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# Introduction and Background

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# Introduction and Background

With the desires to control costs, enhance quality, and improve access to health care has come the need to identify, and to understand what is meant by, cost-effective medical care. Two closely related evaluative techniques—cost-effectiveness analysis and cost-benefit analysis (CEA and CBA, respectively)—are being used or advocated with increasing frequency to address this need. As measured by contributions to the literature, professional interest in these techniques and in their findings grew exponentially through the past decade. A reading of this literature, combined with discussions with numerous individuals and groups, indicates considerable excitement, widespread confusion, and a growing caution about the methods, implications, and usefulness of CEA and CBA in health care.

As a result of these cost-related concerns and the growth of interest in CEA and CBA, OTA was asked by the Senate Committees on Labor and Human Resources and on Finance to examine the feasibility, usefulness, and implications of using cost-effectiveness information in decisions relating to medical technologies. The resulting assessment, which includes this background paper on methodology, examines cost effectiveness by asking three major questions:

- What is the technical, or methodological validity of CEA and CBA when used to assess certain types of medical technologies within certain settings?
- What are the implications of using CEA or CBA? That is, what are the value and ethical, legal, political, medical, health, and economic implications?
- Can CEA and CBA be used appropriately in health care areas such as reimbursement, health planning, individual physician decisionmaking, or prepaid group practice?

The present background paper focuses on aspects of the first question. All three questions are examined in the main report of the assessment. (That main report and the four other background papers are described briefly in app. D.) This volume critically examines the methods of cost-benefit and cost-effectiveness analysis and reviews the literature on CEA and CBA in health care.

## DEFINITIONS OF CEA AND CBA

The terms cost-effectiveness and cost-benefit analysis refer to formal analytical techniques for comparing the negative and positive consequences of alternative projects. Each of us engages in CEA/CBA-like thinking every day, frequently subconsciously. “And ultimately, something like (CEA/CBA) must necessarily be employed in any rational decision” (729).

In this report, the term CEA/CBA is used to refer to the class of techniques that includes both CEA and CBA. In practice, the comparison of costs and benefits is accomplished through a spectrum of approaches, ranging from sophisticated computer-based mathematical programming using large amounts of epidemiological and other data to partially intuitive, best-guess estimates of costs and benefits. Some analyses may take into account the results of clinical trials of a technology and model the technology’s effect on health outcomes. Others may assume that the alternative technologies under study have equal effectiveness and concentrate on the difference in costs involved.

Thus, there is a continuum of analyses that examine costs and benefits. One end of the continuum comprises what will be referred to as “net cost” studies. In net cost studies the emphasis is on costs, and such studies in the past have often assumed benefits or efficacy to be equal. At the other end of the continuum are

analyses that attempt to relate the use of technologies under study to specific health-related outcomes and to compare the costs of the technologies to the differential health benefits. Thus, CEA/CBA includes a set of analytical techniques, differentiated by the specific costs and benefits that are considered and the manner in which they are analyzed.

Both CEA and CBA require analysts to identify, measure, and compare all of the relevant costs and consequences of alternative means of addressing a given problem. The objective of CEA/CBA is to structure and analyze information in a manner that will inform and thereby assist policy makers. It is these individuals, and not analysts, who will decide which, if any, of the competing program or technological alternatives will be proposed or implemented.

The principal technical distinction between CEA and CBA lies in the valuation of the desirable consequences of programs. In CBA, all such consequences—benefits—are valued, like costs, in numerical terms, almost always dollars. Conceptually, therefore, CBA permits an assessment of the inherent worth of a program —Do the benefits exceed the costs?—as well as comparison of competing program alternatives —Which of several programs generates the largest excess of benefits over costs? With all costs and benefits measured in the same (monetary) unit, CBA is designed to allow comparisons of similar or of widely divergent types of programs. Thus, in theory at least, CBA might be used to decide whether certain public resources should be allocated to construction of a dam or to construction of a hospital.

In CEA, certain basic desirable consequences are not valued in monetary terms, but rather are measured in some other unit. In health care CEAS, common measures include years of life saved and days of morbidity or disability avoided. The reason for a nonmonetary measure of program effectiveness is either the impossibility or undesirability of valuing important outcomes in dollars and cents. Unlike the bottom line of a CBA, a CEA is not a net monetary value; rather, it is expressed in units such as "dollars per year of life saved. " CEA permits comparison of cost per unit of effectiveness among competing program alternatives designed to serve the same basic purpose. Unlike CBA, however, the technique does not allow comparison of programs having widely different objectives—because the effectiveness or outcome measures differ—nor does it permit assessment of the inherent worth of a program. Is a cost of $50,000 per year of life saved acceptable? Obviously, this last question requires a social and political judgment; it is not a technical matter.

