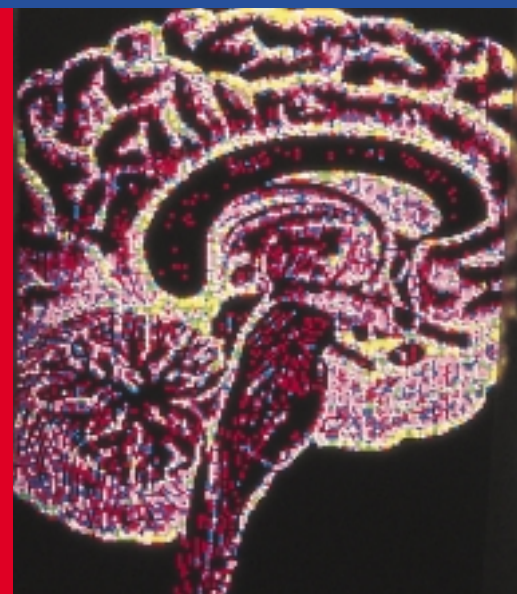
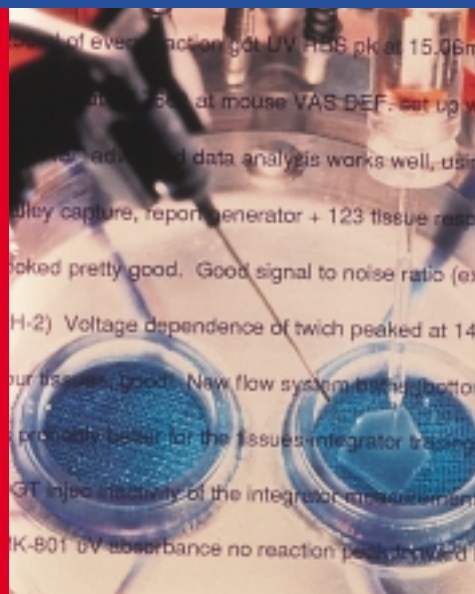
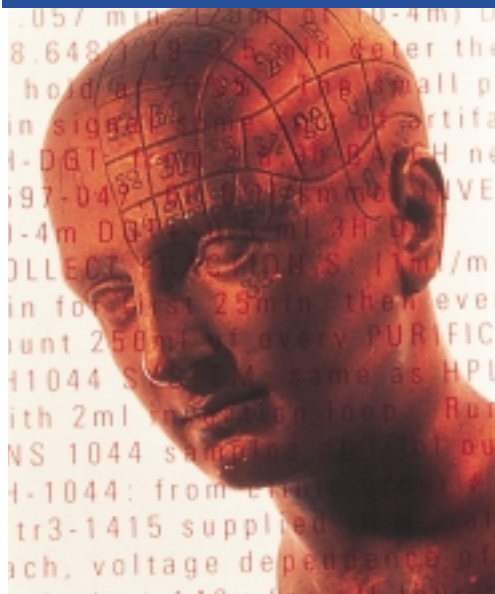


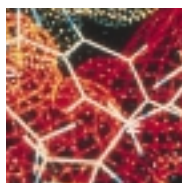
# Exceptional Returns



## The Economic Value of America's Investment in Medical Research







Dear Friends:

The following report, *Exceptional Returns: The Economic Value of America's Investment in Medical Research*, is based on a book authored by nine of America's most distinguished economists that will be published later this year. The findings of these leading economists challenge us to think about an entirely new way to value medical research and help us to understand the enormous contribution of medical research to the American standard of living.

It's not unusual to ask about value: when it comes to our loved ones, or even ourselves, we all recognize that medical research has given us longer, healthier lives — an outcome we regard as so important as to be “invaluable.” This report seeks to answer, for the first time, the question, *What is the true economic value of our national investment in medical research?* It provides a surprisingly dramatic answer: the returns are exceptional.

It is conventional to think of medical research in traditional investment terms. Today the U.S. invests more than \$45 billion annually in medical research from public and private sources. Such research supports hundreds of thousands of skilled jobs at universities, academic medical centers and companies large and small clear across the nation. In 1997, the pharmaceutical industry employed over 260,000 people and generated sales of \$87.1 billion; in that same year over 1,300 biotechnology firms employed 110,000 people and generated \$9.3 billion in sales.

