A Review of Concepts

Economic Costs of Disease and Injury

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WHAT is the cost of sickness and the price of health? What are the costs and prices of alternative health activities and how much should be spent for control of a disease as compared with other programs? What can we afford to do, and afford not to do, in meeting disease problems?

Such questions are raised repeatedly about the costs of specific diseases and about comparative amounts spent for prevention and treatment. These are issues which quantification of costs and prices cannot resolve alone; but, as Winslow emphasized, such quantification can provide a most valuable tool to assist in consideration of these issues (*1*).

The arithmetic of economic gains and losses brought about by health programs can be an important tool, especially in planning for economic development in parts of Asia, Africa, and South America. For these countries, the real price of health programs often includes not only expenditures for public health programs but also costs occasioned by pressures of population growth. These pressures have been intensified by a marked fall in death rates from the application of modern public health measures and techniques. It has been estimated, for example, that the introduction of modern medical technology into some of the nonindustrial nations has resulted in a decline in mortality and a net increase of 1 to 2 percent in population per year.

While cost-price equations have more urgent application in health programing in nonindustrial nations of the world, they also apply to health programing in the United States. They supply a tool for appraising the adequacy of resources devoted to specific health problems and the comparative economic returns from public investment in different disease problems. They permit a summary type of comparison between the costs of a specific disease and the price of the health care associated with the disease. With this type of summary in view, the National Health Education Committee collects information on the major killing and crippling diseases in the United States (*2*).

Review of existing work on costs of specific diseases and health programs, however, suggests a need for clarifying cost concepts in current use, setting forth in a summary way the information now available to estimate costs, and assessing the additional information required. This paper attempts to meet this need by setting forth a tentative classification of costs based on their effects on the use, distribution, and quantity of economic resources, which may help clarify the concept of economic costs of disease. In the context of each of these cost components, the types of information available for measurement are discussed and the additional information required is summarized.

Economic costs, as we are viewing them here, arise out of the impact of disease and injury upon economic resources. The question we must ask is: What is the difference between what actually happens in the economy now and what might happen in the hypothetical situation where sickness from specific causes is eliminated? In other words: What is the impact of a disease upon the use, distribution, and availability of economic resources?

Economic costs may be more sharply de-

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fined into three types: The first is actual use of economic resources (manpower and materials) for prevention, diagnosis, treatment, and rehabilitation. This represents the direct price of health programs; it is measured by actual expenditures, both public and private, for health services and their complement of commodities and facilities. In the absence of disease, these expenditures would not be necessary. The second type consists of transfers (of resources or of income) which arise out of mitigating the burdens of sickness. Costs in this category do not, in the first instance, affect the total resources used up by sickness in the economy as a whole, but they do affect the distribution of resources among individuals or families. Many of these transfers are designed to mitigate the impact on family income of losses due to death or disability. The third type, less clearly defined but perhaps more pervasive in effect than either of the other two, is loss of resources occasioned by sickness—human resources lost or impaired as a result of death, disability, and debility caused by sickness.

For convenience, we will call these three categories of cost resource-use, resource-transfer, and resource-loss. Other classifications have been used. Dr. Raschi Fein, in a recent work for the Joint Commission on Mental Illness and Health, used direct and indirect cost to refer to resource-use and resource-loss respectively. He combined the transfer category with direct costs (*3*).

Resource Use

Each of the major diseases and disabilities requires the use of manpower and material for prevention, treatment, and rehabilitation. If it were not for disease and injury, these resources of men and material could be used to produce other want-satisfying goods and services. The actual use of these resources in the health industry thus constitutes the type of cost of sickness that we have termed resource-use.

Available estimates suggest that the part of the Nation's manpower and of goods and services produced that is devoted to health care has increased in recent years. In 1929, the Committee on the Costs of Medical Care estimated health and medical expenditures at $3.9 billion (*4*), or 3.8 percent of the gross national product; an estimate by the Social Security Administration for 1957 showed that the health share of the Nation's output had risen to 4.7 percent (*5*).

The resources directly devoted to the research, prevention, diagnosis, treatment, and rehabilitation in a specific program or disease category are represented by the outlays of public and private health agencies, employers, and individuals and their families. They include expenditures for (*a*) health services provided by physicians, hospitals, dentists, nurses, and other health personnel; (*b*) complementary commodities such as drugs, prosthetic appliances, and medical supplies; (*c*) public health programs, including, for some disease categories, environmental health services; (*d*) medical research; (*e*) a part of costs of training health personnel; and (*f*) a part of capital expenditures for construction of health plant and facilities used in the provision of health services and the production of complementary health goods.

While progress has been made in the development of estimates for global health expenditures which encompass most of these categories of outlays, figures in current use for specific diseases fall far short of even a complete count of expenditures for hospital and physician services, both public and private (*2,3,6*).

Estimates of expenditures by disease category may be approached and combined from available data in several ways. The following summary of methods consists partly of alternative approaches and partly of methods for approximating additive segments.

1. Data on average cost per case of a disease times number of cases give a rough approximation of total cost of a disease.