Choice of CEA or CBA will depend on technical considerations, the predisposition of analysts and their clients, and on the type of question being addressed. Neither technique is necessarily superior to the other. CBA may be the theoretical ideal, since it permits direct comparison of the desirable and undesirable consequences of diverse programs, but problems of benefit valuation are myriad, particularly in social welfare areas such as health care. CEA avoids the methodologically difficult and morally ambiguous task of assigning monetary values to such nonmonetary measures as years of human life. By rejecting the monetary measure of CBA, however, the CEA analyst loses a unifying metric with which to weigh and compare different types of effectiveness. How are two programs to be compared when one program averts many deaths but has limited effect on disability, and the other prevents considerable disability but averts only a few deaths? Methodological advances (such as measures of quality-adjusted life years) may in time ameliorate this inadequacy, but considerable barriers to using CEA to evaluate programs with significantly different effects still remain.

Both CEA and CBA can be used for purposes of planning for the future or evaluating past program performance. As planning tools, the techniques involve prospective analysis, i.e., an attempt to predict the costs and benefits (or effectiveness) of alternative future programs. Analysis may draw on past or existing programs for data and ideas as to how to model the structure of the future programs, but the focus remains distinctly prospective. In addition, as evaluation tools, CEA and CBA involve retrospective assessment of the realized costs and

benefits (or effectiveness) of existing or past programs. Frequently, a retrospective evaluation will have a prospective or planning intent: The question is asked, should a program be continued into the future and, if so, how should it be modified?

Finally, in this brief introduction to CEA/CBA, it is useful to distinguish these techniques from others that are frequently confused with them. The two "sides" of a CEA or CBA—assessment of a program's costs and desirable consequences—are important forms of analysis in their own right. The latter—assessment of effectiveness—is traditionally the focal point of evaluation in health care. A wide variety of evaluative approaches, including randomized clinical trials and epidemiological studies, form the basis of assessment of the efficacy or effectiveness of numerous medical and public health practices (405). Similarly, though less commonly, the costs of certain programs or technologies are assessed in a cost analysis which treats effectiveness only implicitly or tangentially. Finally, risk-benefit analyses compare the desirable outcomes of a practice with the undesirable but noneconomic ones. Thus, in risk-benefit analysis, the ability of a surgical procedure to alleviate pain or prolong life might be compared with its operative mortality and postoperative morbidity. Ideally, CEA/CBA represents a merging of all of the concerns addressed by these evaluative techniques. Further, the validity of any CEA or CBA is directly dependent on the validity of the efficacy information on which it is based.

The relative advantages and disadvantages of CEA and CBA, as well as the technical problems of both and the implications of their differences, are examined in detail later in this report.

## HISTORY OF CEA/CBA

The common-sense principles of CEA/CBA have been promoted for centuries. Formal application of CEA/CBA, however, is a phenomenon of the present century. In 1902, the River and Harbor Act directed the Corps of Engineers to assess the costs and benefits of river and harbor projects. In 1936, the Federal Flood Control Act required that "the benefits (of projects) to whomsoever they may accrue must be in excess of the estimated costs, " though the Act provided no guidance as to how benefits and costs were to be defined and measured. In the same decade, both the Tennessee Valley Authority and the Department of Agriculture implemented program budgeting systems which included rudimentary attempts at formal CEA/CBA. Official Government criteria for appraisal of river development projects were first enunciated by the Bureau of the Budget in 1952 (753).

Early in the Kennedy administration, the Defense Department, under Secretary McNamara, adopted a program budgeting system which employed CEA/CBA to evaluate alternative defense projects. Success in these endeavors, combined with a burgeoning Federal budget, led President Johnson in 1965 to require the implementation of planning-programing-budgeting (PPB) systems throughout the Federal bureaucracy. CEA/CBA represented both the spirit and the letter of the new initiative to rationalize Government resource allocation decisionmaking (475).

PPB met with mixed and limited success, reflecting a lack of resources to implement it effectively, political and bureaucratic opposition to it, and unrealistic expectations of its role and potential (729). The formal system did not survive for long, though many Washington observers believe it left a legacy of continuing improvement in the use of rational analysis in Government decisionmaking (748). And recently, the philosophy and logic of CEA/CBA and PPB have been reincarnated in the form of zero based budgeting.

As formaI evaluative techniques, CEA/CBA assess public sector resource allocation decisions where conventional private sector techniques,

such as capital budgeting and return-on-investment analysis, will not suffice. Commonly, the inadequacy of conventional private sector techniques reflects the absence of a smoothly functioning market to allocate resources as desired, resulting from either technical problems or distributional considerations. The former motivated the early applications of CEA/CBA. An example is the provision of national defense, which does not occur in the private sector because national defense is what is known as a pure public good, defined as a good which, when provided for one individual, benefits all individuals, since no one can be excluded from receiving the benefits and since one person's consumption of benefits does not reduce their availability for other people. It is impossible to "sell" national defense in a private marketplace, because consumers are aware that they will receive it free if it is provided for anyone else, and if they were to buy it themselves, they would be providing it free to everyone else. Therefore, national defense will exist only if it is supplied by the public sector.

'Other sources of technical market failure are closely related to the "pure public good" problem. These include significant economies of scale —i. e., decreasing average costs as the size of a project increases (e. g., a dam) —and externalities—loosely, costs or benefits experienced by other than the immediate decisionmaker (e.g., pollution of a downstream community's water supply by a firm dumping waste material upstream ). This report will not elaborate on these sources of market failure, but merely emphasize that they require nonmarket decisionmaking and hence provide candidates for CEA/CBA (753).