Equally impressive, but still measured using conventional practices, are the cost savings of diagnostic and treatment procedures for particular diseases. We know, for example, that the development of lithium for the treatment of manic depressive illness results in health cost savings of more than \$9 billion annually; that preventing hip fractures in postmenopausal women at risk for osteoporosis saves \$333 million annually; and that a 17-year program which invested only \$56 million in research on testicular cancer has led to a 91% cure rate and an annual savings of \$166 million.

As impressive as those facts are, the economists whose work is summarized in this report present an even more dramatic analysis of the economic value of medical research. We believe this work will make a major contribution to the nation's understanding of the previously unmeasured economic value of medical research, of its true contribution to the American standard of living. Once understood, we trust that policymakers will enthusiastically support sustained investment in basic and clinical research, in new technologies, pre-doctoral and post-doctoral training programs, and in essential facets of the medical research infrastructure.

The book — and this summary of its findings — was commissioned by the *Funding First* initiative of the Mary Woodard Lasker Charitable Trust. Mary Lasker was one of America's foremost advocates for medical research and public health, and a philanthropist who played a central role in the rapid expansion of the National Institutes of Health over a period of more than fifty years. The mission of *Funding First* is to broaden public understanding of the enormous social and economic value of medical research, and to build a strong public, private and philanthropic commitment to sustaining and expanding investment in it.

We invite your views on this report, and your active support for sustained public funding for medical research. As we enter a new century and a new millenium, we need a sustained national commitment to extend and improve the lives of all people, and in so doing, the economy of our nation and the world.

Sincerely,

**The Honorable Mark Hatfield**  
Chairman, *Funding First*

**Hugo F. Sonnenschein**  
Executive Committee,  
*Funding First*

**Dr. Leon E. Rosenberg**  
President and CEO, *Funding First*



## Exceptional Returns

For decades, public officials and the medical community have debated how much to spend on medical research, how this research pie should be divided and who should foot the bill. Wars on individual diseases have been declared. Breakthroughs in treatment have been hailed. Failures to meet the public's often unrealistic expectations have been the subject of bitter controversy. And lurking behind it all, has been the reality that medical research competes with dozens of other budget priorities – public, private and philanthropic.

Yet remarkably little effort has been made to quantify the value of medical research in terms of its impact on the length or quality of life – and virtually none on how research-related reductions in mortality and morbidity should be translated into dollars-and-cents.

To fill this gap in knowledge, Funding First – an initiative of the Mary Woodard Lasker Charitable Trust – commissioned research from distinguished economists from the University of Chicago, Harvard University, Yale University, Stanford University and Columbia University.\* A comprehensive version, edited by Kevin Murphy and Robert Topel of the University of Chicago Graduate School of Business, will be published later this year. The following summary previews their eye-opening findings, which are likely to change the nature of the debate over the funding of medical research.

Mainstream economists are inclined to be skeptical about the efficiency of the “market” for health services in general and government-directed medical research in particular. This makes it all the more striking that these economists came to a virtual consensus that medical research has produced exceptionally high returns in the past and is likely to deliver exceptional returns in the future. In particular, the economists concluded that:

- *Increases in life expectancy in just the decades of the 1970's and 1980's were worth \$57 trillion to Americans – a figure six times larger than the entire output of tangible good and services last year. The gains associated with the prevention and treatment of cardiovascular disease alone totaled \$31 trillion.*
- *Improvements in health account for almost one-half of the actual gain in American living standards in the past 50 years.*
- *Medical research that reduced deaths from cancer by just one-fifth would be worth \$10 trillion to Americans – double the national debt.*
- *While it is not always possible to pin down cause and effect, the likely returns from medical research are so extraordinarily high that the payoff from any plausible “portfolio” of investments in research would be enormous.*

\*Commissioned papers, including all cited figures and tables, available at: [www.fundingfirst.org](http://www.fundingfirst.org)

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If you think research is expensive, try disease.

**Mary Lasker** (1901-94)

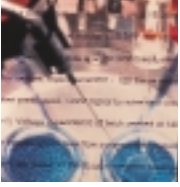
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The **Mary Woodard Lasker Charitable Trust** supports the **Albert & Mary Lasker Foundation**, which annually presents one of the world's most prestigious honors in science, the **Albert Lasker Awards for Basic and Clinical Medical Research, and Public Service**. The Lasker Trust initiated and supports Funding First to broaden public understanding of the enormous social and economic value of medical research, and to build a strong commitment from both the public and private sectors to sustaining and expanding investment in it.

