creased 52.8 percent from 1976. Third, several States enforced school immunization laws requiring that children have adequate documentation of measles vaccination in order to enter or stay registered in school .

State Use of Federal Funds for Immunization Programs

During the past 40 years, the Federal Government has legislated hundreds of programs in health, education, manpower, and social welfare. Federal funding for such programs was particularly made available during the late 1960's and early 1970's. Many of the programs were created through categorical grant mechanisms whereby Federal funds are given to State and local health agencies.

Some authorities believe that the largely unplanned and uncoordinated proliferation of narrow categorical programs, in some instances, can reduce the flexibility needed at the State and local levels to meet the comprehensive needs of individual citizens (Price, 1978). In spite of a possible lack of coordination and loss of flexibility among Federal, State, and local government agencies, however, most States have managed to implement some types of public vaccination programs.

As reported in 1976 by the Association of State and Territorial Health Officials (ASTHO), in 1974, 41 State health agencies supported identifiable immunization programs; most States included some immunization services in their general communicable disease programs (ASTHO, 1976). Most immunization programs, as well as programs for general communicable diseases and venereal diseases, were targeted primarily to women and children.

One State that operates an effective measles control program is Oregon (Francis, 1978). This State has combined a mandatory routine measles vaccination program for all children entering public schools with a comprehensive measles surveillance program. In addition, it has established a measles containment program to vaccinate susceptible individuals who have been exposed to a newly discovered measles case. A key element of Oregon's successful program is a combined State-county effort to continually assess the levels of immunity to measles among children entering public school. In addition to cooperation between State and county health departments, two other key elements of Oregon's measles control program are: 1) strictly enforced school immunization laws, and 2) an ongoing assessment of all programs to identify and correct problems. During a 5-year period of this program's operation, from 1971 to 1976, the percent of entering first-grade students with a history of measles or measles vaccination (i. e., who were immune to measles) rose from 76.5 percent to 92.2 percent.

Alan Hinman described the measles control program in the State of New York from 1963 through 1971 (Hinman, 1972). According to Hinman, termination of Federal financial assistance can terminate a State's commitment to a public immunization program, leading to an unanticipated rise in the incidence of a disease thought to be under control. When Congress stopped funding measles control programs in 1969, Hinman noted, the State of New York did likewise, shifting State funds to rubella control programs. As a consequence, the number of measles immunizations in New York State public clinics dropped from 258,232 in 1968 to 180,187 in 1970; subsequent to this drop in measles immunizations, the incidence of measles in New York rose from 4.14 cases per 100,000 persons in 1970 to 11.08 cases per 100,000 persons in 1971. Hinman believes that measles control requires a strong continuous commitment from the Federal Government.

The history of measles control in this country clearly demonstrates a relationship between increased Government financing for mass immunization and reduced incidence of disease. It strongly suggests that continued long-term Federal financing of State and local immunization programs is needed to effectively control certain communicable diseases.

Appendix 4.3
HISTORICAL CONTEXT OF COST-EFFECTIVENESS ANALYSIS

Historical Background

From the early 1900's, laws in the United States required statements of costs and benefits for river and harbor projects. Later such statements were required for flood-control projects. The political climate during the 1930's supported governmental undertakings to which benefit-cost analysis (BCA) applied. Pigou provided a theoretical underpinning by contrasting private costs and benefits with social ones, and the shortsighted view of individuals with the longer perspective of government and society (Pigou, 1965).

The popularity of benefit-cost studies dates from the late 1950's (Klarman, 1974), and through the mid-1960's the most common subjects were water and transport projects (Prest, 1965).

In the early 1960's, two developments stimulated the Federal Government's interest in the application of cost-effectiveness analysis (CEA) in the health sector. As part of its planning, program, and budgeting (PPB) approach, the Defense Department adopted the use of cost-effectiveness analyses in 1961 (Klarman, 1974), and in 1965, President Johnson extended PPB to all Federal agencies (Wildavsky, 1966). Concurrently, benefit-cost and cost-effectiveness studies appeared in the health field. The first ones concerned mental health, tuberculosis, and polio—medical areas in which the Government had traditionally been involved (Fein, 1958, Weisbrod, 1961).