2. If the average cost per case is not known, average duration of hospital care, times number of cases, times cost per unit of service, plus average drug use times costs of other health services yields a similar approximation.

3. Expenditures (both current and capital) of hospitals and nursing homes specially designed for a specific disease can indicate the costs, as can the allocation of expenditures of general hospitals (or nursing homes) based on hospital use by diagnosis.

4. Expenditures for specific disease-connected com-

modities complementary to health services, for example, eyeglasses and hearing aids, identify special costs connected with some conditions.

5. Number and income of providers of services whose specialty relates to a disease category, such as psychiatrists and ophthalmologists, are indicators of special costs.

6. Expenditures under public and private agency programs earmarked for services, research, or prevention in a special disease category provide a source of costs.

7. Allocation of "overhead" costs, such as costs of training health personnel and construction of facilities, to a disease category can be based on some index of relative importance like number and use of personnel and facilities.

There are several possible methods of combining these approaches. Expenditures can be classified in terms of who pays the bills, either initially or ultimately. Much of the information now available on aggregate health expenditures in the United States is classified in this way: by expenditures of Federal, State, and local official agencies, insurance carriers, employers, and private persons (*5*, *7*). Another classification is by the category of services purchased, for example, dental or hospital (*8*, *9*). A third classification is by age group of patient. Recently, a World Health Organization study suggested still another type of classification based on a rough index of the physical status of the patient, that is, whether the patient is in a hospital, is ambulatory, or is at home on his back (*10*). In each of these classifications, preventive services may be distinguished from curative services, and current outlays from capital outlays for plant and physical facilities.

Sources of data for estimating the resources consumed by a specific disease vary by the nature of the disease, the identification of medical specialties and special hospitals with the disease problem, and the extent of identifiable public and private support for the agency program. Some of the source data represent national compilations of statistics on facets of expenditures, but for the most part the materials must be drawn from special regional or community studies. References to such special studies are compiled by the clearinghouse on morbidity projects of the Public Health Service (*11*) and by the Health Information Foundation (*12*). Detailing each source of data for estimates on expenditures for specific disease categories is outside the scope of this paper. The general types of source data, however, are as follows:

Public hospital expenditures. Data on mental hospitals are compiled annually by the National Institute of Mental Health, Public Health Service (*13*); expenditures on tuberculosis hospitals and tuberculosis control are compiled by the Bureau of State Services, Public Health Service (*14*). In some communities, information has been tabulated on public hospital use by diagnosis, for example, morbidity in New York City's municipal hospitals (*15*). Similar material on Federal hospital use by diagnosis is brought together by the Veterans Administration, the Public Health Service, and the Defense Department and is being collected as a byproduct of the administration of the medical care program for dependents of the uniformed services.

Other public expenditures. Data are available on research and related training expenditures for specific disease categories for which separate appropriations are made by the Congress. These amounts are published as part of the U.S. budget and also in the reports of the National Institutes of Health (*16*).

Household surveys of health service costs per illness case. A number of special household surveys have been made on the nature of illness in population groups, including medical services received and cost of such services. The North Carolina Agricultural Experiment Station, for example, has made such a study from samples of population in Stokes and Montgomery Counties, N.C. (*17*). The Research Council for Economic Security has studied the volume of prolonged nonoccupational illness among 400,000 employees in private nonagricultural employment, and the types and cost of treatment (*18*); a survey in Lyon County, Kans., included data on amount and types of different health services as well as costs of hospitalization and cause of hospital care (*19*); and the Kansas City regional health and hospital survey also included information on both health services and conditions reported (*20*).

Surveys of patients. A number of different types of sample surveys have been made of persons in hospitals or other institutions and of physicians' patient loads which include, along with diagnostic information, data on use

of the different classes of health services, or cost of care or treatment. One example is the Dane County, Wis., survey of services and cost of treatment of the aging and long-term patient (*21*). A nationwide study of all patients discharged in a week in 1956 by hospital use and diagnostic category as well as of physician services received has been made by the Bureau of Medical Economic Research of the American Medical Association (*22*). A nationwide study is reported to have been made of drug therapies and morbidity reported by physicians based on case records kept on patients seen in private practice during a 2-day period.

Prepayment plan and insurance carrier data. Some compilations have been made of the experience under prepayment plans such as Health Insurance Plan of Greater New York and Kaiser-Permanente indicating volumes of selected health services for different conditions or hours of professional work time involved for different procedures (*23–26*). Insurance claims data which have been published for special purposes also provide useful materials (*27*). Fairly detailed data on costs by diagnosis are becoming available in administration of the Medicare program and provide an important source of cost information for the types of conditions to which the Medicare beneficiary group are subject (*28*).

Census and trade data. For some types of health commodities, such as hearing aids, eyeglasses, and drugs, data are available from the retail, wholesale, and manufacturing censuses conducted by the U.S. Census Bureau and from trade journals such as *American Druggist* and *Drug Topics* (*29–31*).

