

# Biomedical Research and Illness: 1900–1979

SOLOMON SCHNEYER,  
J. STEVEN LANDEFELD,  
and FRANK H. SANDIFER

*Division of Program Analysis,  
National Institutes of Health;  
Bureau of Economic Analysis,  
U.S. Department of Commerce;  
Public Services Laboratory,  
Georgetown University*

**S**ERIOUS QUESTIONS ARE BEING RAISED ABOUT THE effectiveness of medical knowledge, at a time when expenditures both for research and for medical care are higher than ever before and still rising. Critics question the contribution that medical measures have made to health progress in the twentieth century, as well as the efficacy and cost of new medical technologies (Illich, 1976; McKeown, 1976; McKeown and Record, 1962; McKeown et al., 1975; McKinlay and McKinlay, 1977). Citing such examples as renal dialysis, coronary by-pass surgery, radiation and chemotherapies, and organ transplants, some analysts charge that medical advances have produced expensive "halfway technologies" that do little to extend life expectancy, attacking a disease after the fact and largely at a symptomatic level (Gaus, 1976). Such discussions often do not distinguish between research and technology. Indeed, they may lump them together, and proposals have been advanced for controlling research/technology as a means of holding down health care costs (Altman and Wallack, 1979; Egdahl and Gertman, 1978b). In a parallel fashion, Schneyer (1979) has observed that in discussions of the allocation of funds for biomedical research there is often no clear distinction made between research and the delivery of service.

It is just this lumping together, and the fact that an individual author's work is often appropriated and improperly extended by others,

that motivated this paper. The original authors may interpret their data with caution, but a number of studies appear to have contributed to an alarming set of conclusions about research. A general idea that has achieved some currency is that biomedical research, by providing the foundation for the development of costly new technology, is contributing to higher health care costs and not improving health. The products of such thinking are not limited to learned journals. In the planning documents preceding the development of the 1975 budget for the then Department of Health, Education, and Welfare, it was suggested that it might be considered appropriate to adopt as a secretarial initiative “the establishment of a biomedical research priority-setting process which formally and explicitly incorporates consideration of the following kinds of factors: ... (4) the likely social costs of using the knowledge acquired through research in a particular area” (Office of the Assistant Secretary for Planning and Evaluation, 1973:30). Although the conclusion was not stated explicitly, one presumes that the assumption behind this suggestion was that research can be expected to drive up “social costs” and that the magnitude of the expected increase should be a factor in deciding whether the research should be done. The suggestion was not, in fact, implemented, but it is to the kind of background data that are used to legitimize such proposals, often without specific attribution, that this paper is directed.

Here, we examine the evidence and arguments employed by some of these critics of the role of medicine. We suggest 1) that, contrary to the findings of some researchers, medicine—and especially biomedical research—has played an important role in the modern decline in mortality; and 2) that discussions of the rising costs of health care often blur the distinction between the costs of research, the costs of care, and the costs of disease. For these as well as other reasons, attempts to control the cost of health care by regulating research are misdirected. Attention would be better directed to cost-effectiveness evaluation of specific new medical technologies before they become widely diffused.

## Biomedical Research and Mortality Rates

Several authors have pointed out the paradox of modern medicine, the relation between health expenditures and changes in mortality

(McKinlay and McKinlay, 1977; Powles, 1973; Rutstein et al., 1976). In the years when reductions in mortality rates were large, expenditures for medical care and biomedical research were small. In recent years, despite substantial increases in expenditures for both care and research, mortality has responded relatively slowly. Therefore, it is suggested that the contribution of medicine to the modern decline in mortality is small. In reality, just the opposite may be true.

In the early years of this century, when disease problems were legion, mortality high, and knowledge of disease limited, relatively small efforts could yield substantial results in reducing death rates. When average life expectancy in the United States was less than 52 years, the National Conservation Commission (1909) reported that it could be extended by more than one-third, more than 15 years, through the adoption of hygienic reforms already then known. Today, however, when average life expectancy has passed 72 years, greater effort is required to achieve further reductions even though disease processes are better understood.

