What does economic research tell us about the economic benefits of investments in medical and health research and training?

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In his letter of invitation to this meeting, Lord Turnberg indicated that the impetus for this meeting stems from The Academy of Medical Sciences’ recognition of “the need for improved evaluation and demonstration of the economic benefits derived from investments in medical research.” I understand the term “demonstration” to mean data and arguments that can be used to advocate for increasing these investments. I understand the term “evaluation” quite differently. Evaluation to me means disinterested data assembly and analysis. In the context of this meeting evaluation means seeking economic data and methods of analysis that allow policy makers to make rational determinations about appropriate levels of investment. My colleagues and I have been engaged in both types of activities.

Before tackling the question of the benefits of investments in medical and health research I think it important to ask “who are the investors, how much do they invest, and why?”
There are two principal investors, the for-profit and the not-for-profit sectors. In the U.S., these two sectors invested ~ $98 billion, or about 0.85% of U.S. GDP, in health R&D in 2004. Of this, ~$49 billion came from the for-profit sector and ~$49 billion from the not-for-profit sector (Fig. 1).

In both the U.S. and Europe, the for-profit sector is comprised of pharmaceutical, biotechnology, and medical device companies. This slide compares U.S. and EU15 pharmaceutical and biotech investments in R&D. The U.S. data show trends in these two industries from 2000 to 2004. The EU15 data go only through 2002 for pharmaceuticals and 2003 for biotech (Fig. 1).

In 2004, the U.S. pharmaceutical industry invested approximately $39 billion, or 18% of sales, in R&D. The major portion of this $39 billion was spent for development. In 2002, U.S. pharmaceutical companies spent $32 billion on R&D, while pharmaceutical companies in the 15 EU countries with the largest GDPs, that is the U.K., Germany, France, Italy, Spain, and 10 others, spent a total of $22.8 billion on R&D (Fig. 1).
In both the U.S. and the EU, the pharmaceutical industry is highly profitable, and invests a larger percentage of its income in R&D than any other industry save one. That one is the biotechnology industry. Start-up biotechnology companies spend all available resources on R&D. Their goal is to develop a salable product before their capital runs out. The 1,473 U.S. Biotech companies spent $10.5 billion on R&D in 2004, and $17.9 billion on R&D in 2003. In comparison, the 1,861 biotech companies in EU15 countries invested $4.2 billion in R&D in 2003 (Fig. 1).

Consistent with the idea that biotech start-ups spend all available resources on R&D, in 2003, the last year for which I have complete data, U.S. biotechnology companies invested 63% of revenues in R&D while EU15 biotechs invested 30% of revenues in R&D.

The sector of greatest interest to this meeting is the not-for-profit sector. In the U.S. it includes federal, state and local governments, universities, foundations, voluntary health organizations, and individuals (see Fig. 2, next page). In 2004 the U.S. not-for-profit sector invested nearly $49 billion (0.4% of GDP), in medical and health R&D. Nearly $37 billion, or 0.3% of GDP came from the federal government, about $2.5 billion came from state governments, another $7.1 billion came from university endowments, and $2.25 billion came from foundations, voluntary health agencies, and independent research institutes. I do not have comparable figures for current EU15 investments in health R&D.

OECD reports that in 1999 the U.S. government invested ~ 0.17—0.18% of GDP in health R&D. EU15 nations invested only 0.05%, while the U.K. invested 0.1% \(^1\).

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\(^1\) The same OECD report shows percent investment in health R&D by EU nations was as follows. For 1999 U.K. = 0.1%, Germany = 0.03%, France = 0.05%, Spain = 0.03%. U.S. = 0.17-0.18% (0.19% in 2000). In 1998 Italy = 0.01%.
Why does government invest in basic and applied medical and health research and research training?

First, it appreciates that discoveries in fundamental science and technology are the engines of social and economic progress.

Second, it appreciates that returns on investments in fundamental research may take much longer than any individual can afford to wait to recapture the cost of investment.

Third, it appreciates that no single investor can capture all of the economic benefits of any discovery.

Michael Faraday put it succinctly in response to Prime Minister Gladstone’s question, “of what use is this stuff you call electricity?” “Someday,” Faraday replied, “you will tax it.”
Lastly, and most importantly, there has been good agreement among a majority of the leaders and members of our society that these investments would be humanly valuable and beneficial even if they yielded no economic returns. In short, they are the right way to invest the public’s funds. Not only are these investments morally right, they are socially constructive. As I will document, they may be the soundest investment the public sector can make from an economic perspective.