Professional income, fees, and hospital rates. The publication *Medical Economics* has put out information from a sample of physicians on gross and net physician income by specialty (*32*). Fee allowances for specific procedures are set up by Blue Shield plans, Medicare, Veterans Administration, and in the course of administration of other health programs. Hospital charges and costs are available from the publications of the American Hospital Association, regional hospital councils (*33*), and from public medical care programs. However, these hospital data are not generally classified by disease category.

National Health Survey. Perhaps the most important single source of data by nature of condition or diagnostic category is the National Health Survey (*34*). From the household surveys, information is being obtained on the condition reported at the time of the interview. In the medical examination survey, information is being obtained on selected conditions for which standard diagnostic procedures have been developed. In both types of surveys, data are being collected on items of medical service use, including hospitalization, physician visits, dental visits, nursing care, and use of specified special aids (hearing aids, artificial limbs, braces, and wheelchairs). Information from the household survey on numbers of days of hospital care and average length of hospital stay have been published for specified hospitalized conditions including malignant neoplasms, heart diseases, arthritis, hernia, fractures and dislocations. and infective and parasitic diseases. Dental visits have been published by type of services received. Other types of services have not been related thus far to the nature of the condition reported.

The various estimates that have been compiled of resources devoted to health services and related commodities on account of specific diseases point up the inadequacies of existing information on which such estimates are based. Additional collection of expenditure data cross-classified by nature of illness is needed.

The problems of collecting information of this type are many. Household surveys are limited by the types of conditions that families are likely to report, and by the undercount of expenditures for terminal cases. Many household surveys omit institutional populations. In addition, with the increase in voluntary health insurance coverage, expenditures for services are paid by the insurance plans and families often have no record of these costs. Other more technical problems include the use of health services and drugs for multiple conditions, the difficulties of obtaining accurate reporting on relatively small expenditure items, and memory biases in reports from households in which detailed expenditure records are not kept.

Small sample studies, moreover, yield an inadequate number of cases on many of the ill-

nesses for which data are sought, such as cerebral palsy cases. The Health Information Foundation in its 1952–53 survey attempted to obtain information from the surveyed families on both expenditures and health conditions but the illness data were not tabulated (*35*). A review of the information obtained by the Bureau of Labor Statistics in its 1950 survey of urban families on the illness for which the major part of the family's medical care expenditures were incurred indicated that the information reported was too sparse to permit analysis by disease category (*36*).

Another step in obtaining materials for estimates of expenditures by specific disease category would be to gather more information as part of the National Health Survey. A tabulation of information on physician visits and on practical and professional nurse services by nature of condition would make a beginning toward approaching expenditures through volume of services. Other health service items and commodities might be incorporated on the questionnaire for special analysis. Information on number of prescriptions, X-ray services, ambulance services, laboratory tests, oxygen, transfusions, and on physical and occupational therapy services and public health services might be obtained. It would probably be desirable to develop a series of questions on health services used for several major disease categories on a supplement to the general questionnaire for surveyed families.

Other approaches might be followed in the collection of information, such as a sampling of hospital and physician records to define the classes and volumes of services used in the diagnosis and treatment of the major diseases, and the independent collection of price data for the defined classes of health services and commodities used. Collation of public expenditure data for specified disease categories would also facilitate the approximation of aggregate expenditures for a disease. The National Institute of Mental Health has worked toward the collection of costs of mental illness not only by assisting in improved financial reporting from State hospitals but also by bringing together other data on public expenditures for mental patients, but these data combining Federal and State mental hospital expenditures are not published.

Resource Transfer

Disease and injury occasion not only a direct use of economic resources for the provision of health services and supporting goods but also transfers of income between the sick and the well. These transfers are costs to the givers, benefits to the receivers; but because they entail a reallocation of resources away from uses which, in the absence of sickness, would be preferred, transfers must be considered in assessing the economic impact of disease.

The size and importance of these transfers in the American economy have increased rapidly in the last two decades. They take two principal forms. One consists of payments made directly to the sick and disabled (or their survivors) and financed from taxes or contributions levied; social security protection under public and private auspices is the principal example. The other is the hidden redistribution of the tax burden that comes about through statutory tax provisions designed to assist families and voluntary agencies in meeting problems arising out of sickness. On both these counts, disease takes resources away from those who are well, and who would otherwise have alternative uses for them, and gives them to those who are sick and to survivors.

Cash Payments

A wide range of cash payments are made to individuals to mitigate the effects of loss of income due to death and disability. It is difficult to distinguish transfer payments attributable to sickness alone. For example, a part of old-age assistance and of old-age insurance benefits are paid because the aged person became disabled and was forced to retire. Under Federal programs, payments are provided to disabled veterans, to survivors and the disabled under the old-age, survivors, and disability insurance (OASDI) program, under the Civil Service system, and under the railroad retirement program. Compensation benefits for work connected with injuries are paid to Federal employees and sickness benefits to railroad

workers. In cooperation with the States, the Federal Government finances payments to the needy blind, disabled, and aged. Under State and local laws sizable cash payments are made to families whose income has been impaired by sickness. These cash payments include workmen's compensation benefits, cash sickness benefits (in four States), benefits under State and local retirement systems, and a part of the general assistance caseload as well.