Economists characterize such relationships in terms of the principle of diminishing marginal physical productivity. That is, beyond some point in a production process, increases in resource inputs will yield decreasing gains in units of output. The control of water pollution provides an analogy. When pollution levels are high and the focus is on gross material wastes, then simple screens on waste water pipes may effect a large reduction in the level of gross residuals. Once that is accomplished, much more sophisticated and expensive equipment is required to screen out the progressively finer units of pollutant. But the fact that the physical returns (i.e., units of output) are declining relative to units of input does not mean that further investments are unsound. What is important is the value of the output relative to the cost of the input. It is this value relation that determines the efficiency of production.

In the case of health care and medicine, one must be concerned with the value of health benefits, such as the value of premature deaths averted, in relation to the cost of the health system inputs, such as biomedical research dollars and health care expenditures. Furthermore, the benefits of medical advances involve more than just the value of reductions in deaths. Minimally, the benefits of reductions in morbidity and general improvements in health status should also

be included. Accepting this position means giving up the comparative comfort of analyses based simply on mortality rates and accepting the unease and uncertainty of broader economic analysis. How else encompass mortality, morbidity, and other aspects of health status in a single measure? So, issues of health status and cost are inevitably interlocked.

Mushkin and her colleagues have estimated the contribution of biomedical advances to reductions in morbidity and mortality over the 75-year period from 1900 through 1975 (Chen and Wagner, 1978; Mushkin, 1979). The relative shares of the decline in sickness and death were partitioned to the various contributing factors: economic, societal, environmental, medical services, and biomedical advances. The dollar values of these changes in mortality and morbidity were estimated on the basis of production gains from the reduction in lost workdays due to illness or premature death in the labor force. A summary of the computations is shown in Table 1. By even this partial accounting, the benefits of biomedical advances more than offset the costs. Even the most conservative estimate of the economic benefits over the period 1900-1975 is ten times the cost of biomedical research.

The measures are very crude and they fail to capture the full effects of biomedical research on the health status of the population and on the general quality of life. For example, they do not include the benefits of providing symptomatic relief from chronic diseases, which allows elderly persons to care for themselves and to function independently. This may have no measurable impact on the gross national product, but surely has some value. And halfway technologies for chronic diseases do have benefits, but the benefits are harder to measure. It is principally the measurement difficulty that has led some critics of modern medicine to ignore these benefits. The development of appropriate measures to supplement or replace existing measures is certainly desirable.

The elimination of the infectious diseases as leading causes of death has left us the chronic diseases to deal with. Since immortality is not likely, research and medicine must concentrate more and more on improving levels of function and quality of life. Analysts who are assessing such efforts must develop measures that are more appropriate to the changed emphases of medicine and research.

TABLE 1  
 Estimated Value of Reduction in Illness and Premature Death Attributable to Biomedical Research,  
 1900-1975 and 1930-1975

	Total Value of Reduction in Sickness or Postponement of Premature Death (in \$ Billions)	Value Attributable to Biomedical Research (in \$ Billions)
Total saving achieved: 1975 compared with 1930	481	145
In deaths	221	44
In objective sickness rates	260	101
Total saving achieved: 1975 compared with 1900	936	300
In deaths	725	218
In objective sickness rates	211	82
Total assets in human capital created, 1930-1975	2,900	800
Labor force addition in 1975 by reduction in deaths since 1930	2,000	400
Reduction in long-term disability since 1930	900	400
Total assets in human capital created, 1900-1975	6,800	2,100
Labor force addition in 1975 by reduction in deaths since 1930	5,700	1,700
Reduction in long-term disability since 1930	1,100	400

Source: Adapted from Mushkin (1979), Table 14-4. In cases where Mushkin gives ranges, the lower bound has been used as a conservative estimate.

## Impact of Biomedical Knowledge in the Past: Infectious Diseases

In assessing the effects of medicine and biomedical advances in the twentieth century, analysts have concentrated for the most part on the infectious and parasitic diseases. It is for these diseases that the most dramatic improvements in mortality have been registered. Infective and parasitic diseases were major killers at the start of the century, accounting for over 40 percent of all deaths, but they have been brought largely under control.