Regrettably, our governments do not always do the right thing when it comes to investments in medical and health research. Moral and social arguments often fall on deaf ears. This has been increasingly the case in the U.S. since the attack on the World Trade Center on 9/11, 2001. So I will spend the rest of my time discussing some of the organizational structures, advocacy strategies, and economic research findings my colleagues and I have used to argue for increased government investments in medical and health research and training.

Before I launch into these topics, I want to say one thing more about the moral argument for government investments in medical and health research and training. On a few occasions, once notably in Congressional testimony, I was asked whether scientists who advocate for increased federal investments in research aren’t just another self-serving special interest group. On that occasion, I responded that if advocacy for investments that speed discovery of new ways to prevent and treat cancer, heart disease, mental illness, and infectious diseases, and that support the education of the next generation of scientists is self-serving, then I want to be counted among the most self-serving of people. For without research, and without scientists to conduct it, there is no hope. When all is said and done, the moral argument trumps all others. But since all is never said and done, we need other tools to convince the skeptics.
Growth of the NIH budget 1994 – 2005. The U.S. government’s investment in NIH-sponsored medical and health research and training has grown spectacularly in the last decade from $11 billion and 0.15% of GDP in 1995 to more than $28 billion and almost 0.24% of GDP in 2005 (Fig. 3). This does not include government investments in health and life sciences research at other agencies such as the Centers for Disease Control, the National Science Foundation, the Food and Drug Administration, the Agency for Healthcare Quality and Research, and others. Total federal government spending on health R&D in 2004 was $36.85 billion, 0.31% of GDP. In contrast, according to OECD, total government spending for health research in 2000 in all EU countries was $3.7 billion.

How did the U.S. achieve this remarkable growth in federal investment in medical research? It occurred because of the sustained efforts of many individuals, scientific societies, health advocacy and voluntary health organizations, and private foundations. I have been associated with three of them, the Federation of American Societies for Experimental Biology, Research America, and the Funding First Program of the Lasker
Foundation. Since this meeting’s central focus is the economic impact of medical and health research, and Mary Woolley is here to discuss Research America’s work, I will touch only briefly on FASEB’s activities and spend the bulk of my time discussing the economic work sponsored by Lasker/Funding First.

I. The Federation of American Societies for Experimental Biology (FASEB): FASEB is a coalition of 22 scientific societies representing over 71,000 professional biomedical research scientists in academia, industry, and government. I had the privilege of serving on its Board of Directors from 1990 until 1996, and as its President in 1994-95.

When I joined FASEB’s Board in 1990, it had one full time professional engaged in political representation and public affairs. Recognizing that good public policy rests on accurate and carefully analyzed data, we hired an experience social scientist, Dr. Howard Garrison, to lead a new office dedicated to policy analysis and research. Dr. Garrison’s initial responsibilities were to create a data base to be used to support arguments for increased appropriations for NIH.

The scope of Dr. Garrison’s responsibilities have grown substantially over the years, and the organization he now leads, FASEB’s Office of Public Affairs (OPA), has grown to a $1.4 million per year operation (Fig. 4). What do these funds support?

**Development of public policy recommendations:** FASEB holds an annual conference at which representatives of its 22 societies review the programs and budgets of the major federal agencies that support life sciences research. They make recommendations about each agency’s activities and budget for the coming year which are compiled into a report. The report for 2005 is available at FASEB’s website. It was unveiled by FASEB’s President, Dr. Paul Kinkade, at a press conference at the National Press Club in Washington, D.C. in the fall of last year.
Research. OPA develops special reports, for example on post-doctoral training. Its “Breakthroughs in Bioscience” articles provide non-specialists with an overview of specific advances in medicine and biology.

Coalition building: FASEB organizes meetings of presidents of scientific societies outside of FASEB’s membership – the American Chemical Society, the American Physical Society - for the purpose of developing consensus.

Government liaison (also known as lobbying): FASEB participates along with Research America in a unique lobbying group - The Campaign for Medical Research. FASEB contributes a portion of The Campaign’s annual budget of ~$400,000.
Engagement of leaders of high tech corporations to help make the case for increased federal investment in NIH.