The mid-1960's and the introduction of Medicare marked a substantial extension of governmental activities in this field, beyond public health to individual medical care. The Department of Health, Education, and Welfare (HEW) applied cost-effectiveness analysis to compare the payoffs from programs to control certain medical problems: cancer of different parts of the body, syphillis, motor vehicle accidents, arthritis, and alcoholic driving, early detection of handicaps among children, and childhood tooth decay. Some of the results led to Legislation: The 1967 Social Security Amendments provided for early detection and treatment of children with handicaps (Grosse, 1972).

Analyses of Preventive Services

The public health literature distinguishes among three kinds of preventive services: 1) primary, which prevent occurrence of a disease; 2) secondary, which detect and treat incipient disease; and 3) tertiary, which deal with rehabilitation during the advanced stages of a disease. All are preventive in the sense of altering the ordinary progression of disease (Mausner, 1974).

Pneumococcal vaccine and other immunizations fall into the category of primary prevention; they are intended to prevent the very occurrence of disease. The Office of Technology Assessment's (OTA) 1979 CEA of vaccination to help prevent pneumococcal pneumonia is presented in chapter 4.[1]

Previous studies indicate both the applicability of CEAs and BCAs to preventive services and the diversity of acceptable methodologies. More important for policy implications, these studies illustrate that the application of preventive technologies is not ***ipso facto*** cost-saving. Many of the findings of these studies suggested that a specified preventive technology would be cost-effective or yield net benefits under certain circumstances. These circumstances, however, are often the very substance of policy decisions and include choices among: 1) alternative programs (e.g., treatment of a disease after it occurs, use of one or another preventive technology, different use of the same preventive technology); 2) rates of use (e. g., different acceptance rates by the target population, different rates resulting from public or private initiatives); and 3) target populations (e.g., different age groups, those with certain pre-existing medical conditions, females or males, blacks or whites).

An example of primary prevention, influenza vaccination has been the subject of both cost-effectiveness and benefit-cost analyses. Kavet conducted a BCA in which he used epidemiologic data for an estimate of death attributed to influenza (Kavet, 1972). Recognizing the variability of certain factors, Kavet constructed alternative calculations for different efficacy rates, vaccination rates, high risk and non-high risk groups, and degrees of severity of the annual influenza outbreaks. The livelihood approach was taken to value years of life and working years saved; average earnings were used to convert these years to dollars. Kavet's analysis indicated that net benefits of influenza vaccination for the high risk group exceeded those for the non-high risk group. Redirecting influenza vaccines to high risk recipients therefore would raise net benefits.

Building on Kavet's work, Klarman and Guzick performed a CEA of influenza vaccination for people more than 65 years old, an age group in which everyone is considered high risk (Klarman, 1976), In this analysis, a vaccination program was compared to the existing situation of partial vaccination (19 percent) of the aged. Existing vaccinations were taken into account, and estimates of lower costs per life-year gained were derived. In recognition of the great variability in influenza incidence from year to year, a composite year in the 1960's was taken as the basis for the calculations. The authors used an intermediate approach between the livelihood estimates of BCA and life-year equivalents of CEA. They did not impute a dollar value to life years saved, but like Kavet, they did value days of sickness or death averted (as distinct from the deaths themselves) in dollars by using average earnings. Thus, their calculations of cost per death averted ($3,237 to $7,241) and cost per life year gained ($311 to $696) referred to net costs reduced $11 billion to $16 billion (or 25 to 44 percent) by the loss in earnings that would be averted by a vaccination program.

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[1]The potential utility and application of OTA's analysis are discussed in chs. 6 and 7.