What was responsible for the improvement? The critics of medicine's role provide a valuable service in highlighting the substantial contribution of disease prevention strategies, as opposed to curing strategies. But these studies are misleading, as when, for example, McKinlay and McKinlay (1977) measure the contribution of medicine solely in terms of the effects of specific medical therapies on changes in mortality, excluding all other medical inputs and all other health benefits. Following the method of McKeown et al. (1975), McKinlay and McKinlay identify one specific medical therapy for each of ten infectious diseases and assess the change in mortality before and after the therapy was in widespread use. In the case of typhoid fever, for example, medicine's contribution to mortality improvement is tied to the introduction of chloramphenicol in 1948, a point at which the death rate due to typhoid in the United States was already quite low. Therefore McKinlay and McKinlay conclude that the specific medical measure had little to do with the overall decline in mortality due to typhoid fever in the twentieth century. A similar argument is made for the other infectious diseases discussed, except that the authors do find "substantial" changes in mortality after the identified interventions for four of the ten diseases.

Following this line of reasoning, McKinlay and McKinlay (1977:425) conclude that "in general, medical measures (both chemotherapeutic and prophylactic) appear to have contributed little to the overall decline in mortality in the United States since about 1900—having in many instances been introduced several decades after a marked decline had already set in and having no detectable influence in most instances." The authors are content to imply that the individual "medical measures" they identified for the analysis are the sole contribution of medicine and biomedical knowledge to the control of infectious dis-

eases. This tactic ignores the numerous advances and interventions that preceded the specific measures that they discuss. The approach is grossly misleading and the conclusion is erroneous.

A more realistic approach to the issue has been taken in the program of studies directed by Mushkin (1979). Under her direction, a careful set of historical case studies on the infectious diseases has been produced (Dwork, 1978, 1979). These case studies present documentary evidence of the effect of biomedical advances combined with informed public health measures. In conjunction with other statistical work on returns to biomedical research in the aggregate, these disease-specific case studies demonstrate the significant and continuing impact of biomedical research on death rates over the twentieth century.

It is illustrative to compare the mortality graph for typhoid prepared by McKinlay and McKinlay (Fig. 1) with that prepared by the Public Services Laboratory (Fig. 2). Figure 2 plots some of the significant medical and related interventions that occurred in the years before chloramphenicol was introduced, showing the cumulative results of