In human affairs, the messenger is often as important as the message, and the Congressional appropriations process is a distinctly human affair. These considerations, and the then prevalent concerns about federal budget deficits, suggested to me that leaders of high technology, science-based corporations could best make the case for increased federal investments in medical and health research. I knew from past experience that leaders of such companies recognized the important contributions federal investments in research make to creating the fundamental knowledge on which their companies’ R&D efforts are based, that they

**Figure 5.** From left to right: Samuel Silverstein, M.D., FASEB President, Edward Penhoet, Ph.D., CEO Chiron Corp., Thomas Urban, President and CEO of Pioneer-Hybrid Corp., Ralph Bradshaw, Ph.D., FASEB Vice-president, Hon. Newt Gingrich, Speaker of the House of Representatives, Gar Kaganovitch, FASEB Director of Congressional Liaison, Joseph Davie, Ph.D., Vice-president for Research, Biogen Corp., Leon Rosenberg, M.D., Ph.D., President, Bristol Myers Squibb Research. (Individual’s titles in May of 1995).
understood that federal support played an essential role in their own education and of their companies’ scientists, and that many of them had been successful university-based scientists before they assumed their current industrial positions. I also felt that their support for increased federal investments in research would have a high impact because of their companies’ demonstrated success in creating jobs and profits. So when Representative John Porter, then Chairman of the House Appropriations Subcommittee for Labor, Health and Human Services and Education arranged a meeting between FASEB leaders and Representative Newt Gingrich, Speaker of the House of Representatives, to discuss the NIH budget, I invited the participation of four high-tech corporate leaders (Fig. 5). Suffice it to say that the meeting went extremely well. At its close, Speaker Gingrich indicated he would revisit the House’s science budget resolution (which called for a 5% overall reduction in federal funding for science). In the event, with the Speaker’s help, Chairman Porter was able to achieve a 5.7% increase in the NIH budget for 1996-1997, to set the stage for 6.8% and 7.3% increases in NIH’s budget in FYs 1997 and 1998; and to gain support for its doubling between FY 1999 and FY 2003.

II. The Lasker Foundation

The Lasker Foundation is known to many of you for sponsoring the Lasker Awards in basic and clinical medical research. Indeed, Drs. Marc Feldman and Ravinder Maini of Imperial College shared the 2004 Lasker Award for Clinical Medical Research.

The Lasker Foundation chose a different approach to making the case for medical and health research. It is an approach with which everyone in this room is familiar. I suspect it also is the one with which you are most comfortable. It is the assembly and reasoned analysis of high quality economic data. Indeed, it is the approach I believe Lord Turnberg had in mind when he said the Academy of Medical Sciences has long-recognized the need to evaluate the economic benefits of medical research.

In the late 1980’s and early 1990’s the U.S. economy was in the doldrums, and NIH’s budget was not keeping pace with increases in scientific opportunity. By 1993 NIH was able to fund only 17.9% of approved new grant applications and 23.5% of all approved
applications\(^{(2)}\). Scientific opportunities vastly outstripped resources. Young scientists felt frozen out of the system. By then, the U.S. scientific community realized that President Clinton’s rhetorical support for science would not be matched by recommendations for increased appropriations for science. In fact, Clinton anticipated that to balance the U.S. budget would require reducing what is called “discretionary” government spending, including NIH’s budget, by 10%.

Recognizing the devastating affects such a decrease would have on medical research, the Lasker Foundation’s trustees created a new program to address the funding problem. To be sure no one would mistake its purpose, they named it Funding First. They selected Mark Hatfield, a former U.S. Senator who had championed medical research, as its chairman, and Leon Rosenberg, former Dean of Yale Medical School and past President of Bristol Myers Squibb Research, as its President and chief operating officer. Hatfield and Rosenberg assembled an advisory committee and sought its advice.

As FASEB President, I had grappled with the same problem. Since the budget deficit was the Clinton Administration’s ostensible reason for under-funding NIH, my FASEB colleagues and I sought evidence that medical research provided economic benefits in excess of its cost. In 1995 we reported that advances in health care due to medical research saved $70 billion annually in medical care costs. In addition, we documented $90 billion annually in sales of products unrelated to health care that resulted from NIH-sponsored research. Our paper (Fig. 6) showed that the government’s $10 billion investment in NIH research in 1994 generated $160 billion in benefits, a 16:1 return. Privately, I joked that this was the first objective evidence supporting Benjamin Franklin’s aphorism, an ounce of prevention is worth a pound of cure.

