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Is biomedical research a good investment?

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Op-Ed

As the US addresses its budget dilemma, the easiest items to cut are those with the longest-term payoff. Research stands out among this group. Biomedical research has already been markedly reduced, and further reductions appear to be in store. As a frequent witness in Congressional hearings on such matters, here I discuss the challenge of assessing the value of investments in biomedical research.

Is biomedical research a good investment?

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As the US addresses its budget dilemma, the easiest items to cut are those with the longest-term payoff. Research stands out among this group. Biomedical research has already been markedly reduced, and further reductions appear to be in store. As a frequent witness in Congressional hearings on such matters, here I discuss the challenge of assessing the value of investments in biomedical research.

Providing mathematical proof of the positive overall cost-benefit relationship of investments in research, particularly biomedical research, is at best a formidable task; nonetheless, the body of evidence in support of the proposition is substantial.

Several years ago, a bipartisan group of the Senate and House of Representatives asked the National Academies to assess trends in America's global competitiveness, and it was my honor to chair that effort. The twenty participants, including university presidents, CEOs, Nobel laureates, and former and future presidential appointees, unanimously concluded that the two most important actions to assure a high-quality life for future Americans were to significantly increase the nation's investment in scientific research and to repair the US K–12 education system (1).

Prior to the above effort, the Congressionally established bipartisan Hart-Rudman Commission on National Security, of which I was also a member, unanimously concluded that ". . . second only to a weapon of mass destruction detonating on an American city, we can think of nothing more dangerous than a failure to manage properly science, technology, and education for the common good" (2).

In the UK, Prime Minister Margaret Thatcher said, ". . . although basic science can have colossal economic rewards, they are totally unpredictable. . . . Nevertheless, the value of Faraday's work today must be higher than the capitalization of all shares on the stock exchange. . ." (3).

In China, Wen Jiabao, then Premier of the State Council of China, had this to say on the subject: "The history of modernization is in essence a history of scientific and technological progress. Scientific discovery and technological inventions have brought about new civilizations, modern industries, and the rise and fall of nations. . . . I firmly believe that science is the ultimate revolution" (4).

But with such broad emphasis the question arises as to why the US spends more on potato chips than on energy research or why, over the past decade, it has reduced its investment in NIH research in real terms by 22 percent and dropped from first to seventh place among OECD (Organisation for Economic Co-operation and Development) nations in the fraction of GDP devoted to basic research (5). Or why our states have disinvested in their support of higher education per student in real terms by a median 27 percent in the past five years alone (6).

Having testified before Congress dozens of times in support of increased investment in research, I have personally experienced the difficulty of making a succinct, compelling, analytical case as to the cost effectiveness of research, certainly including biomedical research. In the latter instance, personal anecdotes are powerful, but the specific does not prove the general.

Similarly, I have reviewed dozens of studies that examine the cost-benefit relationship of biomedical research, and, while many of these investigations offer valuable insights to the professional engaged in the field, none seems to offer what might be termed compelling "proof" — especially to a skeptic.

In the case of specific curiosity-driven research projects, there never can be an a priori cost-benefit defense. Yet in 1945, Vannevar Bush, writing in "Science the Endless Frontier," pointed out that "discoveries pertinent to medical progress have often come from remote and unexpected sources, and it is certain that this will be true in the future" (7). Among the canonical cases have been studies of butterflies, seals, and, serendipitously, molds, that have led to cancer treatments; advances in surgical procedures; and the discovery of penicillin, respectively.

Assessments of the benefits of biomedical research suffer a variety of afflictions. Many seek to place a monetary value on human life (the Environmental Protection Agency's value of statistical life is $7.4 M; ref. 8), but few citizens, certainly including members of Congress, will agree upon any such esoteric metric. Other analytical studies in effect simply stipulate the answer, say, by assuming that half of the gain in quality-adjusted life expectancy is attributable to biomedical research. Similarly, few taxpayers are motivated by tortured counts of research papers, citations, patents, or even Nobel Prizes. Although many assessments are based on purely economic considerations, even overlooking such complications as those above, one would seem to be poorly advised to argue that the justification of biomedical research is to make money, save money, or produce jobs.