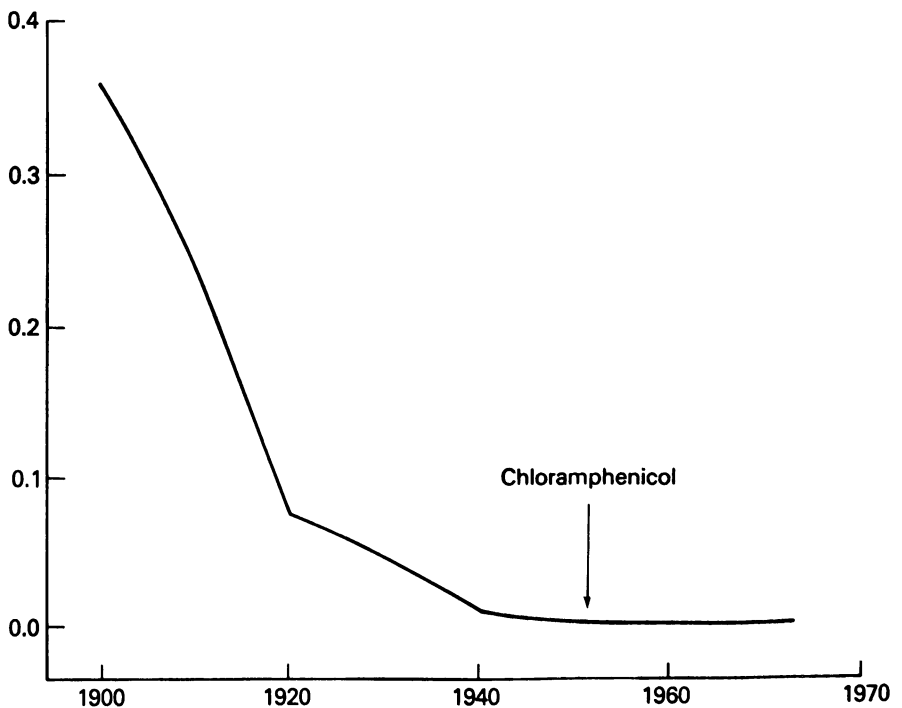


FIG. 1. Fall in standardized death rate (per 1,000 population) due to typhoid. *Source:* McKinlay and McKinlay (1977).

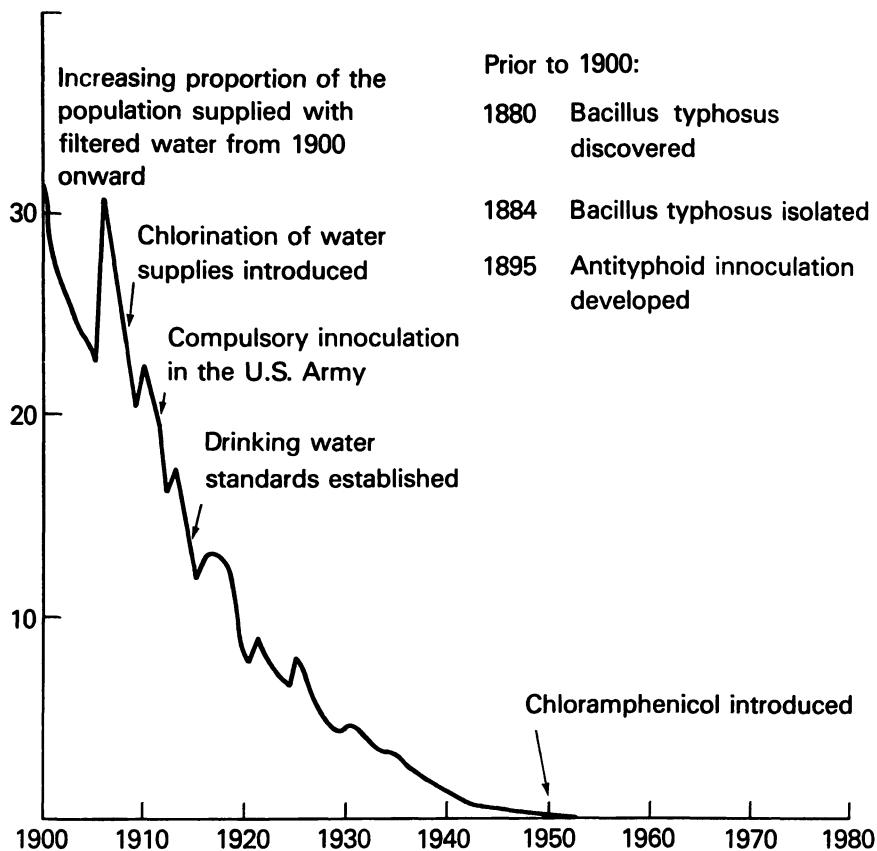


FIG. 2. Age-adjusted death rates (per 1,000 population) due to typhoid. Source: Public Services Laboratory, Georgetown University, unpublished paper.

advances in biomedical knowledge and the interventions based on that knowledge. Typhoid is just one example. There is similar evidence of a range of interventions for other infectious diseases as well (Public Services Laboratory, 1979). While it is true that specific cures for many of the infectious diseases did not become available until these disease problems were greatly reduced, the conclusion that medical science had little to do with the decline in mortality is incorrect. It is simply that the product of biomedical science is delivered in many different ways, and these are general as well as disease-specific.