It is no accident that the origins of CEA/CBA lie in the area of water resource management and that the Department of Defense was PPB's showcase in the 1960's. Dams, irrigation projects, and the like have significant characteristics of public goods, yet market analogs permit the valuation of most of the projects' most significant costs and benefits. For example, a dam may produce electricity, which has a direct market value, and provide flood control and irrigation, where property values, insurance policies, and crop prices and yields serve to value benefits or costs. In the case of defense, once an objective has been agreed upon, evaluation of alternative projects may lend itself to CEA, a technique used to compare programs oriented toward attainment of the same quantified, but not monetarily valued, outcomes.

In the Federal PPB area, CEA/CBA has achieved less consistent success in social welfare areas, including education and health programs (751), than in the areas of water resource management and defense. The problems in applying these analytical techniques in social welfare areas include frequent disagreement on appropriate outcome measures and the valuing of redistributions of money, educational resources, access to health care, and so on. The benefits of redistribution—the seeking of a more just and humane sharing of society's resources—are particularly difficult to quantify and value.

## HEALTH CARE AND CEA/CBA

In the period of a decade, society's principal health system goal has shifted from increasing access to health care to controlling the rapidly inflating costs of care. The dilemma today is in containing costs without sacrificing desired benefits such as improved access to health care and quality. Thus, a logical approach would seem to be to identify and reduce the use of tests, procedures, and visits which are medically ineffective, unnecessary, or excessively expensive relative to their limited effectiveness. Increasing numbers of procedures and medical devices are being cited as candidates for attention as skepticism about the value of much medical technology replaces the enthusiasm of former years. Interest in and encouragement of the analysis of the safety and efficacy and, more recently, cost effectiveness of technology has accompanied the growing concern with health cost inflation (405).

Public efforts to improve financial access to care—primarily through medicare and medicaid—account for the rapid growth in Government's share of the national health care bill. Combined with increasing depth and breadth of

private insurance coverage, social programs have reduced the linkage between receipt of health care services and financial liability for them. Third-party payment is particularly extensive in the highest cost component of the health care system—hospital care, where Government and private insurance pay over 90 percent of the total bill (720).

The consequence of the growth in third-party liability is that most medical resource consumption decisions are divorced from liability for their financial implications. Thus, a physician may order an additional lab test which has a very low probability of improving a diagnosis, but which will not impose any direct and immediate additional financial burden on the insured patient.2 Russell has observed that ". . . as third-party payment has increased over the years, the benefit required to justify a decision in the eyes of doctors and patients has declined. This has led to increased use of resources in many ways—including the introduction of technologies that otherwise might not have been adopted at all and, more often, the more rapid and extensive diffusion of technologies that had already been adopted to some extent. "[3] In some respects, the principal constraint on the provision of care is the state of the art and the availability of technology.

Thus, a number of factors have come together to create a perceived need for formal evaluation on the economic and medical implications of individual technologies: The market's ability to evaluate and ration has deteriorated to the point where it plays a minor role at best; as a Nation, we want to assure equitable access to needed medical care and to minimize care which is ineffective, unnecessary, harmful, or excessively costly; we want to contain health care costs which currently impose significant burdens on many citizens and whose continuing real growth threatens everyone; and we confront an array of new and future medical technologies that may be introduced into the practice of medicine with little regard for their cost implications (705). In this environment, attention has turned to nonmarket means of assessing and controlling medical resource allocation. CEA and CBA have been attracting interest as possible techniques for performing the assessment function.

2A typical failure to comprehend fully the role and implications of third-party reimbursement is represented in the propensity of some critics to blame physicians for overuse of certain procedures. The assumption that physicians should perform the appropriate social cost-benefit calculation perhaps puts them in an untenable position: To represent society's Interests, they may be asked to deny a patient a procedure which might benefit the patient and in any case would not harm the patient economically. This can be regarded as violating the medical ethic of representing the patient best interest, Were the patient responsible for paying the cost of the procedure, then the physician's cost-benefit calculation might weigh the patient's economic sacrifice against the potential for medical benefit.

[3]*See* L. Russell, *Technology in Hospitals: Medical Advances and Their Diffusion* (Washington, D.C.: Brookings Institution, 1979).

## GROWTH AND COMPOSITION OF THE HEALTH CARE CEA/CBA LITERATURE

Chapter 3 and, to a lesser extent, chapter 2 of this volume are based in large part on an extensive review of the health care CEA/CBA literature. A detailed descriptive analysis of the composition of that literature, including trends over time, is presented in appendix A, A portion of that analysis is presented here, however, as background for chapters 2 and 3.