Then there is the matter of attribution. For example, what fraction of the investment in robotics and computational research that played such an important role in deciphering the human genome should be charged to the cost of the medical benefits that derive from the latter research? And should not the cost of implementing the results of basic research be included when assessing the cost-benefit ratio of that research? How much of the extension of statistical life expectancy due

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to the decline in smoking should be credited to biomedical research and how much merely considered a cultural change, albeit triggered by research? Should the health benefits accrued by future generations or the citizens of other nations be credited to advancements made by specific research entities, such as the NIH? And how does one treat so-called research "failures" — that years later not infrequently prove to be of value?

In such regards, biological systems are extraordinarily complex entities that interact in complex ways, both internally and with their environments, the latter including social factors not readily quantified. The challenge when assessing cost-benefit relationships of such systems is that, if all possible interactions are included, the task becomes insurmountable and, if all important interactions are not included, the results become irrelevant. Professor Friedrich Wiekhorst of the Max Planck Institute derived the equation that defines the number of possible states that exist for a system having a specified number of elements, each of which interacts with every other element in a binary manner, the simplest of all manners. He called his equation, "The Monster" — and with good reason. In the case of a two-element system there are only four possible states. But with even ten elements the number exceeds the count of stars in our galaxy. So what of the human brain with its 10^{11} cells and 10^3 connections per cell?

While in no way disparaging the informative value of mathematical assessments of cost-benefit relationships in biomedical research, particularly when taking the form of parametric analyses, it would appear that evaluations that depend on the judgment of experts may have to play a far greater role in the assessment process than has been generally accepted.

Another possibility, of course, is simply to ask the citizens who pay the bills and reap the benefits of biomedical research to offer their views. It is likely that few would prefer to live in the environment that existed in, say, 1900, with its polio, tuberculosis, rubella, yellow fever, measles, and tetanus and absence of antibiotics, insulin, artificial joints, laser eye surgery, and stents — and a life expectancy of 47 years. The cost portion of that assessment hinges upon what a person would be willing to pay to have the benefit of the advancements — medical and nonmedical — that have taken place since 1900. In my own youth, few argued for reducing the investment in research on potential polio vaccines in order to fund means of improving the efficiency of producing iron lungs.

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In the case of the basic research supported by the NIH, the cost per US citizen is about 25 cents per day (9). In polls conducted by Research!America, over half of the respondents indicated a willingness to have their taxes increased by an amount that, assuming the same willingness to pay on behalf of their children, would permit the NIH research budget to be increased by more than fifty percent (10).

The nation's citizens can presumably afford such an investment, given that they currently spend an average each day of 56 cents on snack foods, 95 cents on illegal drugs, 98 cents on store-bought alcoholic beverages, 18 cents on spectator sports, and 93 cents on legal tobacco products (11–13).

The question nonetheless arises with regard to investment in biomedical research, "How much is enough?" Many people today would probably agree that having invested more in research to counter Ebola would have been a sound decision. And with 18 percent of America's GDP being devoted to healthcare, there is a great deal of leverage to be realized from research that reduces the purely financial burden of providing health care. But, with a mere 0.2 percent of GDP currently being devoted to federally funded basic research of all kinds and about 0.1 percent to biomedical research (5), it would seem that we are far from any danger of overinvesting.

It has not infrequently been pointed out to me by members of Congress during Congressional hearings that "America has a budget problem." Indeed, it does . . . a very serious budget problem. But, as a businessperson from an industry that once lost 40 percent of its employees and three-fourths of its companies in a five-year market downturn, it is very clear that even when drastically cutting back overall there are some areas in which one must simultaneously increase funding. The key, if one wishes to survive the long term, is to understand the difference between spending for investment and spending for consumption.

Unfortunately, an air-tight mathematical proof of the full cost and full benefit of America's investment in biomedical research seems beyond our grasp. Even so, research in the biomedical sciences appears to be among the soundest investments the nation can make on behalf of its citizenry.

About the author

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