The period from 1900 to 1930 was characterized by increasingly informed public health and social response to the biomedical research discoveries that certain diseases were infectious. Once it was under-



stood that what was contagious was controllable and even preventable, the medical profession became aware of its responsibilities in that regard. Education of the public and government officials about the course and transmission of disease focused public action. Armed with knowledge of the cause and means of transmission of disease, public health officials instituted a wide spectrum of measures. The reforms brought dramatic changes. In 1890, less than 2 percent of the urban population was supplied filtered water; by 1915, 40 percent of the American population was supplied filtered drinking water; chlorination of water supplies was introduced, and pasteurization of milk was made mandatory. Isolation of infectious individuals was stressed. During the reform era, the number of dark unventilated rooms, which fostered the survival of pathogens, was reduced; crowding was alleviated and plumbing was upgraded. Coincidentally, important diagnostic and therapeutic measures were being introduced. Among these were the tuberculin test for tuberculosis, the X-ray, and antitoxin for diphtheria. The medical profession—and medical researchers in particular—were heavily involved in all these developments. Death rates did not simply decline in these years for no reason, and medicine was not lying around idly waiting for disease problems to solve themselves.

While the period 1900–1930 was one of informed social response to disease, the period since 1930 has been characterized by specific medical interventions. Often, although the modern “specific” was not developed until relatively recently, it had many antecedents. They were not often as effective as modern therapies, but they were nonetheless important.

McKinlay and McKinlay (1977) argue that the medical measures they investigated had “no detectable influence in most instances.” We can agree that general medical and preventive health measures (based on biomedical research) had greatly reduced the magnitude of infectious disease by the time modern specific therapies were introduced. However, this does not mean that the specifics have had no observable effect on health. Heyssel (1979:265) cogently notes that “health status is certainly something other than death rates.” You address the most serious consequence of illness first—mortality. Then you turn to the other manifestation of disease—morbidity. Measuring the effect of medicine only by its effect on mortality is insufficient in assessing the effects of medical advances.