A bibliography on CEA/CBA in health care is presented in appendix B. This bibliography contains approximatelv 600 references, Primarily from the years 1966 through 1978. OTA'S analysis of this literature shows a clear and dramatically growing interest in health care applications of CEA/CBA. As described in appendix A, each of the references was classified according to the following dimensions: 1) year of publication, 2) type of analysis (CEA or CBA), 3) publication audience, 4) medical function of the technology, 5) physical nature of the technology (drug, device, etc. ), *6)* decision orientation (e.g., societal perspective), and 7) subject matter. Only a minority of the bibliographic citations are actual

CEA/CBAs. The majority address CEA/CBA or CEA/CBA-related issues. Several citations, however, are connected to CEA/CBA only through their titles; their actual content is either cost or effectiveness related alone.

Widespread interest in health care CEA/CBA seems to be a phenomenon of the 1970's. Figure 1 shows the growth in the numbers of published CEA/CBAs and the numbers of CEA/CBA-relevant articles. This growth has greatly surpassed the increase in the overall medical literature. Figure 2 shows that the growth has been especially rapid in medical journals as compared to nonmedical health care journals. This trend is suggestive of an increased economic consciousness on the part of physicians, but it does not allow any firm conclusion to that effect.

Prior to 1975, the annual number of CBAS generally exceeded the number of CEAS. The reverse has been true since then. The reasons for this shift are difficult to determine. Some discussion of possible explanations is included in appendix A, and an examination of the differences between CEA and CBA, and the implications of those differences, can be found in chapters 2 and 3.

Analysis of the literature by medical function of the technology under study shows that prevention and diagnosis each account for slightly over a quarter of the references, with treatment accounting for the remaining 44 percent. Recently, however, there has been a shift away from studies of prevention, which dominates the other two categories in the earlier years, and toward those of diagnostic technologies and treatment technologies. (See table 1.) In terms of decision orientation, health care CEA/CBAs retain as their principal orientation a societal perspective on problems, though studies with an individual practitioner orientation seem to be becoming increasingly common.

Given the strength of recent growth in the literature and social forces promoting future consciousness of cost effectiveness, OTA anticipates continued significant growth in the literature over the next several years, particularly in the medical literature. It is possible that the relative preference for CEA over CBA will increase.

Table 1.— Numbers of Health Care CEA/CBAs by Medical Function and Year (1968-78)

| | Number of CEA/CBAs by Medical Function | | | |
|---|---|---|---|---|
| Year | Prevention (1) | Diagnosis (2) | Treatment (3) | Other[a] (4) |
| 1966. . . . | 0.0 | 0.0 | 0.0 | 5 |
| 1967. . . . | 0.0 | 0.3 | 1.7 | 3 |
| 1968. . . . | 2.5 | 3.0 | 3.5 | 6 |
| 1969. ., | 1.5 | 0.5 | 2.0 | 2 |
| 1970. . . . | 3.0 | 2.0 | 3.0 | 8 |
| 1971. . . . | 6.5 | 3.5 | 4.0 | 11 |
| 1972. . . . | 7.0 | 2.0 | 4.0 | 14 |
| 1973. . . . | 14.5 | 4.0 | 10.5 | 15 |
| 1974. . . . | 2.5 | 5.0 | 14.0 | 22 |
| 1975. . . . | 5.0 | 10.0 | 14.5 | 22 |
| 1976. . . . | 15.0 | 16.0 | 28.0 | 33 |
| 1977. ., . | 12.5 | 17.0 | 37.5 | 35 |
| 1978. ., | 18.0 | 25.5 | 18.5 | 31 |
| Total | 88.0 | 88.8 | 141.2 | 207 |

[a]Includes mixes of all three functions (prevention, diagnosis, and treatment). administration, general, and unknown

