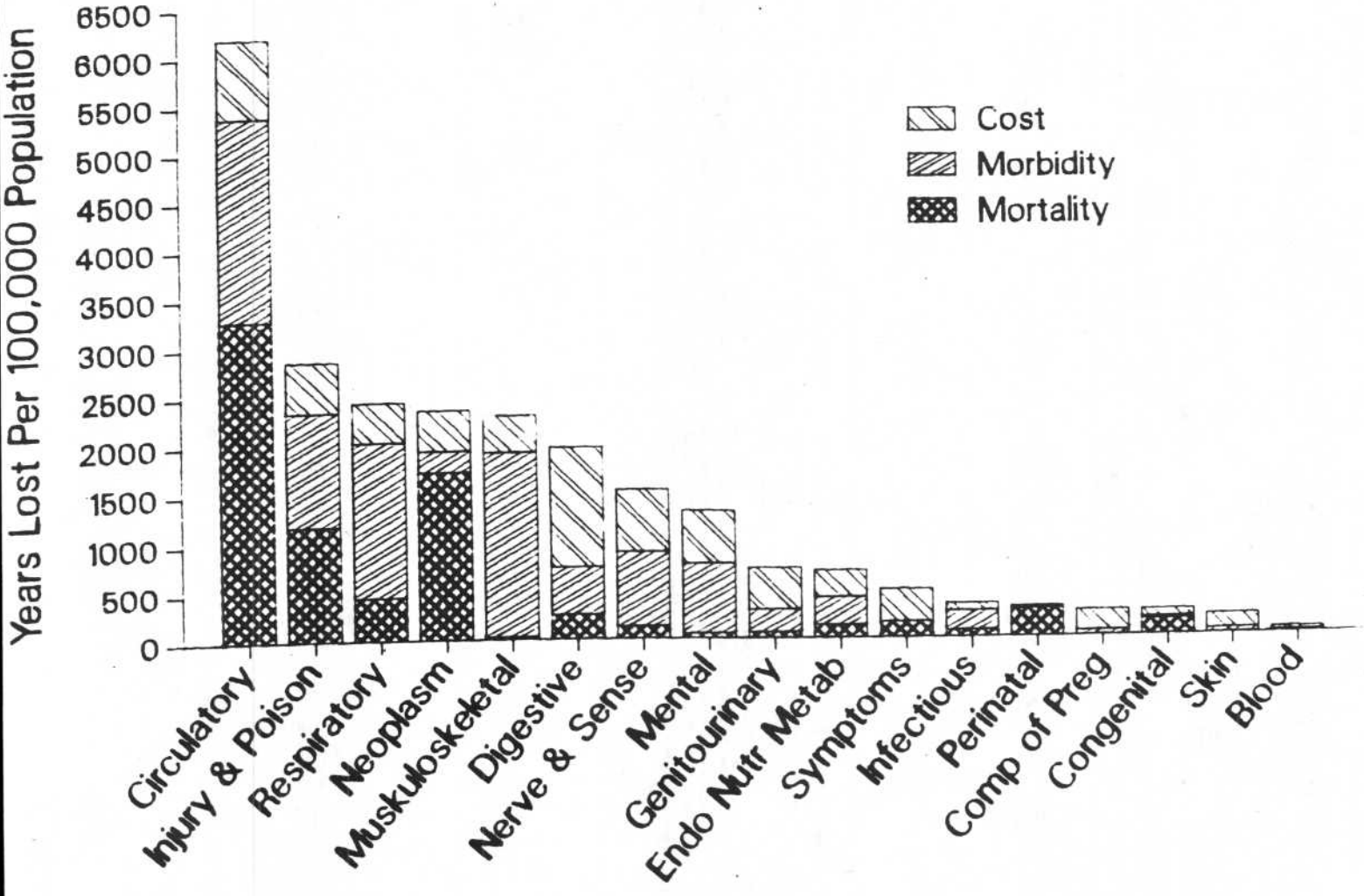
Disease Impact, Minnesota, 1978



Measuring Loss of Life, Health, and Income Due to Disease and Injury

A method for combining morbidity, mortality, and direct medical cost into a single measure of disease impact

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SETTING PRIORITIES IN PUBLIC HEALTH requires decisions about the relative importance of various disease conditions. At local, State, and national levels, the mortality, morbidity, and cost related to a disease are often used in assessing the potential cost effectiveness of proposed control programs. Public priorities as expressed in the political process then lead to a decision to implement or not implement programs. Usually a combined consideration of mortality, morbidity, and cost quantitatively is not possible, and the partisans or opponents of a particular program give various degrees of emphasis to these three important aspects of any disease condition.