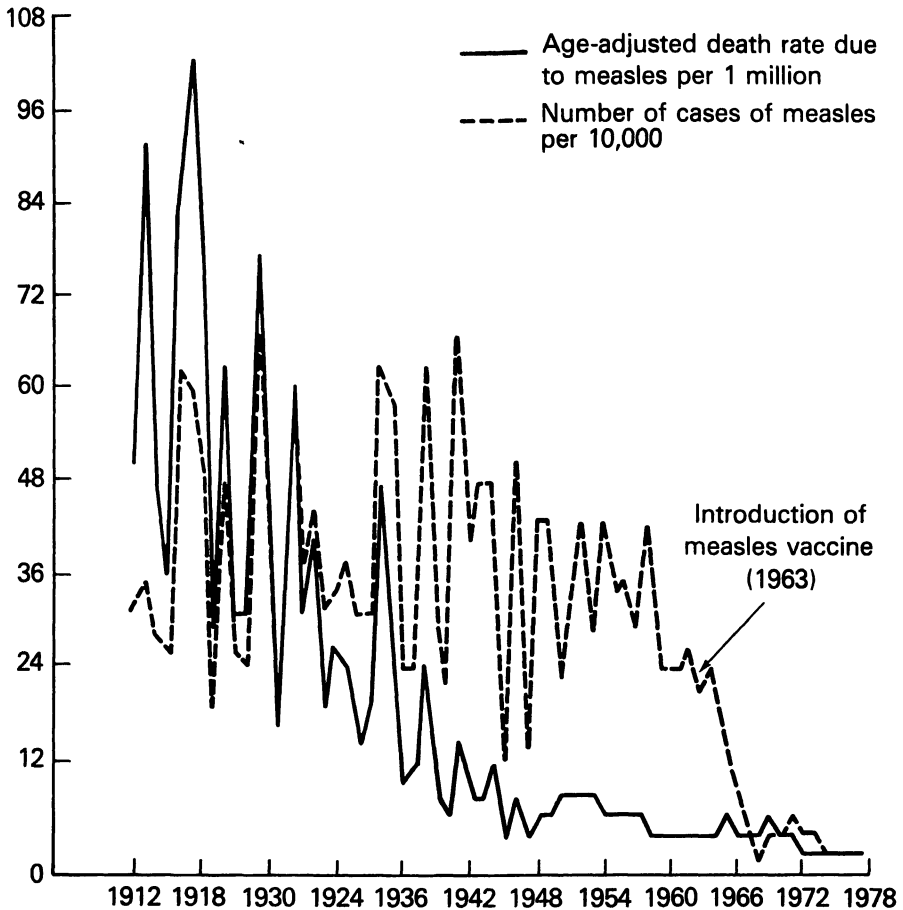


FIG. 3. Death rates and sickness rates from measles. *Source:* U.S. Center for Disease Control: *Morbidity and Mortality, Weekly Report, Annual Supplement*; U.S. National Office of Vital Statistics: *Vital Statistics: Special Reports*, Vol. 7, No. 9; U.S. Public Health Service: *Public Health Reports*, various issues, for 1912-1919 data.

An example of the incomplete picture resulting from such a limited evaluation is presented in Figure 3. If we evaluated the introduction of the measles vaccine only in terms of death rates, it would be judged to have had very slight impact. But sickness rates tell quite a different story. In 1963, the year the vaccine was introduced, the incidence of measles was 204 per 100,000. In 1965 it dropped to 135 and, by 1970, to 23. Clearly, in evaluating medical measures, death rates alone do not provide an adequate basis for drawing conclusions about the efficacy of new therapies.

## Effect of Biomedical Research at Present: New Technologies

Technology, such as computerized axial tomography (CAT), is often cited as a major source of growth in health care expenditures. (Parenthetically, one wonders if complaints about the CAT scanner will continue, following last year's Nobel awards.) But new technologies in themselves are not the problem. What happens to them is symptomatic of a number of fundamental problems in our health care system.

Certainly, one problem is the absence of a market test for innovations. The growth in the share of medical expenses paid for by third parties has dramatically reduced out-of-pocket costs to consumers. The result has been increased utilization and diminished incentives for efficiency in the provision of medical care. Increased insurance coverage, combined with the increased threat of malpractice suits, may also contribute to the use of extensive testing and therapies that are at best defensive and at worst unnecessary. Under what is basically a cost-reimbursement system, administrators and doctors have little incentive to be efficient. They may indulge themselves in the luxury of having "all the latest equipment," which results in duplication of facilities and excessive utilization. The point is not that the newer equipment is ineffective. Many of the recently developed technologies are unquestionably valuable. However, in many cases, the technologies have been too widely diffused. Costly procedures that are useful in specific cases have been adopted as part of standard medical practice and used routinely in most cases. Services that could be provided effectively and more economically at *regional* treatment centers are provided at *all* treatment centers.

A second major problem is that innovations are not sufficiently tested for effectiveness before they are diffused. This problem is related to the inadequate incentive structure as well. Controlled clinical trials of new technologies before their widespread diffusion have been rare. Banta and Thacker's (1978) case study of electronic fetal monitoring (EFM) illustrates the problem. The authors note that the evidence from recent controlled, clinical trials of EFM raises serious doubts about its efficacy. Yet the technique has already become widely diffused since its introduction in 1960, despite the lack of convincing evidence of its efficacy. The authors comment that "public and private

policies have largely acted to encourage diffusion of EFM, and none has acted to slow or prevent its spread,” and conclude that the case of EFM “suggests the need for mechanisms to assure the timely evaluation of new medical technologies before they are diffused into medical practice” (Banta and Thacker, 1978:2).

A full-scale analysis of the rising costs of health care is clearly beyond the scope of this paper. That problem has been the subject of a voluminous literature in recent years and at least two major symposia have discussed the specific issue of the role of technology (Altman and Blendon, 1979; Egdahl and Gertman, 1978a).

It would be irresponsible to suggest that the problem is a simple one. Lewis Thomas (1971), who introduced the concept of halfway technology and pointed out how much more expensive and less desirable such a technology is than a high technology that truly prevents or cures, also pointed out the dilemma presented by halfway technologies. They “make up for disease or postpone death” (Thomas, 1971:1367). To save life is a primary requirement that we—that is, society—place on our physicians, and we have not yet provided them with a specific calculus for trading off lives against dollars. Thus we have a renal dialysis program, with its enormous costs and all of the problems presented to patients who live by the sufferance of machines. But without the program many alive would now be dead. Can we decide not to use such a technology, despite its cost?