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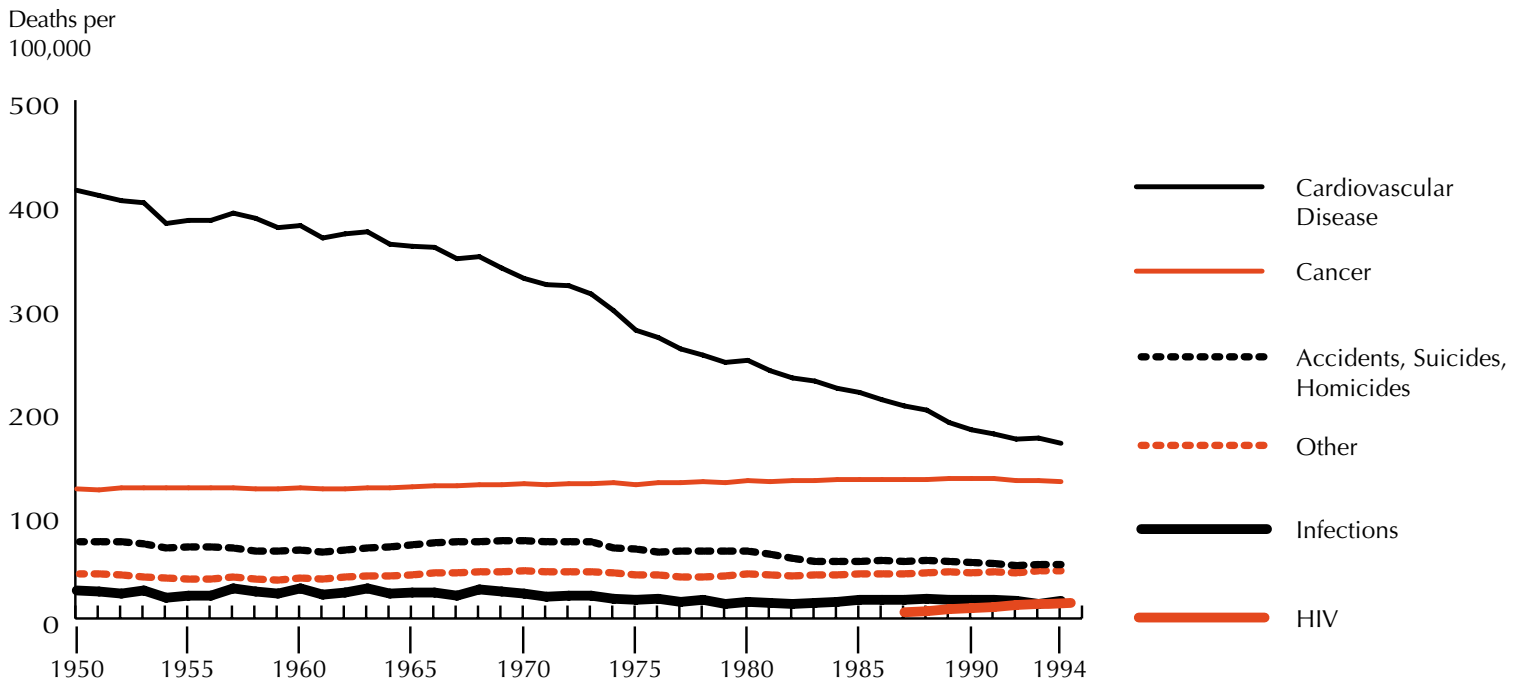
## The Health Revolution

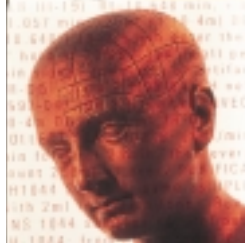
Before one can assay the economic value of health gains, one must understand what has happened to longevity and why. David M. Cutler of Harvard and Srikanth Kadiyala of the National Bureau of Economic Research analyzed increases in life expectancy in America, and found that health has improved fairly steadily since the middle of the 18th century. Life expectancy at birth in 1900 was less than 50 years, while today it is 77. And morbidity has been falling in concert.

