to managed care in the 1990s.

Eliminating waste—or, in economic terms, reducing costly treatment use where the marginal value is low—is an important goal. Our results suggest, however, that this needs to be balanced by concern about impacts on technical change. Policies that eliminate waste and increase the incremental value of treatment may also directly or indirectly retard technological progress. This fear is a particular concern in light of recent evidence that managed care has slowed the rate of diffusion of new medical technologies. If managed care has reduced the adoption of treatments of low value or has limited the treatment expansion effect only to patients with expected benefits greater than costs, then it may have increased productivity growth even as it slowed technology diffusion. But if the reduced technological change is not of marginal value, then managed care growth may have reduced long-term productivity growth in health care. There is considerable evidence that managed care and other policy changes can reduce costs without harming outcomes at a point in time. But there is less evidence on the dynamic effects of managed care and other policy influences. Our results suggest that this issue and the impacts of any change in technical innovation should be carefully monitored.

- Price indices for medical care. Official data indicate that medical prices are increasing more rapidly than prices in the rest of the economy. For example, between 1960 and 1999 the medical care Consumer Price Index (CPI) increased by 1.8 percentage points annually above the growth rate of the all-items CPI.

There are two problems with such indices. First, they include as price changes many factors that are more accurately counted as quantity increases resulting from medical innovation. For example, a day in a hospital was traditionally included in the CPI. It showed a very rapid price increase, but this was almost certainly a result of the increased technological sophistication that has occurred in hospital
stays over time.

More fundamentally, official price indices have only a poor adjustment for quality change. If price increases over time are matched by quality improvements, the quality-adjusted price of medical care will not increase. Our results imply that quality change has been greater than, or at least comparable to, price increases for a range of conditions. Thus, the quality-adjusted price index for these conditions should not be rising. An equivalent statement is that productivity in treating these conditions has been greater than that of the typical industry. Government statistical agencies are beginning to incorporate quality adjustment into official indices. As demonstrated here, this is a difficult task. We expect that continued changes in this direction will greatly reduce the perceived inflationary component of medical care cost increases.

The fact that price indices for medical care are falling should not be taken as a recommendation that Social Security cost-of-living increases or increases in other government programs should be moderated. That is in large part a distributional question of how much of the higher costs associated with rising health care productivity should be borne by the elderly versus workers. Conventional price indices may not be what we want to use in updating benefit payments for public programs.

Managed care and other policy reforms. Our analysis has focused on technological changes in medical practice over time, but it is equally applicable to technological changes in the delivery system, such as the growth of managed care. Managed care has clearly reduced medical spending increases, at least over the short term (several years). This cost savings must be compared to any effect of managed care on the quality of medical services provided—either improvements, as advocates claim, or reductions, as detractors fear. The net benefit of managed care is the cost savings less the value of reduced health (or plus the value of health improvements).

Estimating the health impacts of managed care can be done with the same sort of data that we have analyzed in this paper, expanded to include people in different insurance plans. One needs to separate out the impacts of managed care on treatment from selection differences in patients over time, but this is possible. The impact of other health system reforms such as malpractice law changes or steps to affect provider competition can be evaluated in the same way.

More complete National Health Accounts. Current National Health Accounts track the costs of medical care. This is an important and difficult task. Our results suggest adding another task as well: measuring the benefits of medical care. Including the benefits side in National Health Accounts is vital for making sound
policy. At least some of the focus on reducing medical spending is because spending, and not health outcomes, is what is currently measured. A fuller set of National Health Accounts could allow policymakers to make more sound decisions.

Two steps are needed to include health in national accounts. First, it is necessary to measure the population's health. We focused our analysis primarily on longevity, but an ideal system would measure quality of life, too. Second, it is necessary to decompose the sources of changes in health. Our analysis suggests that it is possible to do this at the disease level, if enough conditions are chosen. We hope that the expanding research on productivity changes in the treatment of common illnesses helps us to move toward this goal.