\(^{(2)}\) For purposes of comparison, in 2003, the last year for which complete data is available on NIH’s website (http://grants2.nih.gov/grants/award/success/rpgictype7003.htm), NIH funded 25.3% of new approved applications and 29.2% of all approved applications.
Hatfield and Rosenberg reasoned that if an amateur economist could assemble this type of evidence, professional economists could do much better. They were right. With the help of Hugo Sonneschein, a noted economist and former president of the University of Chicago, they brought together some of our nation’s leading economists – among them Kevin Murphy and Robert Topel of the University of Chicago, William Nordhaus of Yale, David Cutler of Harvard, Frank Lichtenberg of Columbia, and Mark McClellan of Stanford. These economists developed a novel approach to assessing the economic benefits of medical and health research. Their findings are summarized in the Lasker Foundation’s brochure “Exceptional Returns,” and spelled out in full in Murphy and Topel’s book “Measuring the Gains from Medical Research.”

The method they chose is analogous to national income accounting, which uses the value of goods and services consumed (i.e., food, travel, etc.) and of salaries and wages paid to assess living standards. Correspondingly, they assessed the economic value of increased life expectancy and decreased mortality as a proxy for the overall value of medical and health research. In the U.S., life expectancy at birth has increased from about 71 years in

Figure 6

Economic Benefits of Medical Research**

<table>
<thead>
<tr>
<th>Description</th>
<th>1995 U.S. $ (billions)</th>
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<tbody>
<tr>
<td>Estimated Annual Medical Care Costs Saved by Medical Research Discoveries</td>
<td>$ 69.31</td>
</tr>
<tr>
<td>Estimated Retail Value of Ten Biomedical Discoveries Adopted by Industry for Purposes other than Health</td>
<td>$ 91.92</td>
</tr>
<tr>
<td>Total</td>
<td>$ 161.23</td>
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<tr>
<td>NIH budget in 1994 – 1995</td>
<td>$ 10.33</td>
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<tr>
<td>Ratio: Medical Care costs saved in 1995 + Value of products &amp; processes unrelated to health care in 1995. NIH costs = 1:16</td>
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1970 to about 78 years in 2000. That’s an incredible increase. How much is a year of healthy life worth?

We say health is priceless. And it is to each of us individually. But society does make judgments about the dollar value of a life. For example, in compensating the families of people who died on 9/11 in the World Trade Center the U.S. government’s Special Master valued a life at about $3 million.

Murphy, Topel, and Cutler used what is called the “willingness to pay” approach to determine the dollar value of a life. How much are you willing to pay for an airbag or a better braking system to reduce the likelihood of dying in a car crash? Kip Viscusi(4), a lawyer, economist, and expert on risk valuation, estimated that an average adult would pay between $300 and $700 to reduce the likelihood of dying in an accident by 1 in 10,000. The product of 10,000 people paying $300 to $700 each is $3 to 7 million. By this means these economists estimated that a whole life is worth between $3 and $7 million, and one year of healthy life is worth about $100,000.

They then calculated the dollar value of increased longevity from 1970 to 1998 for men and women of different ages. The largest increase occurred for men at age 50 and for women at age 60, and therefore the value of these gains in longevity was largest for this segment of the population. Gains in longevity were smallest in childhood and old age, and therefore the dollar value of gains in longevity was smallest for these two segments of the population.

Finally, they multiplied the dollar value of gains in longevity for people in each age group in the period 1970 to 1998 by the number of people in each age group. Adding these gains for all age groups they obtained the total dollar value of gains in longevity for the whole U.S. population for the period 1970 to 1998. It totaled $72 trillion dollars, or about $2.6 trillion per

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year. By comparison, U.S. GDP averaged about $5.6 trillion over this same period. If the value of this increase in life expectancy over these 28 years had been included in calculations of U.S. GDP, it would have increased the average U.S. GDP from $5.6 trillion per year to $8.2 trillion per year, a gain of about 50%.

The two leading causes of death in the U.S. and Europe are cancer and cardiovascular disease, including stroke. Using similar metrics Murphy and Topel found that a 1% decrease in death rate from cancer would be worth about $440 billion per year. That's about 4% of U.S. GDP.

These numbers are so large they are hard to grasp. Let me bring them down to the level of the individual.

Life expectancy of a typical 45 year-old male has increased by 4.5 years from 1970 to the present. A 50% decrease in deaths from cardiovascular disease and stroke is the single biggest factor in this increase in life expectancy (see Fig. 7).

![Figure 7: Reduced death from cardiovascular disease and stroke is the single biggest factor in the increase in life expectancy in the period 1960 to the present.](image)

Life expectancy at age 45 increased by 4½ years.