Figures on these public outlays are available, and give some idea of the magnitude of resource-transfer under public auspices that occurs in our economy as a result of sickness. Disability payments under social insurance and related programs alone total more than $3.5 billion at the present time (*37*). Aid to the needy blind and disabled under the assistance program accounts for an additional $340 million per annum (*38*).

Private health, sickness, and disability plans have reached major proportions, but data in this area are piecemeal and often incomplete. In 1957, employer contributions to private pension and welfare plans totaled $7 billion (*9*). Alfred M. Skolnik, of the Social Security Administration, has estimated premiums paid under group cash sickness insurance plans alone at $434.5 million. A survey of 3,100 firms employing 6.8 million persons made by the National Industrial Conference Board found that 85 percent of hourly workers and 75 percent of salaried workers were covered under group accident and sickness insurance (*39*); the benefits for slightly under half of these employees were paid for entirely by the employers, and in almost all the remainder the employers contributed substantially.

Current practice in national income accounting does not define employer contributions to disability, cash sickness, and life insurance plans as transfer of income. They are regarded as supplements to wages and salaries, thus as part of the current return for productive services given. These contributions, however, are essentially pooled and go to finance payments to survivors and to those who are sick or disabled. The benefit payments accordingly represent from our point of view not an addition to national output but a shift in the shares of the national output from all workers covered to those whose income is impaired by death and disease. However, if sickness were miraculously eliminated it may be assumed that these employer payments would go instead directly into wages and salary compensation for the services.

Data on total benefits for each of the various types of protection are piecemeal and incomplete. For specific disease categories, they are even less adequate. Under the OASDI program, data are available on the number of beneficiaries by disability group and primary diagnosis, although amounts paid are not tabulated in this way (*40*). Benefits paid to disabled veterans, by broad disease categories, are included in the Annual Report of the Administrator of Veterans Affairs (*41*), but more detailed figures are not published. Benefits paid under State workmen's compensation programs are not recorded on a national basis, but some States publish data by diagnostic category. Some studies of State temporary disability insurance programs provide information on benefits paid by cause of disability (*42*).

Hidden Subsidies

The tax structure is increasingly being used to foster redistribution of income in the interests of specific public program ends. This amounts to a form of hidden subsidy. Under National, State, and local statutes there are a wide variety of exclusions, exemptions, deductions, and allowances made for reducing the costs of operating health facilities, for stimulating private giving, for reducing the burden of taxation on families incurring sickness and disability. For every deduction, or equivalent means of reducing the tax on those who are sick, there must be a corresponding increase in some other tax source to maintain a given level of revenue. Tax relief for some groups, for example those who are sick, means larger tax burdens for others. The losses in revenue from those who contribute to health agencies, who take deductions allowed for medical expenses, or who deduct income received as sick pay must be made up in the form of higher tax rates or additional tax levies. This shift in tax burden represents a shift in income after taxes and in the distribution of funds available for consumption among families.

Estimates of the magnitude of resources transferred in this indirect way are naturally lacking in precision. Some illustrative magnitudes may be suggested. Deductions from income on account of medical expense amounted to $3.5 billion in 1956, the latest year for which data are available (*43*). Sick leave pay and cash sickness benefits deducted from income amounted to $1.4 billion (*43*).

A large part of these costs appear again either as resource-use or resource-loss. The hidden transfers are not generally additive to these other types of cost because they do not represent a change in the total cost to the community as a whole; they represent rather a shift in command over income within the community. Similarly, cash transfer payments in large part represent payments made to individuals and families to partially compensate them for a loss in earnings represented more fully in the estimates of loss in labor product due to deaths and disabilities. Cash transfers included in the resource-loss estimates are not an additional cost item; where they are added there is a double counting (*3*). However, in the absence of estimates of resource-loss, cash transfer payments as a partial measure of income loss attributable to a disease may be added to resource-use.

Resource Loss

The type of sickness cost we have categorized as resource-use relates to the way in which existing economic resources are diverted to the sector of the economy that produces health services. Without sickness and injury, these health services would be unnecessary and the resources would be free for other productive uses. Resource-transfer represents shifts in command over resources between persons or groups, which may be direct costs to one sector of the economy but are of benefit to another. However, sickness and injury also affect the quantity of resources available in the first place. Disease and impairments cause a loss of economic resources, a loss that would cease if disease and injury were to be eliminated. This is also part of the total economic cost of sickness.

The resource lost as a result of sickness is human labor. In order to value the loss in dollars, it is necessary to estimate the output foregone. The question is, if there were no sickness how much would those persons who are now sick have produced?

The effects of sickness upon the amount of human labor available for productive purposes can be summarized under three heads: deaths (loss of workers), disability (loss of working time); and debility (loss of productive capacity while at work).