But this relatively steady improvement obscures sea changes in the causes of improved health. Reduction in infant mortality, presumably linked to improved diet, sanitation, housing and education and the introduction of effective pharmaceutical weapons against infectious disease, largely explains the gain prior to the middle of the 20th century. Since then, the gains are closely associated with declining mortality among the elderly, where chronic degenerative diseases are the primary culprits. Thus, life expectancy increased from 69 in 1965 to 76 in 1996.

Mortality from cancer, diabetes, liver and kidney diseases has hardly changed, offering opportunities for extending life expectancy from breakthroughs in research. But the death rates from cardiovascular diseases, both among the middle-aged and the elderly, have been plummeting since the mid-1960s. Indeed cardiovascular deaths are less than half what they were three decades ago. And while trends in morbidity are harder to come by, there is evidence that severe cardiovascular illness is now less debilitating. To a large extent, then, the value of improved health is linked to the decline in cardiovascular illness, and the large returns to investment in medical research have come principally from gains against heart disease and strokes. (Fig.1)

### Declining Mortality Since 1950 (Fig. 1)






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## Translating Longer Life and Better Health into Dollars and Cents

Getting from here (the good news about mortality and morbidity) to there (the economic value of medical research) requires two big steps. First, one must somehow monetize the value of better health and longer life. Second, one must isolate the impact of medical research – direct and indirect – from gains unrelated to research and development. And while both steps are difficult, the analysis offered in this report convinced economists not known for credulity.

William Nordhaus of Yale University, along with Kevin Murphy and Robert Topel of the University of Chicago, offer parallel estimates of the value of recent increases in longevity. To the casual observer it hardly seems possible – and may seem morally offensive – to put a dollar value on human life. Ask a committee setting priorities for organ transplants, and the answer will have a lot to do with how long the person might live if cured of the threatening ailment. Ask a dying person what an extra year of healthy life is worth and the number is likely to be close to whatever his or her assets are. By the same token, value may vary widely according to social or political context.

But modern economics has devised a credible way around these imponderables, inferring the value people put on life from what they must be “bribed” in everyday settings to incur small but predictable increases in the risk of death.

Let’s say that moving from a factory line to outdoor construction increases a worker’s chance of a fatal accident by one in 10,000 each year. In other words, if 10,000 workers made the shift, expected on-the-job fatalities would rise by one per year. Suppose further that to induce 10,000 workers to play this death lottery voluntarily, an employer would have to pay an extra \$500 annually to each worker for a total of \$5 million. One of these new construction workers is likely to die in return for the group gaining \$5 million. Thus the value of one life in this example is said to be \$5 million.

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### THE VALUE OF ADVANCING FUNDAMENTAL KNOWLEDGE

Because science is an investigation into the unknown, it is inherently unpredictable. Nowhere is this more apparent than in genetics and molecular biology. Fundamental research conducted 30 years ago profoundly changed the methods of medical research and laid the groundwork for today’s biotechnology industry. Scientists are now working to identify the inherited mutations that contribute to cancer risk, birth defects, deficiencies in the immune system, epilepsy, stroke, autism, psychoses, and degenerative disorders such as Alzheimer’s and Parkinson’s disease.

*Investing in Health: The Unfinished Business of Medical Research*  
**Funding First**