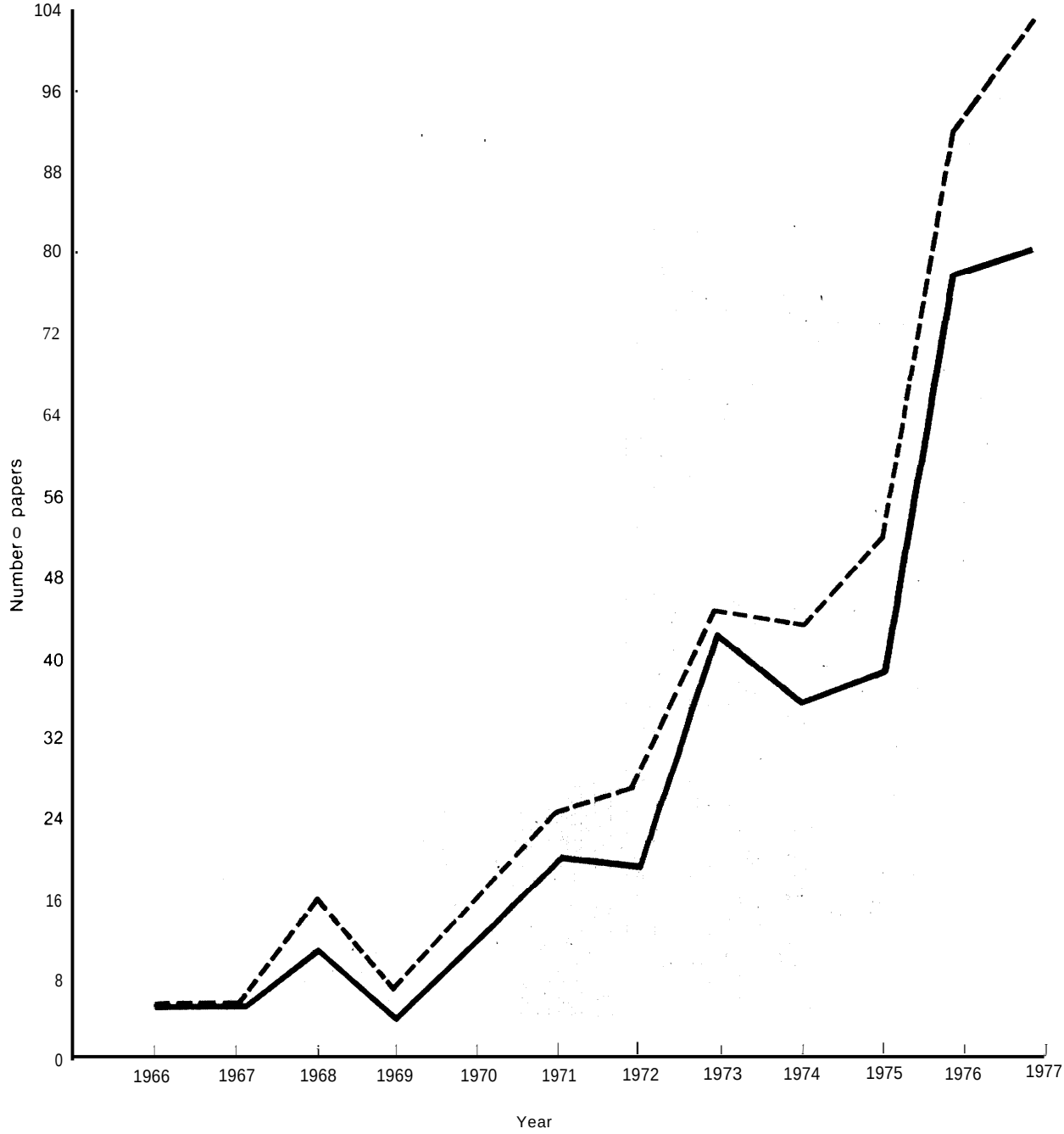
SOURCE Off Ice of Technology Assessment

Concern with the cost effectiveness of technology has motivated much of the recent CEA/CBA work in health care, and this motivating concern probably will persist for several years.

The single disease class that has captured the most attention in the literature is also the Nation's current leading cause of death: cardiovascular disease (CVD). More than two dozen papers in the bibliography concern CVD, and an additional 16 citations relate to hypertension screening and treatment. Other major disease problems have also received considerable attention. Cancer screening programs have been the subject of over 20 papers, including 9 on breast cancer screening (27,95,230,267,303,313,375, 376), although cancer treatment per se has not received attention. [a] Eighteen papers have addressed mental illness problems and programs (31,99,113,218,223,351,352,353, 369,414,580), and 18 others pertain to dental care (49,59,75, 126,127,187,229,245,283, 331,390,518). Drug abuse (24,186,225,243,265,266,269,278,326, 328,358,444,464,486) and alcoholism (259,268, 281,474,532) combined account for a similar number of references. Renal disease, the subject of 18 papers, has received attention dispropor-

[a]Primary prevention of cancer also has received no attention in this literature, but many opportunities for primary prevention lie outside of the conventional personal health care system. Studies of the costs of air p(>llutic~n, for example, and of the benefits of abatement do concern themselves with cancer prevention.