Figure provided by David Cutler, Department of Economics, Harvard University.

What factors are responsible for this decrease in deaths from cardiovascular disease and stroke? Most
experts agree that about 1/3 of the decrease is due to improvements in high-tech invasive treatments (angioplasty, stents, etc.), 1/3 from pharmaceuticals (statins, plasminogen activators, anti-hypertensive drugs), and 1/3 from behavioral change (smoking cessation, exercise, decreased dietary salt and fat).

Let’s match the benefits and costs of decreased death from cardiovascular disease and stroke. For 45 year olds, on average the present value of all spending for cardiovascular disease and stroke is about $30,000.

What about the benefits? Medical research made important contributions to the knowledge that smoking, diet and a sedentary lifestyle contribute to cardiovascular disease. But to be conservative, David Cutler excluded them in estimating the economic value of increased life expectancy. Assuming that 2/3 of the increase in life expectancy – that is 3 years - is due to biomedical research – i.e., high tech interventions and new pharmaceuticals – how much are these three additional years of life worth?

Discounted for the present value, they are worth about $120,000, yielding a net benefit of $90,000 or $4 for every dollar spent on healthcare.

There are about 5 million 45 years-olds in the U.S. Five million times $90,000 equals $400 billion. $400 billion is the average annual social benefit to the U.S. economy of the decreased death rate from cardiovascular disease and stroke. This does not take into account decreases in death from improvements in diagnosis and treatment of cancer, gastrointestinal diseases, infectious diseases, etc.

To put this $400 billion into perspective, it is about 3.4% of U.S. GDP for 2004. Four hundred billion dollars is about 4-fold more than the $98 billion spent by all for-profit and not-for-profit groups for medical and health R&D in the U.S. in 2004, about 10-fold more than the $37 billion spent by the U.S. government for all medical and health research in 2004, and 14-fold more than the 2004 NIH budget.
These findings translate Franklin’s adage, health makes wealth, into dollar terms. They confirm that human capital is the most valuable form of capital.

Most importantly, they indicate that so long as four currently prevailing conditions persist, the economic value of improvements in health will increase. These four conditions are:

1. **A growing population.** Population growth means the number of 45 year-olds ultimately will increase. As illustrated above for cardiovascular disease and stroke, the total value of decreased death from these diseases increases as the number of 45 year-olds increases.

2. **Aging population.** In this case, a larger percentage of the population will be represented in the cohort of 45 year-olds. As in 1 above, the larger the cohort of 45 year-olds, the larger the total social benefit.

3. **Increasing longevity.** All other things being equal, if a three year increase in life expectancy is worth $120,000, then a four year increase is worth $160,000.

4. **Rising income levels.** As income levels rise, each year of life becomes more valuable.

Viewed from the perspective of the findings of Nordhaus, Murphy, Topel and Cutler, these findings lead to two most important conclusions: First, the economic value of improvements in health is higher today than in the past, and is likely to grow over the next several decades. Expenditures on health-related research will be of **increasing** value over time.

These findings have been widely reported in the popular and business press. Senator Hatfield, Professor Robert Topel and I presented them in public testimony to the Health Committee of the U.S. Senate. They have been cited in Congressional reports. Surprisingly, despite the fact that few doubt their validity, they appear to have had little impact on the way Congress or the Administration views federal investments in science. Why?

Some think it is because the numbers are so large that politicians don’t believe them. But I don’t believe that. I believe there are at least three more likely explanations.
1. The American public, and consequently politicians, find it distasteful to put a monetary value on a human life. This may be so. But federal agencies such as the Environmental Protection Agency have used cost-benefit analyses that include valuing human life to assess environmental regulations that have the largest payoffs in terms of lives saved for several years.

2. These are social returns. Social returns cannot be captured by any single entity. More importantly, presidents and prime ministers, senators and MPs (Deputies) do not recognize social returns as monies they can appropriate.

But these improvements in health can be translated into numbers elected officials can take to their treasuries. Assume that the 4.5 year increase in life expectancy means the average 45 year-old will remain in the workforce for an additional 3 years. The mean annual income of U.S. workers was about $33,000 in 2003, and the average tax rate was 20%. Thus an average worker paid about $6,600 in taxes in 2003. $6,600 x 5 million 45 year olds x 3 years = $98.8 billion dollars in tax revenues.