To provide an objective measure of the impact of various diseases on the population, for use both in public decisionmaking and general health education, it would be desirable to have a uniform method of combining illnesses, deaths, and direct medical costs in a way that would yield a single unit which the public could readily understand. In economic studies of disease, this end has been achieved by converting mortality and morbidity into dollar equivalents and combining these equivalents with direct medical costs. The disadvantage of this method is that future discount rates, salaries for homemakers, students, and children, and other characteristics of the economy not directly related to disease control must be estimated. However, studies in which this method has been used, such as the "Cost of Disease and Illness in the United States in the Year 2000" (*1*), provide an example of the kind of integrated data that would be desirable for routine use.

Sullivan (*2*) has proposed a single index of health in which measures of mortality and morbidity are merged to obtain the expected years of disability-free life that a person has at birth. This index requires the construction of a life table based on the current age-specific rates of mortality and disability for the population of interest. In Sullivan's model, traditional life tables and disability data for the total population of the United States are used. However,

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data for application of the model to specific population groups and smaller areas within the country would be difficult to obtain. Also, the index does not appear to be useful for disease-specific disability.

Chen (*3*) devised a population health index called the gross national health product (GNHP) that also combines morbidity and mortality to give the number of disability-free years of life expected per 100,000 persons in a population. Chen considered an index devised by Chiang (*4*), which also combines measures of morbidity and mortality, as too complex mathematically for routine public health use (*3*). Neither of these models includes medical expenses as a part of the damage caused by illness.

In planning disease prevention and control programs for Minnesota, we considered it desirable to estimate the combined effect of deaths, illness, and medical expenses on the population. Values for the three parameters were converted to common units of measurement and added to produce a disease impact scale (DIS). In order to focus primarily on disease control rather than on economics, we chose to express morbidity, mortality, and cost in terms of person-years of life, health, and income lost. With the DIS, medical expenses are converted into person-years of income by calculating the direct medical cost in person-years of annual per capita personal income. The average personal income for each of the 50 States for the past 20 years has recently been published (*5*), and use of this average provides a crude but convenient method of adjusting medical costs for the effect of inflation.

To illustrate the method, we have used data from the National Health Interview Survey (NHIS), the National Ambulatory Medical Care Survey (NAMCS), and various Minnesota-specific cost and mortality statistics available within the Minnesota Department of Health or from other agencies. However, because these data are sometimes expressed in incompatible units, available only for the wrong year or otherwise incomplete, we have made a number of arbitrary decisions and rather crude adjustments, which will be readily apparent. Nevertheless, we believe that the combined results are more useful than pure mortality, morbidity, or cost estimates; they can form a common framework not only for discussion of disease control but also for designing improved data-collection methods that can increase the relevance of statistical information. We are actively working to devise methods for systematic assessment of disability due to specific diseases in Minnesota, and we eventually hope to be able also to measure the prevalence of risk factors in the population and to estimate the effect of their removal on the overall disease impact in the State.

Methods

Mortality. Our mortality figures were derived from 1978 certificates of death for Minnesota residents. In accordance with a method used by the Centers for Disease Control (CDC) in dealing with leading causes of death (*6*), we took 75 years as the "expected" span of life. Years of life lost before age 75 were calculated and summed over major disease categories of the ICDA-8 (International Classification of Diseases, Adapted, Eighth Revision) to calculate the total years of life lost to "premature" deaths. However, because with the CDC method, the causes of all deaths occurring after age 75 are ignored, we distributed the total years of life lost before age 75 per 100,000 population into disease categories in proportions determined by similar calculations for the years of life lost before age 100. For example, 41 percent of the years of life lost before age 100 is attributed to cardiovascular disease. Applying this percentage to the total 7,981 years lost before age 75 gives 3,270 years of life lost per 100,000 population, a figure that is used in our disease impact scale for "mortality" due to cardiovascular disease. The total for the years of life lost is, therefore, the same as that obtained by the CDC method, but our distribution of specific causes more accurately represents actual mortality patterns, since the causes of death from age 75 to 100 are included as well as the "premature" deaths represented by the CDC method.

Morbidity (disability). Estimates of disability associated with nonfatal illness in the civilian noninstitutionalized population of Minnesota were made from National Health Interview Survey data for the entire United States. Survey data on acute illnesses are from the period July 1977 through June 1978 (*7*). Data on disability associated with chronic conditions are for 1974 and are assumed to approximate the pattern of such disability prevalent in 1978 (*8*).

Data for estimating disability in the institutionalized population were obtained from a Quality Assurance and Review Program summary report concerning Medical Assistance patients in skilled nursing homes, State mental hospitals, and intermediate care facilities in Minnesota (*9*).

For our scale, certain measures of disability employed in the NHIS are used. Disability associated

with acute illness is classified either as involving restriction of usual activity or confinement to bed. Confinement to bed, of course, is a subset of restriction of usual activity. Disability related to chronic conditions is also defined as involving restriction in one's usual or major activity, but three levels of restriction are recognized. The virtue of "limitation of usual activity" as an indicator of disability is that it can be applied to all persons without regard to such factors as age, sex, or occupation.