The analysis of a swine influenza program by Schoenbaum, McNeil, and Kavet also drew on Kavet's original work (Schoenbaum, 1976). Analysts in this study used the benefit-cost framework and valued mortality and morbidity by average earnings. With 70-percent efficacy of the vaccine and IO-percent probability of an epidemic, the net benefits of a public vaccination program would have been greatest for the high-risk group, if vaccination rates were between 24 and 59 percent. With higher vaccination rates, a public program would attain maximum net benefits if targeted to people 25 years and older. A program for the general population had the lowest cost per case averted ($65), but the highest cost per life year saved ($13,000). A program for the high-risk population alone had the highest cost per case averted ($410), but the lowest cost per life year saved ($1 ,000).

Other studies of vaccines have been in the realm of BCAs, in which mortality and morbidity averted are valued by livelihood measures. As early as 1961, Weisbrod analyzed costs and benefits connected with polio vaccine (Weisbrod, 1961). Weisbrod in this study pioneered in devising methodology that has since been widely used in analyses of medical technologies, preventive and treatment alike. Among other things, he stressed the importance of including costs of a vaccination program in the calculations. The subject of Weisbrod's analysis, however, was not the use of the vaccine, but return on investment in the research that generated that vaccine.

In another study, Schoenbaum and his colleagues compared alternative strategies for rubella vaccination and concluded that vaccination of females at age 12 (either with or without vaccination of both sexes at age 2) would yield greater net benefits than the existing policy of a single vaccination at an early age (Schoenbaum, 1976). These results held for both 100-percent and 80-percent vaccination rates.

Sencer and Axnick calculated one element of a BCA of rubella vaccination; the social costs of a rubella epidemic (Sencer, 1973). These researchers, however, did not include in their calculations such costs as the treatment of side effects and the cost of vaccination.

More recently, Merck Sharp and Dohme (MSD) has developed a framework for benefit-cost studies of pneumococcal vaccine (Beck, 1978). Here it is noteworthy that the methodology used by MSD resembles that of Sencer and Axnick in including only a partial list of crucial variables. Excluded, for example, are side effects of the vaccine and efficacy rates below 100 percent.

Cost-effectiveness and benefit-cost analyses of secondary preventive technologies abound. Schweitzer and Luce explored the cost-effectiveness of Pap smears to detect cervical cancer (Schweitzer, 1978). Eddy considered the cost-effectiveness of screening for various cancers: breast, cervical, colon, lung, and bladder (Eddy, 1978). Other evaluations include the cost-effectiveness of the stool guaiac, a test for colon cancer, and the benefit-cost of phenylketonuria (PKU) screening, a test for a genetic deficiency (Neuhauser, 1976, Steiner, 1973).

The study of hypertension by Weinstein and Stasson represents not only a very thorough analysis of a technology, but also, in many respects the extent of the development of the cost-effectiveness methodology (Weinstein, 1977). The effect specified in this analysis was quality-adjusted life years (QALYs), an index developed for weighting years of life and years of illness. Both screening for hypertension and its treatment (secondary prevention) were considered. Findings from Weinstein and Stasson's analysis of hypertension suggested that, given a fixed budget, stress on improving adherence to the treatment regimen —at least on cost-effectiveness grounds—be preferable to screening for this disease. Also, the cost-effectiveness of treatment for males and females showed a different relationship with age: For females, the cost-effectiveness ratio declined with advancing age; the reverse was true for males—a reflection of age differences between the sexes in strokes and heart attacks.

Another example of CEA studies include Klarman's analysis of syphillis control (Klarman, 1965). There he attempted to value the intangible element of the disease, in that case the stigma of having syphillis, and used psoriasis as an analogous disease for estimation.

Treating chronic kidney disease can be considered tertiary prevention. Treatment may tide the patient over to transplantation or dialysis itself may lengthen or improve life. Studies of these modalities agree that home dialysis is more cost-effective than center dialysis (Klarman, 1968, Strange, 1978). As noted previously, with new data on survival, the views of transplantation changed from the 1968 to the 1978 study .