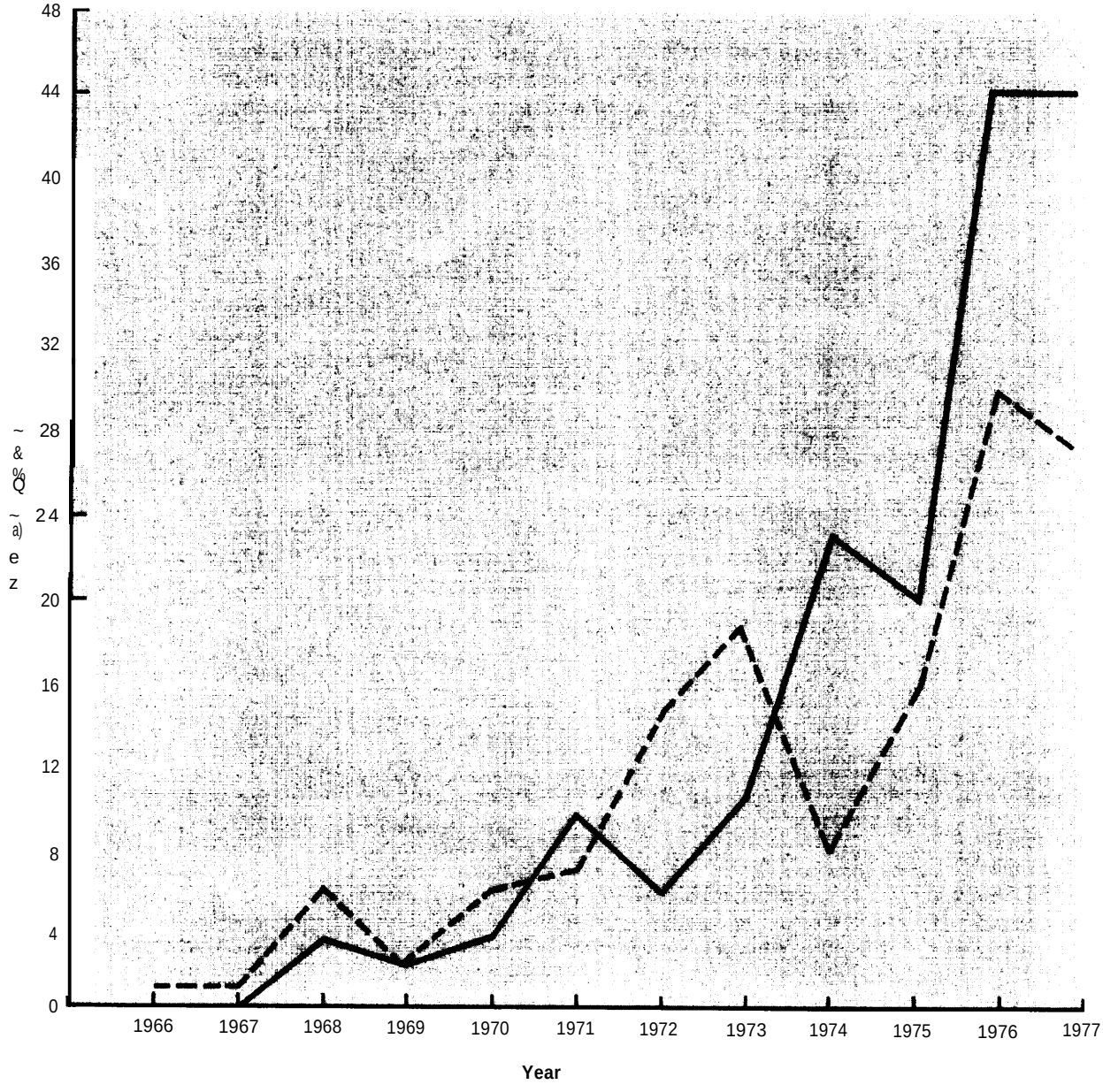
Figure 1.— Diffusion of Health Care CEA / CBAs by Year (1966-77)




Key — Number of CEAs + CBAs per year from column 3 of table A-2, app. A
— — — CEAs + CBAs + related papers per year, from column 5 of table A-2 app. A

SOURCE Off Ice of Technology Assessment

Figure 2.— Diffusion of Health Care CEA / CBAs in Medical and Nonmedical Health Care Journals by Year (1966.77)




Key: ———— CEAs and CBAs in medical journals, per year (from column 1, table A-3, app. A)
— CEAs and CBAs in nonmedical health care journals, per year (from column 3, table A-3, app. A)

SOURCE Off Ice of Technology Assessment

tionate to its prevalence, but reflective of the political and economic importance associated with public funding of dialysis (80,146,298,327, 361,363,367,459,471,520). The Federal Government's mid-] 960's interest in disease control programs, and in kidney disease in particular, made this the only disease problem to have more than one citation in the period prior to 1969.

Two general classes of health problems—communicable diseases and birth defects—have captured considerable attention. A variety of communicable diseases (including cholera, influenza, malaria, measles, polio, rubella, tuberculosis, and venereal disease) have been the subject of over two dozen papers (1,23,65,100,101, 160,173, 180,289,297,368,377, 406,438,461,472, 473,506). Since the detection and treatment of communicable disease have distinct "public goods" characteristics, [5] they are logical subjects for CEA/CBA, and it is not to surprising to find that half of all the communicable disease papers date from before 1974. By contrast, another class of problems—the prevention of birth defects—has been studied much more in recent years, with only 2 of 15 papers predating 1974 (34,114, 221,246,370). Several birth defect disease problems have received isolated attention (e.g., Down's syndrome, spina bifida, Tay - Sachs disease), but at least one—phenylketonuria —has been the subject of three studies (78,517,553),

Several disease problems emerge in the guise of surgical procedures intended to treat them. Each of the following operations is the focal point of at least one reference in the bibliography: radical cystectomy (63), tonsillectomy (68), cholecystectomy (191), herniorrhaphy (222,394), appendectomy (398), synovectomy (416), joint replacement (534), and hysterectomy (103,275). In addition, there is a large number of papers relevant to surgery and CEA/CBA but not identifiable with a specific surgical procedure (3,39,40,74,214,231). Many of the surgery-related papers were contributions to a recent book on the subject (73).

Close to 30 papers were classified as nonspecific screening and prevention (43,87,105,106, 107,109,133,157,158,227, 239,309,320,362,428, 455,458 ,478,484,489,497,535). Some of these related to particular activities (e. g., multiphasic screening (87, 105,106, 107)), while others discussed CEA/CBA issues more generally.