Loewy (1980:697) undoubtedly voices the opinion of many physicians when he argues that the cost of care is an irrelevant issue. He believes that “optimization of survival and not optimization of cost effectiveness is the only ethical imperative” in medical practice. We can also note the ultimate absurdity, both for cost-benefit analysis and for policy development, that a “premature” death avoided as a result of research and good medical practice may represent a contribution to human capital at the time, but will eventually add to the total cost of medical care. Nonetheless, cost continues to be a matter of great concern to many and the issue must be faced. With regard to rising health care costs, Heyssel (1979:269–270) has argued that “the issue is cost containment, not technology, mismanagement, or other bogies. It may be that focusing on technology as the culprit is politically easier than dealing with the wages and salaries of health care workers, the increase in numbers of physicians, and the untrammelled freedom of health care professionals to practice where and how

they wish. However, the notion that it is easier to deal with technology is illusory. To do so will lead to greater problems than a more general cost containment strategy."

The problem of cost has two facets. One is the delivery of services, in the most general sense. New technologies are overutilized, but so are existing technologies. One of the most rapidly growing components of hospital costs is the cost of laboratory services (Fineberg, 1979; Scitovsky and McCall, 1976). Laboratory tests have increased in both sophistication and number. Hospital expansion and excess capacity are another part of the problem. The services are useful, but there is little incentive to efficiency in their use. The solution to this aspect of the cost problem must lie in the development of improved social mechanisms for controlling service delivery. Improved health services planning and review may contribute to this.

The second facet is knowledge. We need not less, but more. Research and resultant technological change have been instrumental in our economic growth and physical well-being (see Denison, 1974). The outcome at any given time may be impossible to predict, but research results historically are extremely significant, and demonstrable. To attempt to limit research as a way of controlling health care costs is an admission of intellectual bankruptcy in the management of social problems and may also be a prescription for disaster.

## References

- Altman, S.J., and Blendon, R., eds. 1979. *Medical Technology: The Culprit Behind Health Care Costs? Proceedings of the 1977 Sun Valley Forum on National Health*. Washington, D.C.: National Center for Health Services Research. DHEW Publication No. (PHS) 79-3216.
- , and Wallack, S.S. 1979. Is Medical Technology the Culprit Behind Rising Health Costs? The Case For and Against. In Altman, S.J., and Blendon, R., eds. 1979. *Medical Technology: The Culprit Behind Health Care Costs? Proceedings of the 1977 Sun Valley Forum on National Health*, 24-38. Washington, D.C.: National Center for Health Services Research. DHEW Publication No. (PHS) 79-3216.
- Banta, H.D., and Thacker, S.B. 1978. *The Premature Delivery of Medical Technology: A Case Report*. Hyattsville, Md.: National Center for Health Services Research.