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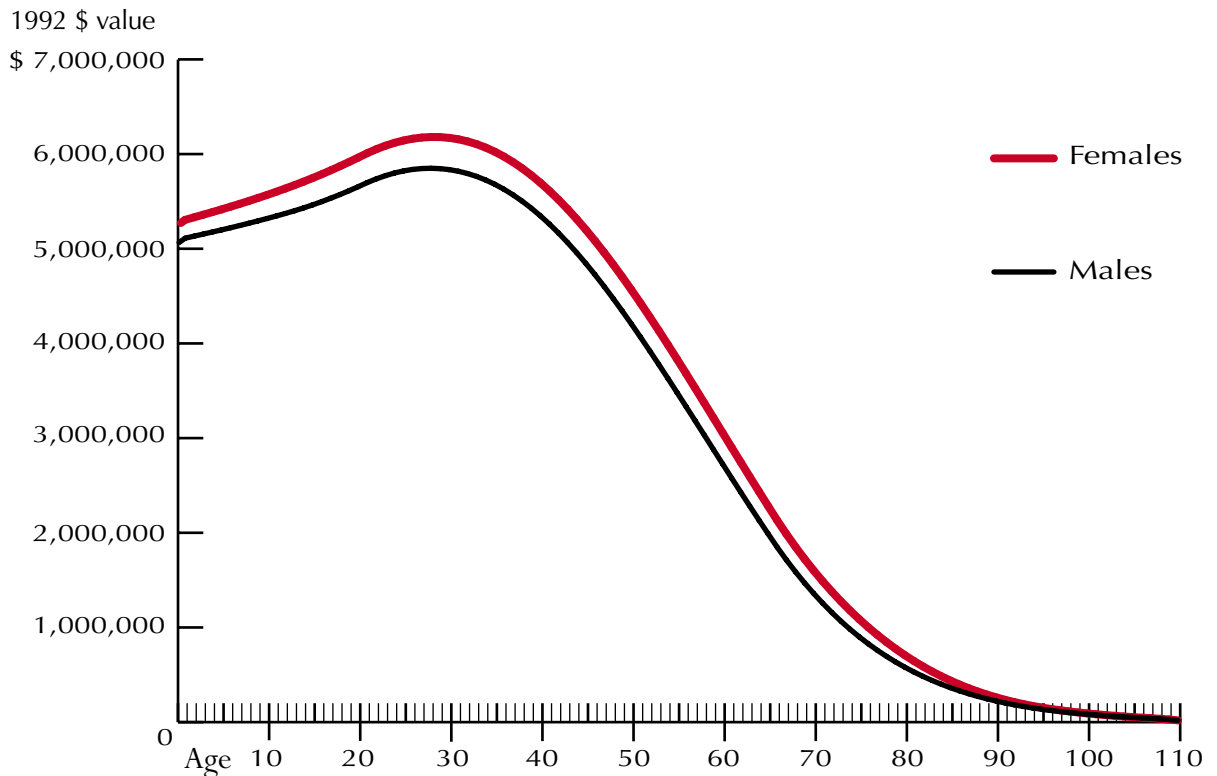
In theory, the value of life could be revealed in other “natural” experiments: the amount people will pay for smoke alarms, airbags and other safety equipment; the discount in rent that people demand to live near chemical factories spewing toxic chemicals, and so forth. In practice, however, labor market models are less problematic. And strikingly, estimates from the dozen or so sophisticated work-related studies since the mid-1970s put the value of a statistical life in the relatively narrow \$3 million-to-\$7 million range.

Note that this concept of the value of life is not directly related to forgone earnings from premature death, which is the common approach to assessing damages from death in civil liability suits. Thus extending years of leisure in retirement by treating illness in old age can have a very high value, even though it does not increase the beneficiaries’ lifetime wages. Nor is it equal to the cost of life-extending medical treatment – although this is how we infer the value of health care in the government’s national income statistics. By the same token, the value of life far exceeds average lifetime earning power; it thus isn’t related in any simple way to how much the average individual could pay to extend his or her life.

While the actual calculation of the value of extending life can be quite complex, it follows in a straightforward and uncontroversial fashion from the estimate of the remaining value of life at any particular age. (Fig.2)

Nordhaus uses the relatively conservative estimate of \$3 million for the average value of avoiding one death to calculate the value of extending life. He estimates that in the 1975-1995 period the value of life extension nearly equaled the gains in tangible consumption.

Changing Value of Life by Age (Fig.2)



Source: *The Economic Value of Medical Research*, Murphy/Topel, Figure 1\*

And this period is no anomaly: the value of the gains from increasing life expectancy between 1900 and 1975 were even greater compared to the improvement in living standards linked to greater tangible output. (Table 1)

Murphy and Topel approach the issue of estimating the value of extending life from a somewhat different perspective, asking what the “present value” of the extra years are worth the way an MBA would estimate the value of an investment as the discounted sum of future income flowing from it. Since decreased mortality is not uniform across ages and the value of life turns in part on the age and life expectancy of the person spared, Murphy and Topel calculate values for each age group.

For example, from 1970 to 1980 the gains per individual male aged 35 to 44 exceeded \$171,000. The figures for younger men are smaller because they were at less immediate risk of fatal disease and, by virtue of financial discounting, reducing risks that are far in the future are less valuable. The values for women are much smaller because women are less susceptible to the fatal diseases where the most progress was made. (Table 2)

Murphy and Topel’s estimate for the value to the entire U.S. population – \$57 trillion over two decades – is mind-boggling. This number, by the way, is nearly equal to the tangible gain in consumption as measured by the government’s national income accounts – and is thus consistent with the estimate by Nordhaus for 1975 to 1995.