In recent years, a great deal of policy discussion and regulatory activity has concentrated on the adoption, diffusion, and use of expensive, sophisticated capital equipment. Thus, it was with considerable interest that OTA explored whether such equipment had been the focal point of numerous CEA/CBAs. With one exception—the computed tomography (CT) scanner—the answer is a striking no, The CT scanner was the most talked about medical technology of the 1970's, and both the quantity and nature of the general interest are reflected in the CEA/CBA literature on CT. Some 18 citations are on this technology, all but 2 of them published in 1977 and 1978 (2,26,28,32,42,83,166, 167,169,211,300,301,317, 408,527,541,559,594) .

Will other equipment-embodied technologies emerge as the subject of much attention in the literature? As the controversy on specific technologies grows, particularly related to their cost implications, additional CEA/CBA papers can be anticipated. Electronic fetal monitoring is an example of one such technology which has already been the subject of several papers (34,35, 435,436). The work of the National Center for Health Care Technology, combined with general interest and concern, might increase the proportion of CEA/CBA literature focusing on equipment-embodied technologies.

A variety of services accounted for a significant proportion of the articles. Some of these services have relatively tangible outcomes and hence are good candidates for CEA/CBA. Six studies of pharmaceutical services basically involve issues of efficiency, with equity concerns of less importance (20,357,592,599). Aside from moral considerations, some studies related to reproductive health lend themselves to reason-

[5]The technical economic problem is one of significant externalities: These diseases are public health problems because of their communicability, and their prevention, for example through immunization, confers benefits on people other than the immediate recipient of the prevention measure. Thus, society has an interest in immunizing individuals that goes beyond the private interest of those individuals.

ably objective analysis. An obvious example, abortion, was the subject of only one paper during the period covered (338), though continued policy debate and development may lead to increased analytical interest (84). In addition, the literature review yielded several articles on family planning and on maternal and child health programs.

Other services address social needs that are extremely difficult to quantify in a meaningful fashion. In general, one would expect that such services would not receive a great deal of attention in literature which places a premium on quantification and measurement. Exceptions most likely would reflect a policy of unusual social importance. Above, it was noted that *18* CEA/CBA-relevant articles in the mental health area were found. Similarly, there were a dozen papers on geriatric services (148,149,286,319, 568), and an additional four papers on institutional versus home care, with the patient type not indicated (121,321,348,486). Given current problems and anticipated growth in the elderly population, continued interest in this subject matter would not be surprising. Two other areas of considerable current interest are occupational health and rehabilitation. The literature search identified more than 10 articles on relevant topics (21,61 ,89,111,112,141,174,175, 270,373,423,546).

Program services is not the only area in which social importance recommends analysis while quantification problems limit it. Manpower programs illustrate another area in which technical innovations—often, in this case, substitution of one type of personnel for another—produce outcomes which are difficult to quantify usefully. Nevertheless, analysts have made a dozen contributions on this subject (82,90,120, 142,226,316,374,437).

Related to the dearth of equipment-specific studies, relatively few diagnostic procedures, apart from screening procedures, have been the subject of CEA/CBA attention. A few procedures have received isolated discussion—for example, fiberoptic laparoscopy and colonoscopy *(224),* sigmoidoscopy (581), and gastrointestinal exams (207)—but only radiology has received frequent attention (2,26,28,32,42,83,166,167, 169,211,300,301,317,408, 430,431,433,527,541, 559,594). Weinstein (569) has identified the evaluation of diagnostic procedures as deserving of CEA/CBA efforts. His plea is supported by the growing body of literature which indicts the increasing use of diagnostic tests as a major source of medical cost inflation (752). The evidence suggests that everyday, mundane tests are at least as significant contributors to that inflation as the more sophisticated and expensive technologies (745), yet the former have received very little CEA/CBA attention. Again, problems of measuring and valuing the outcomes of diagnostic procedures stand in the way of ready application of CEA/CBA (360,559),

In closing this section, two other areas which seem underrepresented in the literature should be mentioned. For the last several decades, drugs have epitomized the scientific growth of medicine and dramatically altered the practice and outcomes of health care. Drugs have been the subject of hundreds of biochemical and medical studies, and within the social sciences, of numerous analyses of medical technical change. Yet aside from implicit and tangential interest in them (e.g., as a component of hypertension management), drugs have not often been the subject of CEA/CBA analysis. (See, however, reference 190 for a case study on cimetidine. )

Finally, the literature reveals very little evidence of attempts to compare the costs and benefits (or effectiveness) of specific medical interventions with nonmedical interventions to deal with health problems. Although this background paper focuses on medical approaches, one might have anticipated identification in OTA's literature search of a few studies which cross the medical-nonmedical border. With the exception of early Department of Health, Education, and Welfare efforts *(240),* however, studies of this type were not found. Conceivably, heightened awareness of prevention alternatives *(743)* will motivate formal efforts to grapple with medical-nonmedical comparisons in the future.