Essentially, there are two stages in calculating the output foregone: (*a*) estimating the loss in productive work time, and (*b*) assigning a money value to the output that this lost work time represents. The result is then a dollar figure which represents the value of the loss in output attributable to deaths, disability, and debility. In other words, it is a rough estimate of the increase in output that would occur if the loss of resources due to sickness were eliminated.

In view of the conceptual difficulty of the idea of resource-loss, we will explain the problems involved in arriving at an estimate at somewhat greater length than we have done for resource-use and resource-transfer.

Conceptual Problems

An estimate of work-loss due to a disease involves the assumption that, if it were not for the disease, those persons in the productive age groups stricken by the disease would have been employed. In fact, where there is unemployment or substantial underemployment, improved health may result in more unemployment rather than more output. One obvious reason for using the simplifying assumption of full employment is that unless we do so we cannot arrive at any definite concept of what the resource-loss is. Apart from this, however, the fact that production losses resulting from poor health cannot be realized in an unemployment situation should be attributed to unemployment, not to ill health. Unemployment has its own costs which in effect may cancel out reductions in the costs of sickness, but for analytical purposes it is valuable to distinguish between the two. We, therefore, measure the costs of disease in the assumed absence of costs of unemployment, recognizing, however, that unemployment itself may have an impact on the incidence of illness (*44*).

There is another assumption implicit in the view that loss in production due to death, disability, and debility can be attributed to a particular disease. This is that the persons who die from or are disabled by the disease would otherwise be in good health. Here again, it is possible that persons saved from one disease may promptly die of another, and their production thus be lost in any case. It seems reasonable enough to disregard this possibility for clearly defined diseases that strike primarily at persons of working age; but it is less reasonable for cases where the disease, or treatment required to overcome it, weakens the patient by making him more prone to other ailments, and for cases when the disease strikes mainly at persons who are constitutionally weak in any case, as with the diseases of old age. In these cases, the loss in production can less clearly be identified with the effects of one disease. The result of disregarding the presence of multiple diseases is an overestimate of the cost of any single disease. At some later stage in refinement of the concept of disease cost, a methodology must be developed to deal with this problem.

Moreover, the assumption that side effects of other diseases may be disregarded in order to measure the direct effects of the disease in question means that the indirect costs of each disease, taken individually, cannot be added together to make a meaningful total for all diseases. Conceptually, such a summation could be made only if all alternatives to every disease were eliminated, in which case there would be nothing to sum. This problem illustrates the difficulty in applying the concept of resource-loss, as we are describing it here, to sickness as a whole.

The time scale of any estimate of resource-loss due to sickness involves further problems. Conceptually, it is possible to view the loss in production as (*a*) the loss in a given time period (for example, 1 year), (*b*) the loss over a productive work life.

The first of these seems most relevant to the present discussion because it is most nearly comparable to the types of estimates of resource-use and resource-transfer described earlier. It should be recognized, however, that death and permanent disability this year have a continuing cost in terms of productive resources lost in the years that follow. Cost studies by Weisbrod (cancer, poliomyelitis, and tuberculosis), Malzburg (mental illness), Reynolds (road accidents) and Laitin (cancer) relate their estimates to the second of these concepts, the loss over a productive work life (*45–48*); the Fein study on the cost of mental illness developed 1-year estimates as well (*3*). The emphasis upon the lifetime estimate is perhaps due to the far-reaching influence of Dublin and Lotka's "Money Value of a Man," which presented an actuarial approach to this problem; but the authors of this work recognized that their method might not be applicable to the economy as a whole; it was intended originally to value a life for indemnity purposes only (*49*).

The 1-year estimate is conceptually much simpler, involves fewer assumptions, and in addition yields the most conservative estimate of resource-loss; for these reasons, we feel it to be the most appropriate measure in this context. The difference in estimates derived by these alternative approaches will not be so great as might appear at first, because (*a*) the appropriate disability figure in the case of a single-period estimate is that of disease prevalence, whereas in the case of a lifetime estimate it must be disease incidence, and (*b*) a rapidly diminishing value is attributed to future output in the process of placing a present value on these future earnings. Different interest rates assumed will affect the rapidity of the decrease as illustrated by the Weisbrod study which used alternatively interest rates of 4 and 10 percent—these being based respectively on the cost of long-term Government borrowing and the rate of return on corporate taxes (*45*). Conceptually the two types of estimates—for a single year and over a lifespan—must be regarded, however, as distinctly different.

There has been suggested earlier a threefold classification of resource-loss: losses from death, disability, and debility. In practice, these categories need closer definition, and it may be necessary to subdivide them further to make them correspond to available data.

Death is unambiguous in meaning, but cause of death is sometimes not. In estimates of resource-loss caused by a particular disease, deaths from multiple causes may need to be treated

differently from those caused by the disease in question alone. Disability caused by sickness may be partial or total, and it may be short term or long term. Cases of long-term disability, especially when total, may be found primarily in institutions, and thus it may be convenient to subclassify again into institutional and noninstitutional populations and use data available on institutional cases to measure a part of the disability caseload. The division between disability and debility, furthermore, will not be clearcut in many cases.