This is not a pie in the sky conjecture. OECD data show that the average retirement age in EU15 countries and in the U.S. has risen by 1 year since 2000. Thus, better health currently bolsters U.S. government tax receipts to the tune of $32.9 billion a year, roughly $5 billion more annually than the current NIH budget. This does not include the economic benefits that accrue to employers from increases in worker productivity and days of work not lost. These translate into higher profits and tax revenues.

3. New concepts take time to gain acceptance. This is undoubtedly part of the answer. We accept this as a fact of life in science. Why should it be otherwise in public affairs?

Indeed, there is good evidence that time is required to gain political traction for ideas that seemed fantastic when first proposed. As shown in Fig. 8, it took six years from the time
doubling NIH’s budget over 5 years was proposed until Congress appropriated the first installment of the required funds.

In his book “The Health of Nations,” William Nordhaus argues for the implementation of national income accounting systems that include improvements in human health as measures of societal wealth. Several of the economists who participated in the studies I have just described are working on national health accounts that measure the benefits of improved health, not just health spending. I am hopeful that in time they will develop such systems, and that elected officials and governments will use national health accounting methods that take into account the beneficial outcomes of past investments in medical and health research in determining future levels of investment in research.

While we wait for this to occur, U.S. economists are pursuing two other promising economic approaches.
First, the work of Kenneth Manton and others shows disability and morbidity is declining at an annual rate of 1-1.5%, and has done so for the last 20 years (Fig. 9). Funding First is supporting studies of the causes and benefits of this decline. What are the relationships between improvements in health and retention of older workers in the workforce? Does decreased disability and morbidity translate into lower Social Security and Medicare costs? We do not have full answers to these questions yet.

![Figure 9](image)

**Fewer elderly have impairments in personal or living functions**

Decline between 1.0 and 1.5 percent per year.

**Graph courtesy of David Cutler, Ph.D., Department of Economics, Harvard University.**

Second, we in the U.S. continue to emphasize the relationships between investments in medical research and growth of the biotechnology, pharmaceutical, and medical device industries. It is no accident that the biotech industry began, and today is located primarily in areas surrounding major academic centers – Seattle, San Francisco, San Diego, Boulder, Michigan, Boston, North Carolina, and the NJ-Philadelphia corridor. As shown in Fig. 10, basic research performed in the not-for-profit sector provides at least half of the knowledge base on which these industries are based. Moreover, in the main they are led and staffed by university trained scientists.
Biotech companies have low environmental impact. They are a source of high paying jobs (average ~$54,000 per year), presently employ nearly 200,000 people, develop very profitable products and processes, and consequently attract substantial venture capital. Politicians recognize them as the businesses of the future, as businesses that will provide jobs for their constituents and bring tax revenues to their districts.

Third, we continue to emphasize that leadership in basic science and technology creates and maintains a skilled workforce capable of creating entirely new industries. Invention creates wealth.

These approaches to advocacy for government support for medical and health research and training have proved successful in the U.S. Whether they will be equally successful in the U.K. only you can determine. But whether or not you choose to adopt them, there is at least one thing each of you in academic institutions can do to advance the cause of public awareness of the value of medical and health research. In the U.S. all research institutions that receive NIH support are required to give a course on the responsible conduct of
science. At Columbia University where I teach, all first year graduate students are required to take this course. For the past 15 years I have lectured in it on the subject of “scientific citizenship.” In that lecture I focus on the responsibilities of scientists to communicate with elected officials and the larger public about the essential role government support for research and education plays in the advancement of health, the inventiveness of our people, and the vitality of our economies. You and I recognize that now more than ever, our democracies require citizens who comprehend the nature of science as well as its fruits. We scientists must do more to see that this occurs.

To this end, we must improve our own advocacy and communication skills, and make greater efforts to encourage and engage our students in this work. Your country has produced some of the world’s most effective communicators of science to the public. For example, Michael Faraday, T.H. Huxley, and J.D. Bronowski. Indeed, you may find that like T.H. Huxley you derive unanticipated personal benefits from talking to the public about science. “Popular lecturing,” Huxley wrote, “has convinced me that the necessity of making things plain to uninstructed people is one of the best means of clearing up the obscure corners of my own mind.” Having listened to you for the past day, I know you are outstanding communicators.

My colleagues and I wish you well in your efforts to convince your government that investments in medical and health research and education are among the most valuable investments it can make. We are pleased to share with you our materials, experiences and ideas. But only you can assemble the data, fashion the arguments, make the contacts, and stand as advocates for further British and EU investments in medical and health research and training.

Thank you.