## Growth in Living Standards (Table 1)

(average annual percentage change)

	1900-25	1925-50	1950-75	1975-95
From Measured Gains in Consumption	2.0	1.8	2.4	2.0
From Increased Longevity**	2.3	3.2	1.8	1.6

Source: *The Health of Nations: The Contribution of Improved Health to Living Standards*, Nordhaus, Table 2\*  
\*\* most conservative of four alternative estimates

## The Economic Value of Life Expectancy (Table 2)

(in dollars)

Age Range	Gender	1970 to 1980	1980 to 1990
0-4	Male	89,076	48,151
	Female	67,776	30,338
5 to 13	Male	93,440	51,120
	Female	70,321	30,821
14 to 17	Male	107,818	58,143
	Female	81,969	35,137
18 to 24	Male	122,894	61,362
	Female	93,300	38,268
25 to 34	Male	150,683	75,810
	Female	110,115	46,375
35 to 44	Male	171,583	110,890
	Female	119,027	56,165
45 to 54	Male	167,068	126,061
	Female	114,295	53,520
55 to 64	Male	132,838	102,660
	Female	105,988	45,143
65 to 74	Male	78,376	69,082
	Female	90,422	42,971
75 to 84	Male	40,520	36,076
	Female	63,525	33,547
85 plus	Male	20,298	18,604
	Female	33,820	18,701

Source: *The Economic Value of Medical Research*, Murphy/Topel, Table 1\*



## The Fine Print

Murphy and Topel acknowledge an element of “double-counting” in this initial estimate.

Consumption, as measured in the national income accounts, already includes outlays for life-extending medical care – which really are inputs in the “production” of longer life. To correct for this double counting, Murphy and Topel make the extreme assumption that all health care expenditures are inputs in life-extension and recalculate their numbers. The result: the gain in the value of life, net of what was spent to attain the longer life, is just 15 percent smaller.

Refinements in the model used for estimation could conceivably reduce the net figure by still more. But the bottom line wouldn’t change: the often-ignored economic value of increases in life expectancy must count as the single largest source of gains in living standards in our time.

A few other points – all of which strengthen the general findings – are worth noting:

■ *The economic value of longevity rises as the society becomes more prosperous because richer people are willing to sacrifice more in traditional goods and services in return for the chance to enjoy them longer. Perhaps having a car and a comfortable house with indoor plumbing is worth an extra year of two of life. But who would sacrifice years in return for a Mercedes and a mansion in Beverly Hills instead of a Honda and a bungalow in Pasadena?*

■ *Progress against one disease – say breast cancer – actually increases the value of progress against another – say diabetes – since it increases the average gain in life expectancy from successful diabetes treatment.*

■ *Progress against the degenerative killer diseases of middle- and old-age is worth less to the young than to people on the brink of getting them because people discount the value of illness that is still far in the future. Thus, the value of curing or preventing cancer, cardiovascular disease, Alzheimer’s and the like is rising along with the average age of the population.*

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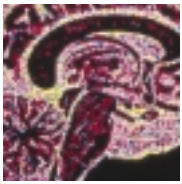
We cannot be a strong nation unless we are a healthy nation.

**President Franklin D. Roosevelt**

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### WHO PAYS?

- Less than a nickel of every health care dollar is spent on medical and health research.
- Only 1% of the Federal budget is spent on medical and health research.
- Just 19 cents per person/per day is spent on medical and health research from Federal sources.
- Just 56 cents per person/per day is spent on medical and health research from *all* sources – public and private.



## The Economic Bonanza from Medical Research

While the economic value of longevity is clearly enormous, the estimates don't tell policy-makers all they need to know to quantify the economic value of medical research. The knowledge gained from research interacts in complex ways with other factors – among them, better access to health care, public education and incentives like the regulation of auto safety and alcohol – to yield greater life expectancy.

To take one example, the dangers of smoking were well understood in the mid-1960s, before the big declines in cardiovascular fatalities. Thus while research played a critical role in reducing smoking, so have the long public information campaign that it triggered, the growing inclination of the affluent to invest more in their own health, higher taxes on tobacco and regulations against smoking in public places.