- Chen, M., and Wagner, D.P. 1978. Gains in Mortality from Biomedical Research 1930–1975: An Initial Assessment. *Social Science and Medicine* 12:73–81.
- Denison, E.F. 1974. *Accounting for United States Economic Growth 1929–1969*. Washington, D.C.: Brookings Institution.
- Dwork, D. 1978. *Biomedical Research: The Case of Tuberculosis*. Washington, D.C.: Public Services Laboratory, Georgetown University.
- . 1979. *Biomedical Research and Infant and Maternal Health: A Chronology*. Washington, D.C.: Public Services Laboratory, Georgetown University.
- Egdahl, R.A., and Gertman, T.M., eds. 1978a. *Technology and the Quality of Health Care*. Germantown, Md.: Aspen Systems.
- . 1978b. Summary of Conference Discussions. In Egdahl, R.A., and Gertman, T.M., eds. 1978a. *Technology and the Quality of Health Care*, 263–278. Germantown, Md.: Aspen Systems.
- Fineberg, H.V. 1979. Clinical Chemistries: The High Cost of Low-Cost Diagnostic Tests. In Altman, S.J., and Blendon, R., eds. 1979. *Medical Technology: The Culprit Behind Health Care Costs? Proceedings of the 1977 Sun Valley Forum on National Health*, 144–165. Washington, D.C.: National Center for Health Services Research. DHEW Publication No. (PHS) 79–3216.
- Gaus, C.R. 1976. Biomedical Research and Health Care Costs. In *Report of the President's Biomedical Research Panel. Supplement 3*, 273–285. Written statements supplementing verbal testimonies of witnesses. U.S. Department of Health, Education, and Welfare, April 30. DHEW Publication No. (OS) 76–508.
- Heyssel, R.M. 1979. Controlling Health Technology: A Public Policy Dilemma. In Altman, S.J., and Blendon, R., eds. 1979. *Medical Technology: The Culprit Behind Health Care Costs? Proceedings of the 1977 Sun Valley Forum on National Health*, 262–272. Washington, D.C.: National Center for Health Services Research. DHEW Publication No. (PHS) 79–3216.
- Illich, I.D. 1976. *Medical Nemesis*. New York: Pantheon.
- Loewy, E.H. 1980. Letter to the Editor: Cost Should Not Be a Factor in Medical Care. *New England Journal of Medicine* 302:697.
- McKeown, T. 1976. *The Role of Medicine: Dream, Mirage or Nemesis*. London: Nuffield Provincial Hospitals Trust.
- , and Record, R.G. 1962. Reasons for the Decline in Mortality in England and Wales during the Nineteenth Century. *Population Studies* 16:94–122.
- , Record, R.G., and Turner, R.D. 1975. An Interpretation of the Decline of Mortality in England and Wales during the Twentieth Century. *Population Studies* 29:391–422.

- McKinlay, J.B., and McKinlay, S.M. 1977. The Questionable Contribution of Medical Measures to the Decline of Mortality in the United States in the Twentieth Century. *Milbank Memorial Fund Quarterly/Health and Society* (Summer) 55:405–428.
- Mushkin, S.J. 1979. *Biomedical Research: Costs and Benefits*. Cambridge, Mass.: Ballinger.
- National Conservation Commission. 1909. *Report: Vol. III, 737*. U.S. Senate Document No. 676, 60th Congress, 2d Session, Washington, D.C.
- Office of the Assistant Secretary for Planning and Evaluation. 1973. *Health Program Memorandum—FY 1975 Budget, 30*. Washington, D.C.: Department of Health, Education, and Welfare, July 18.
- Powles, J. 1973. On the Limitations of Modern Medicine. *Science, Medicine and Man* 1:2–3.
- Public Services Laboratory. 1979. *Mortality Graphs and Short Chronologies of Medical Progress against the Infective Diseases*, Washington, D.C.: Georgetown University.
- Rutstein, D.D., et al. 1976. Measuring the Quality of Medical Care: A Clinical Method. *New England Journal of Medicine* 294:582–588. (Tables revised in 1977, *New England Journal of Medicine* 297:508.)
- Schneyer, S. 1979. Allocation and Priority Setting in Research. In Mushkin, S.J., and Dunlop, D.W., eds. *Health: What Is It Worth?* 237–245. New York: Pergamon.
- Scitovsky, A.A., and McCall, N. 1976. *Changes in the Cost of Treatment of Selected Illnesses: 1951–1964–1971*. Hyattsville, Md.: National Center for Health Services Research.
- Thomas, L. 1971. Notes of a Biology-Watcher: The Technology of Medicine. *New England Journal of Medicine* 285:1366–1368.

---

Preparation of this paper was partly supported under National Institutes of Health Contract No. NO1-OD-5-2121 with the Public Services Laboratory at Georgetown University, Principal Investigator, Selma J. Mushkin. Any opinions expressed are the sole responsibility of the authors. An earlier version of this paper was presented at the 107th Annual Meeting of the American Public Health Association, November 4–8, 1979, New York, New York.

*Address correspondence to:* Solomon Schneyer, Ph.D., Director, Division of Program Analysis, OPPE/OD, National Institutes of Health, Bethesda, MD 20014.