We are grateful to Hugh Rochmann and Olga Sanyina for research assistance, and to the National Institute on Aging, the U.S. Bureau of Labor Statistics, the U.S. Bureau of Economic Analysis, and Eli Lilly Corporation for research support.

NOTES


4. There is substantial debate about whether such costs ought to be included in the analysis or not. See Panel on Cost-Effectiveness in Health and Medicine, *Cost-Effectiveness in Health and Medicine*; and D. Meltzer, "Accounting for Future Costs in Medical Cost-Effectiveness Analysis," *Journal of Health Economics* (Jan/Feb 1997): 33-64. These two sources present opposing views. Conceptually, such costs ought to be included, but too should the gains from extending longevity. To see why, consider the simplistic case of a medical technology that at negligible monetary cost would add one year to the life of a person just about to die. The technology will be worthwhile if the value to society of the person living a year is greater than the cost to society of having the person alive. Omitting either the costs or benefits from this equation biases the anwer. The argument against including these costs and benefits has largely been based on the practical difficulty of doing so.

5. This is the approach followed by J.P. Bunker, H.S. Frazier, and F. Mosteller, "Improving Health: Measuring Effects of Medical Care," *Milbank Quarterly* 72, no. 2 (1994): 225-258.

6. As we discuss later, one exception is heart attack care, where clinical trial evidence on treatment effects as well as epidemiologic evidence on specific treatment trends is extensive.

7. D.M. Cutler et al., "Are Medical Prices Falling?" *Quarterly Journal of Economics*

8. Hospital spending is the bulk of costs for heart attack patients. Incorporating more limited data on physician services does not change our conclusions qualitatively.


10. Cutler et al., “Pricing Heart Attack Treatments,” has a detailed discussion of the methods used.


13. Average birth-related costs are about $20,000 per low-birthweight baby. The remainder are Medicaid and disability spending for disabled children and special education costs for severely disabled children during school years. The probability that a child has any disability in 1990 is about two-thirds for the very lightest infants (under 1,000 grams) and about one-quarter for the remaining low-birthweight infants. About half of children with disability are severely disabled.

14. Maternal behavior has a powerful influence on the birthweight of the baby but, conditional on birthweight, does not have a large impact on infant survival.

15. The undiscounted value is $1.2 million. The present value is lower because a baby who survives will live about seventy years on average, and many of these years are far in the future.


18. The National Ambulatory Medical Care Survey shows such an increase.

19. A typical episode of depression lasts about half a year, and medication results in a roughly 30 percent reduction in depressive symptoms. Thus, the impact on time spent depressed is about eight weeks. See Agency for Health Care Policy and Research, Depression in Primary Care, Clinical Practice Guideline No. 5 (Washington: AHCPR, 1993).


21. In another metric, Frank and colleagues estimate that incremental spending per QALY is about $13,000, which is well below the value of a year of quality-adjusted life. Frank et al., "The Value of Mental Health Care."


25. To isolate the role of breast cancer treatments, we consider deaths only from breast cancer.


29. Two studies that consider dynamic effects, at least over short time periods, are D.P. Kessler and M. McClellan, "Do Doctors Practice Defensive Medicine?" Quarterly Journal of Economics (May 1996): 353–390; and D.P. Kessler and M. McClellan, "Is Hospital Competition Socially Wasteful?" Quarterly Journal of Economics (May 2000): 577–615. These studies find one-time beneficial productivity effects of malpractice liability limits and increased competition, respectively. However, they find little evidence of dynamic effects on productivity.


31. In other work with Joseph Newhouse, we have begun to develop evidence on this question. D.M. Cutler, M. McClellan, and J.P. Newhouse, "What Does Managed Care Do?" RAND Journal of Economics (August 2000): 526–548.

32. This approach is conceptually similar to the understanding of investment at the aggregate level, which involves the analysis of about 800 separate types of investment. See J. Triplett, "What's Different about Health? Human Repair and Car Repair in National Accounts and National Health Accounts," in Medical Care Output and Productivity, ed. Cutler and Berndt.