Loss of Working Time

The loss in resources through death, disability, and debility must, for the first stage of the estimate, be stated in terms of units of productive work time lost. The second stage to be dealt with later is to assign a value to these units. In the case of death and long-term disability, these units of work time are lost because of subtractions from the productive work force. With short-term disability, the loss will take the form of periods of lost time from the job and these may be converted into equivalent units of full-time work lost. Debility, defined as reduced productive efficiency per man, too may be converted into full-time equivalents. For convenience, the following discussion will refer to man-years as the units of productive work time.

How the equivalent of the full-time work force is defined operatively is of central importance to the estimate. For purposes of a single-year estimate, for example, a decision must be made on the age limits within which persons who contract disease will be considered as productive workers. In the United States, the age of entry into the work force is usually considered as 14 years. This starting age is largely a historical carryover in definition which has been perpetuated for comparative purposes in spite of the trend toward later entry into the work force. The retirement age varies widely among different groups and in different areas; the average age of retirement for the United States is estimated at present at 68 years of age for men (*50*).

The consequence of this limitation of work-force participation, for a single-period estimate, is to count the resource-loss from death, disability, and debility of the young and retired aged as zero. This is consistent with the definition, since persons outside the work force are not considered to contribute anything to production in the year in question. For the extended time-scale analysis, however, infant and childhood deaths represent a future loss to society and must be allowed for, although the time interval between death and anticipated entry into the work force may be such that the present value of the future loss of working time is small.

The importance of the retirement-age assumption will vary with different social and economic settings. In some economies, the urgency of production for survival leaves little room for retirement prior to death or total disability; with higher productivity and industrial advances, cessation of work activity becomes feasible before extreme old age is reached. In an industrial community, therefore, it seems reasonable to exclude retired persons who cease to contribute to production, but in others retirement may be disregarded.

Whatever age limitations are set upon the productive work force, further qualification is necessary because not all persons of productive age are actually engaged in production. At full employment, only a certain proportion of the members of each age group will be productively employed, and the loss in man-years attributable to these persons alone should be counted toward the estimate of resource-loss. Here again, this implies that the death or disability of a person not in the active work force occasions no loss of productive resources.

Special problems arise in the case of women working in the home. Such women are not normally included in standard definitions of the work force, and their product, unlike that of paid domestic workers, is not included in the national economic accounts. Thus defined, their death or disability is not an economic cost. However, this is clearly highly anomalous; it implies that the national product is increased if every wife does housework for pay for the family next door, and lowered if every man marries his cook. The only alternative is to impute some value to the services of housewives in the home, thus imputing an indirect cost to their

death or disability. Although proposals have been advanced for broadening the concept of production used for national product purposes to include such nonmarket services, no generally agreed way to do so at present exists (*51*). To simplify the estimate and to follow an approach consistent with national product accounting it seems desirable at this stage of analysis to omit the valuation of housewife services.

A related problem concerns the method of counting deaths and disabilities among unpaid family workers. In the United States and several other countries, unpaid family work is included in the national product accounts, in effect requiring a prorating of income among the working members of the family enterprise. In this case, there is a basis for allocating a value to the services of such a worker. The importance of this problem obviously varies in different social settings, but in countries where a large proportion of production is carried on on farms and in other family enterprises it would be clearly advisable to count deaths and disabilities among those who work within the family unit without money wages.

In estimates over a lifespan, work life tables developed by the Bureau of Labor Statistics may be applied which identify the remaining years of work life at each age group. Estimates of work life years have been developed for 1940 and 1950 for both men and women; and historical changes in the pattern of work life expectancies have been estimated for 1900 and projected to the year 2000 (*52–54*).

Further problems arise in connection with part-time workers. The loss of productive work time for a given impact of disease among these persons will be less than that among full-time workers, and this loss will have to be converted to a full-time equivalent for purposes of the estimate. The effect will be to consider the loss of, say, two part-time workers as being equivalent to that of one full-time worker; the exact ratio might be determined with reference to average hours of work or other available criteria.

The most practical solution to these definitional problems may be to use existing concepts of "work force" and "labor force" (converted to full-time equivalents) to distinguish the cases of the disease that result in actual loss of productive work time. In the United States, the basis for classifying persons in or out of the "labor force" is their activity during a specified week. Employed members of the labor force comprise those at work for pay or profit during the survey week, those who worked without pay for more than 15 hours on farms or in family businesses, and those who would have been in these two categories in the work force but for vacation, temporary illness, bad weather, or industrial disputes. Unemployed members of the labor force comprise all those without work who were actively seeking work during the survey week. Data will often be available only within this framework, and this method has the further advantage that it makes the estimate of resource-loss comparable in scope with existing national product estimates. The effect, however, is to exclude almost all the nonmarket costs of death, disability, and debility from our estimate of resource-loss, and this should be clearly recognized as a serious source of understatement of the total.