To shed light on the issue of apportioning the credit for longevity, Cutler and Kadiyala focus on cardiovascular disease, the source of the greatest gains since 1970. Changes in survival rates in the immediate aftermath of acute events – heart attacks and strokes – are almost entirely a result of new technology, which puts a lower bound on the likely benefits from medical research at 20 percent of the reduction in mortality. And they estimate that another 13 percent is tied to new drug therapies that reduce blood pressure and cholesterol.

Thus roughly one-third of the total gain is apparently the result of medical research that led to new drugs and treatment protocols. However, some fraction of the credit for the other two-thirds also should go to research since gains attributed to changes in public policy and individual behavior depend on research-derived information.

Using the methods of their earlier calculations, Murphy and Topel estimate that the total economic value to Americans of reductions in mortality from cardiovascular disease averaged \$1.5 trillion annually in the 1970-1990 period. So if just one-third of the gain came from medical research, the return on the investment averaged \$500 billion a year. That's on the order of 20 times as large as average annual spending on medical research – by any benchmark an astonishing return for the investment.

None of the authors claim that the spectacular returns to research on cardiovascular diseases guarantees that future research on these or any other diseases would be high. But Murphy and Topel point out that the economic value of extending life is so large that research generating even modest advances against major killer diseases is bound to be a superb investment.

They estimate, for example, that a true cure for cancer – the unlikely magic bullet that eliminated cancer deaths – would be worth \$46 trillion. So the more likely sort of narrow research success that spared one cancer death in a thousand would be worth \$46 billion – far more than Washington now spends on all medical research annually! Or, to put it another way, research leading to substantial progress against any of the less common forms of cancer would almost certainly be worth hundreds of billions of dollars to Americans. (Table 3)

The Economic Value of Reducing Deaths from Selected Diseases  
(Table 3)

Disease Category	Increase in Value of Life (in billions of dollars)		Total
	Men	Women	
Cancer	24,325	22,212	46,537
Breast	25	4,617	4,642
Digestive Organs	5,469	4,160	9,629
Genital/Urinary	1,810	2,334	4,145
Heart	28,636	19,712	48,348
Stroke	3,473	4,156	7,629
Circulatory Disease	3,085	2,654	5,739
Flu	1,841	1,591	3,432
AIDS	6,278	1,263	7,540



## The Morbidity Puzzle

None of these calculations include the value of improving the quality of life, in contrast to increasing its length. Morbidity has fallen as life expectancy has grown. A variety of diseases are clearly less debilitating, and the percentage of the very old who remain mobile and able to care for themselves is apparently rising.

But as David Meltzer of the University of Chicago argues, evidence of the economic value of this decreased morbidity is hard to come by. And seemingly straightforward approaches to valuing life-quality – asking people how much they would pay in dollars for good health or how much longevity they would trade for good health – produces inconsistent answers. The young seem to place great weight on the quality of life, while those who are already ill or disabled weigh longevity more.

In any event, the fact that this economic value has yet to be measured credibly doesn't mean that the benefits of reducing morbidity should be assumed equal to just the tangible benefits associated with greater labor productivity and lower expenditures on convalescent care. After all, it is a fair presumption that physical mobility, full command of one's senses and freedom from chronic pain are all immensely valuable in their own right. But one can say that, in the absence of a plausible measure, the estimated return on investments in better health linked solely to longevity will be very conservative.

Federal support for basic science is an aspect of spending that has a payback, and a massive one at that. It puts money out and gets back new products, healthier people and cash. But federal support for basic science has been declining as a percentage of GDP since the mid-60's. Significantly increasing our federal investment in basic medical and scientific research will pay handsome dividends in the 21st century.

### Peter Lynch

*Vice Chairman*

Fidelity Management and Research Company

### PREVALENCE AND COST OF UNCURED DISEASE IN THE UNITED STATES

Uncured Disease	Prevalence (people)	Annual Economic Cost (billions)	Source
Heart Disease	56,000,000	\$ 128	<i>American Heart Assoc.</i>
Cancer	10,000,000	104	<i>American Cancer Society</i>
Alzheimer's	4,000,000	100	<i>Alzheimer's Association</i>
Diabetes	16,000,000	92	<i>American Diabetes Assoc.</i>
Arthritis	40,000,000	65	<i>Arthritis Foundation: Alliance for Aging Research</i>
Depression	17,400,000	44	<i>National Depressive and Manic Depressive Assoc.</i>
Stroke	3,000,000	30	<i>National Stroke Assoc.</i>
Osteoporosis	28,000,000	10	<i>Alliance for Aging Research</i>




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## How to Invest the Public's Money

The aggregate statistics suggest that virtually any investment in medical research that has a chance of increasing life span is worthwhile. But in the real world, many demands compete for inelastic research budgets, both public and private. And the conclusion that the economic value of medical research has been remarkably high does not address the issue of setting specific research priorities. For example, a very promising line of attack against a minor killer could be worth more than a long-shot thrust against a major one.