## DECISION TECHNIQUES RELATED TO CEA/CBA

Other bodies of literature are related to the application of CEA/CBA in health care, but OTA, in the attempt to set reasonable bounds for this inquiry, did not systematically explore these. For example, more attention could have been given to the areas of decision analysis, multiple objective programing, and health status indexes (HSIs). In all three of these areas, there is a rich and growing health-related literature. In omitting them during our literature search, OTA did not identify some applications specifically related to CEA/CBA in health care. Each area will be considered briefly below.

Decision analysis is a collection of analytical methods used to assist in making decisions under uncertainty. This technique commonly uses the familiar decision tree diagram, depicting alternative decision pathways (or "branches") each of which is accompanied by a probability that a certain event will occur *(335,558).* Since CEA/CBA studies ordinarily include many uncertain variables, some element of decision analysis may often be desirable, as is discussed by Schweitzer *(478).* (For an excellent review of decision analytic application to health care, see reference 735. )

Multiple objective (or multiobjective) programing is another field of study whose application may be important to the use of CEA/CBA in the health field, but which has received relatively little attention partially because the general field itself is quite new. Multiobjective programing is a subfield of mathematical programming, which in turn lies within the discipline of operations research. For a comprehensive, but non-health-related, discussion of the subject, see Cohon, 1978 (719). Essentially, multiobjective programing consists of a set of analytical techniques, such as linear programing, which attempts to find solutions to a problem which has more than one objective. The rationale behind the use of these techniques is that many problems—especially public policy ones—which require decisions, have multiple objectives, many of which may be conflicting. That is, by achieving one objective, another objective must be sacrificed. The purpose of multiobjective programing in public policy decisionmaking is for the analyst to provide the decisionmaker with options and their probable consequences. As Cohon describes it (719), when a problem is solved for a single objective, and when there actually are multiple objectives, one of two undesirable events is apt to occur: Either some objectives are ignored, and therefore treated as if their value were zero; or the analyst, in an attempt to combine objectives, assigns relative weights to them. Either of these actions results in the analyst's actually making the key decisions which are supposed to be made by the decisionmaker. In multiobjective programing, by contrast, the analyst describes the degree to which each objective is or is not met as a result of each course of action. With the analytic process accomplished, decisionmakers are then faced with the political process of deciding which course of action to follow.

HSI research is the third field which is not fully assessed in this report. Nevertheless, a preliminary investigation suggests that the field is maturing in an orderly, scientific manner, that the body of literature is growing fairly rapidly, and that HSI research holds significant promise for future evaluation of all social and technological interventions which affect the public's health status.

The Federal agency that has been most interested in HSI research and application has been the National Center for Health Statistics (NCHS), whose job it is to monitor and report on the Nation's health and whose Health Interview Survey instrument has played a key role in much of the HSI work noted below. Located within NCHS is the Clearinghouse on Health Indexes, an office which maintains a current computerized and indexed bibliographic file on all health-index-related literature. Quarterly, the Clearinghouse publishes the "Bibliography on Health Indexes" which includes annoted citations of recent published and unpublished studies.

OTA's preliminary review of the HSI literature revealed several significant research

groups that are active in health status measurement. The San Diego group, working on the "Health Index Project, " has done pioneering work in developing both survey instruments and relative weighting scales for physical health measures which include values for levels of well-being (functional status and symptom-problem indicators) and disease transitional probabilities (e.g., *726,731,732,733,741,742).* Another group is working on the "Sickness Impact Profile (SIP)" study, which includes multiple weighting scales and one overall scale for physical and social health as well as general health perceptions (e.g., 707,708,728). A third group at RAND is developing multiple indexes, using an expanded definition of health, consisting of physical, mental, and social health and general health perceptions (79,711). This research effort is part of the RAND Health Insurance Study and will be used to help assess the impact that various insurance mechanisms have on health status.

OTA's discussion of the aforementioned research is not meant to indicate that other research in the area of HSIs is either not being done or not being done well.

## ORGANIZATION OF THE REPORT

Chapter 2 examines issues relating to the methodology of CEA/CBA, essentially organized by the components of analysis. It is oriented less toward describing the methodology of CEA/CBA as conducted in practice than toward describing the components of an ideally conceived CEA/CBA process. Consequently, it should not be construed as a practical "cookbook" for use by someone wishing to learn how to "do" a CEA/CBA. Chapter 3 is a critical review of the published literature of CEA/ CBAs. It describes how the components of CEA/CBA have been addressed in actual practice. Chapter 4 contains OTA's findings in regard to the methods of CEA/CBA. It also includes a set of 10 principles of analysis developed by OTA to guide an approach to formal analysis.

There are five appendixes. Appendix A is an analysis of the growth and composition of the health care CEA/CBA literature. Appendix B is a bibliography of CEA/CBA in health care. It includes a discussion of the criteria for inclusion of items in the bibliography. Appendix C is a collection of abstracts of items in the bibliography of appendix B, including the *19* case studies of medical technologies prepared as part of OTA's full assessment, *The Implications of Cost-Effectiveness Analysis of Medical Technology.* A brief description of the main report and other background papers of OTA's assessment is presented in appendix D. Appendix E lists the members of the OTA Health Program Advisory Committee and the authors of case studies conducted as part of this assessment.