Our measure of resource-loss is posited on the assumption of full employment. However, it may be felt desirable to make an allowance for frictional unemployment, that is, the essential unemployment that exists even at full-employment levels as when persons change jobs or are temporarily laid off. In the United States, this is usually considered to run at about 3 percent of the labor force at any time; thus 3 percent fewer deaths and disabilities than the total of those from the labor force actually affect production at any time. It is also desirable to allow for absenteeism over-employment, which is normal absenteeism of workers from jobs because of vacations, bad weather, and temporary sickness. These adjustments may be applied to the final estimate of productive work time lost due to the disease as a straight percentage reduction, or in terms of a full-time equivalent number of man-years.

It is apparent even from this brief discussion of the problems of defining lost work time due to disease that many of the factors involved are dynamic. The single-period type of estimate, which sets out to quantify the gain in work time in a given year that would result if a specific disease were eliminated, avoids the problems of estimating future trends in work-force partici-

pation. For the lifespan type of estimate, these problems could only be solved by making a large number of assumptions about the future course of such trends, and the uncertainty and complexity of the estimate would be greatly increased.

Loss of Output

The previous stage in the computation has resulted in an estimate of the productive man-years lost because of deaths, disability, and debility from sickness. This, in itself, may prove a useful piece of political arithmetic, but in most cases it will be desirable to translate this into dollar cost by assigning a value to the man-years foregone in terms of lost production.

In the available studies on losses from illness, two essentially divergent approaches have been used in assigning a value to each unit of labor work time. The first is to value each unit by an amount equivalent to total product per worker; the other is to use earnings as a measure of labor product per worker.

The first of these assumes, as Fein (*3*) has indicated, ". . . that all of the national product (income), and therefore any gains in national product, are attributable to labor rather than to some combination of joint factors of production, land, labor, capital, etc. Although it may, indeed, be true that if there were no labor there would be no product, it is equally true that if there were no capital there would be very little product."

The total-product-per-worker approach was used by Reynolds in his study of the cost of road accidents in Great Britain (*47*) and also in the National Planning Association study on the costs of tuberculosis in the United States (*55*).

The second alternative—to use earnings as a measure of the output attributable to labor—seems to us to be more appropriate for purposes of estimating resource-loss. Earnings, in this case, must be distinguished from income, which includes returns on property or capital; earnings consist only of wages and salaries (or equivalents for the self-employed). These wages and salaries are paid in direct return for productive services, and, according to economic theory, they correspond to the individual's contribution to production. The estimate of resource-loss put in these terms thus measures the loss of production attributable to labor which this earnings-loss represents.

A choice between these two alternatives arises also in estimates of the costs of unemployment, which are perhaps more familiar than those of the costs of disease. Here, however, gross product per worker seems the more appropriate concept, because it is fair to assume in these circumstances that some capital will be unemployed along with labor. This brings to light another assumption implicit in our concept of resource-loss from a disease: this is that the ratio of investment of capital to labor used remains approximately constant. If this were not so (as, for example, if the investment or capital stock were assumed to be constant and unchanging), the labor released by eliminating the disease might have to work with less capital per capita, and diminishing marginal returns to labor would ensue. A related implicit assumption is that the capital stock is infinitely divisible, so that there is no question of the product of each man being tied to the availability of a machine or implement.

The earnings figure used may be an average for all employed workers. This assumes that the average earnings pattern among those who contract the disease is the same as that of the working population at large. For greater accuracy, it would be preferable to use a series of averages applied to sex-age groups, occupational categories, or other subdivisions and to take account of the findings of studies relating earning levels and disease incidence.

The use of average earnings per full-time employed worker is in fact only an approximation of marginal earnings, which are needed to actually measure the additional labor product that would become available as a result of eliminating the disease. Under the assumptions of full employment of labor and constant labor-capital ratio that we have made, average and marginal earnings will be the same. In practice, however, if elimination of the disease were to throw a relatively large number of workers onto the labor market, it might be found that these assumptions would need to be relaxed for purposes of realistic prediction.

A word must be added about an argument

appearing sometimes in the literature (*49*) that a man's contribution to production should be considered net, exclusive of the essential consumption required to maintain him as a producer, rather than gross as we have taken it here. Quite apart from the virtually insoluble difficulty of defining "essential" consumption, the frame of reference of our problem is to determine the loss in total output caused by disease and thus by definition the gross approach is indicated. The fact that saving a life adds a consumer as well as a producer to the economic process is immaterial to an estimate of change in total output. Calculation of the resulting change in consumption levels per capita is basically a problem of resource-use rather than losses in production.

Average earnings multiplied by the number of man-years lost as a result of the disease yields the dollar estimate of resource-loss caused by a disease. We are now in a position to define the result more closely. It is, essentially, an estimate of the money value of the labor product lost as a result of death, disability, and debility due to a disease.

Gaps in Statistical Data

The foregoing summary of concepts and definitions in the measurement of output-loss due to a disease suggests the wide range of assumptions and approximations which must sometimes take the place of factual information in estimating the dollar amounts.

Statistics on employment patterns are applied to data on deaths by cause, age, and sex without taking account of the specific employment history of those who die. The assumption of average work-force participation is made necessary by the absence of specific information on employment status of the deceased. In fact, there will be differences in the importance to productivity of each death: elimination of a key worker in a basic industry, for example, might affect the ultimate output of hundreds of others.