But the economists do offer some insights into identifying the most valuable investments. First and foremost, the failure of private research to exploit opportunities to reduce mortality is likely to be greatest where the pharmaceutical house or medical equipment maker is unable to capture the bulk of the return – or as economists would say, where the "social" benefits far exceed the private benefits. This is a well-known issue to policy-makers, and explains why the government pays for a disproportionate part of research where there is little prospect of a private payoff because the knowledge gained cannot be patented. But it is particularly relevant to medical research.

Thus while pharmaceuticals research has had an incredible payoff – Frank Lichtenberg of Columbia University estimates that the average new drug saves 11,000 life-years per year – there would be relatively little justification for the government to underwrite pharmaceutical research. At the other end of the spectrum is epidemiological research like the Framingham study that can identify incredibly valuable life-saving initiatives, yet has virtually no corporate payoff. Thus, while research on, say, anti-oxidants like lycopene or chemicals that may inhibit vascular damage like folic acid may have an enormous social return, it won't be done unless Washington covers the costs.

In this vein, the paper by Paul Heidenreich and Mark McClellan of Stanford University suggests an area of medical research that has been inappropriately neglected by government funders. They argue that information identifying best practices in actual treatments flows two ways – through research results disseminated to practitioners by the health care industry and the medical journals, and from practitioners to the research establishment. This latter, less formal research is certainly worthy of public support because the researchers can capture little of the return. But ironically, this important avenue of research has been less traveled in recent years because Federal funding for teaching hospitals – and practitioners working at the cutting edge – has diminished.

Another criteria suggested for setting research priorities is the likely cost of treatments that follow. While the average payoff to medical research has been enormous, it is possible – even likely – that the return in some cases is greatly diminished by the cost of implementing the new technology.

But, while obviously important to public policy, the inability to set research priorities with complete confidence should not be allowed to distract from the principal findings of these economists. Medical research surpasses every other source of rising living standards in our time. And every sign points in the direction of an equally stunning payoff from medical research in the future.

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The impact of ... public investment is invisible in the short run because the payoff is always in the future, sometimes taking two decades or more. The long lag can fool us into believing that there is little relationship between what we invest in the public sector and what we reap in return. Putting more resources into medical research today will not show up in reduced cancer rates until well into the next century. But if we do not make adequate provision for such investments now, there will be no payoff in the future.

**Barry Bluestone and Bennett Harrison**

*Growing Prosperity*

A Century Foundation Book

Published by Houghton Mifflin

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## Lasker Charitable Trust/ Funding First

*Economists who participated in the December 1999 Conference on the Economic Value of American's Investment in Medical Research*

### **Authors of Presented Papers**

*The Economics of Better Health:  
The Case of Cardiovascular Disease*

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*Pharmaceutical Innovation,  
Mortality Reduction, and  
Economic Growth*

**Frank R. Lichtenberg\***

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*Biomedical Research and Then  
Some: The Causes of Technological  
Change for Heart Disease*

**Mark B. McClellan\***

Stanford University  
and

**Paul Heidenrich**

Stanford University

*Can Medical Cost-Effectiveness  
Analysis Identify the Value of  
Research?*

**David Meltzer, M.D.**

Departments of Medicine and  
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and the Harris Graduate  
School of Public Policy Studies  
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*The Economic Value of Medical  
Research*

**Kevin Murphy\***

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**Robert Topel\***

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*The Health of Nations: The  
Contribution of Improved Health  
to Living Standards*

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Medical Foundation.*

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the report.*

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- ***Investing in Health: The Unfinished Business of Medical Research***, monograph, 1998
- ***How to Fund Science: The Future of Medical Research***, monograph published in conjunction with the American Academy for the Advancement of Science, 1999

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