Estimates of average full-time earnings are applied to deaths in the productive age groups without taking into account the differential death rates in different industries and occupations, which may pay different wages. The absence of recent data on deaths by occupational groups and by earnings classes necessitate the use of average figures.

Improvement of the estimates now in current use of the resource-loss due to deaths not only requires agreement on concepts and definitions for measurment, but also additional data on mortality by cause of death, relation of the deceased to the work force in a period preceding death, and occupation and earnings in a period prior to death.

Data on work-loss days for those attached to the work force have become available through the U.S. National Health Survey of the Public Health Service. These data, however, are published only for the following groups of conditions: infectious and parasitic, circulatory, respiratory, digestive, genitourinary, arthritic and rheumatic, injury and impairment due to injuries, other impairments, and all other conditions. Until such data become available for more specific disease categories, information on disease prevalence and on duration of illness will be combined with average work-force participation for age and sex groups to approximate the work-loss days. Moreover, data are needed on usual earnings rates received by persons reporting work loss due to a condition. The existence of multiple conditions yields an inflated count of work loss attributable to each condition and an overcount of the sum of days for more than one condition.

The impact of diseases which cause debility, or loss of working efficiency, is no simple matter to define. In its broadest dimension, a measure of loss of output due to disease debility requires formulation of a standard of output in the absence of the disease, from which shortcomings may be measured. Additional work is required on the concept of measurement, as well as on the collection of data permitting a count of lost product per unit of work time. In highly industrialized countries, machines have taken over much of the physical work of man, and maximum demands are seldom made upon the physical energy of the average worker in the mechanized industries. What, however, are the appropriate counts of maximum output in terms of human capacity in service and nonmechanized employment and of deviations from these maximums? In other economic settings, the energy capacity of a man at work may be of

great importance. In subsistence agriculture, reduction in debility from malaria, trachoma, or dysentery can be as important a factor in increasing productivity as a change in tools or technology.

Debility, where relevant, thus represents the least well defined of the three categories through which we examine the resource-loss from disease. However, its influence is so pervasive that some basis for estimating its impact on the economy is badly needed.

Conclusions

To summarize, the economic costs of disease and injury are of three types: (*a*) costs which use a share of the Nation's resources of manpower and materials to supply health services and their commodity components; (*b*) costs represented by the transfer of income and resources from the well to the sick in public and private efforts to mitigate the burdens of illness; (*c*) costs reflected in a reduced national production of all goods and services. These three types of costs are termed resource-use, resource-transfer, and resource-loss.

The price of control of a disease is the health resources used up in the treatment and control of a disease. In economies characterized by severely limited resources and low food supplies, there must be added the minimum essential consumption of people whose lives are saved by the successful disease control action.

The economic cost of a disease for price-cost comparisons is the loss in labor product, or the amount by which the national output in a year is reduced by death, disability, and debility.

The omissions and limitations of this type of economic arithmetic are many. The scheme fails to take into account the pervasive force for social and economic change released by improvement in mortality rates and changes in expectations of survival. Changes in life expectancy and in health status radically alter attitudes toward work and enterprise. Disease and early death are deeply implanted in the mores of many people of the world. The fears, superstitions, rigid social patterns, and resistance to change are in part cultural adjustments to high disease and death rates. While they are not to be changed overnight, one cause of them will be removed when illness is limited and death rates sharply reduced.

Changes in expectation of life, moreover, alter individual attitudes toward sacrifice of some part of today's consumption for tomorrow's. The time perspective of planning and investment for economic development is deeply affected by health levels. A prospect of longer life disposes the individual to support long-run development projects because he sees for himself a better chance of reaping some of their benefits. Changes in life expectancy, especially of infants and children, offer some promise of adjustment, over a period of time, in size of family, fertility rates, and age structure of the population.

The accounting of economic gains and losses as described also omits what is perhaps the simplest and most direct economic effect of all. Health is itself an element in the standard of living. Concentration on health as an investment in economic resources—an intermediate product of value in that it helps to increase national output—must not obscure its parallel importance as a final product for human welfare.

Objection on ethical grounds has sometimes been raised to conversion of human lives to money terms, to the disregarding of human suffering and to the counting of saved lives of children and other nonproducers as a price rather than gain. The value of human life and relief of suffering obviously cannot be disregarded in health programing. Disease prevention and control measures which yield zero or even negative economic returns can be fully justified in terms of human values. The fact that the economic arithmetic of a disease is only one of a number of tools for evaluation of health programs does not in itself argue against development of cost estimates of disease.

Voluntary and public agencies concerned with specific diseases have developed or used such estimates to further programs of medical research and disease control. They have financed studies of these costs to give them a tool to describe the size of the problem in public discussion. Review of these studies indicates clearly the need for development of a conceptual framework for such estimates, for a clearer formulation of their assumptions and limita-

tions, and for indication of the areas in which relevant data still need to be collected.

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