To generate an aggregate measure of disability in person-years per 100,000 population by major disease category, we had to assign weights to the different levels of disability and to make assumptions regarding the duration of chronic disability. Disability associated with a chronic condition was assumed to prevail at the reported level for the entire year. Thus, a person unable to carry on his or her usual activity at the time of the survey contributed 1 person-year of disability to the DIS (disease impact scale), with a weighting factor equal to 1. Disability resulting in partial limitation of a person's usual activity was weighted at 50 percent, and a limitation not in a person's usual activity was weighted at 25 percent. For acute disorders, each day spent in bed was counted as 1 person-day of disability; a non-bed day of restricted activity was counted as 0.5 person-days of disability.

For the institutionalized population of Minnesota, we treated all diagnoses as chronic and as resulting in the person's being totally unable to perform his or her usual function for an entire year. Thus, each bed in a long-term institution that was occupied at the time of the survey contributed 1 person-year to the State's total estimated morbidity.

Chronic disability as estimated by the NHIS is reported according to chronic condition groups (*8*). Although many of these groups correspond to ICDA-8 classification codes, others do not. A chronic condition group may include disorders that are coded in two major ICDA-8 disease categories. In addition, part of the chronic disability reported in the NHIS is attributed to impairments of various kinds. Although there are detailed codes for impairments, these codes do not translate directly into the major disease categories of the ICDA-8 (*10*). Consequently, we had to make certain approximations in allocating chronic disability to the major ICDA-8 disease categories. We allocated 100 percent of the disability due to visual impairments, hearing impairments, and paralysis to diseases of the nervous system and sense organs (ICDA-8 codes 320–389). One hundred percent of the disability caused by the absence of extremities and 50 percent of the disability due to all orthopedic and other impairments were allocated to injury and poisoning (ICDA-8 codes 800–999). These allocations were slightly greater than the proportion of impairments attributable to injury in the United States in 1971 (*10,11*). The remaining 50 percent of disability resulting from orthopedic and other impairments was attributed to diseases of the musculoskeletal system and connective tissue (ICDA-8 codes 710–738).

Our data source for the institutionalized population provided the percentage of residents who had a diagnosis in each major category. Since members of this population commonly had more than one diagnosis, the sum total across all disease categories exceeded 100 percent. However, for purposes of calculating person-years of disability by major disease category, the percentage in each category was proportionately reduced, so that the total was 100 percent.

Under a physician-oriented disease surveillance system implemented in Minnesota in 1980, randomly selected samples of physicians report each day to the Minnesota Department of Health information on all patients seen during that day. Data from this surveillance effort are expected to supplement and validate State-level estimates for morbidity and disability, which currently are based on NHIS and NAMCS data.

Cost. Only direct medical costs are included in the DIS. Estimates of the dollar value to society or to the person of lost productivity due to premature death or disability have not been made, since these losses are reflected in the years of life lost due to mortality and disability, and dollar values could be assigned to these results if desired.

Hospital costs. An estimate of the percentage of hospitalization for each major disease category was obtained from the Minnesota Patient Origin Study done on all patients admitted to hospitals (excluding the Veterans Administration hospital) in the Metropolitan District of Minnesota in 1978 (*12*). An average charge per hospitalization by major disease category was derived from a record of charges for all Medicaid hospital admissions in Minnesota in 1978 (*13*). We used these data, together with the 1978 budget for all Minnesota hospitals (*14*), to estimate total hospital costs by major disease category.

Long-term-care costs. The number of persons in long-term-care facilities by major disease category

was estimated from data in a Quality Assurance and Review summary report concerning Medical Assistance patients in skilled nursing homes, State mental hospitals, and intermediate care facilities in Minnesota (*9*). The overall cost was estimated by multiplying the number of people in each category by the average Medicaid payment for eligible institutionalized persons in 1976 (*15*).

Physicians' services. The cost of physican services was taken from data on national health expenditures in 1978 (*16*). We estimated the Minnesota portion of these costs by multiplying the total costs of these services for the United States by 0.0184 (the population of Minnesota as a proportion of the U.S. population in 1978). These costs were then allocated to major disease categories according to the disease-specific distribution of costs found nationally in the 1972 study of Cooper and Rice (*17*).

Dental services. The direct cost of dental services was obtained from data on national health expenditures for 1978 (*16*). Costs for the population of Minnesota were again estimated by multiplying the total costs for the U.S. population in 1978 by 0.0184. All costs for dental services were allocated to diseases of the digestive system.

Eyeglasses and appliances. Data on national health expenditures in 1978 were used to determine the cost of eyeglasses and appliances (*16*). The Minnesota portion of this cost was again estimated by multiplying the total cost for the U.S. population by 0.0184. All costs for eyeglasses and appliances were allocated to diseases of the nervous system and sense organs (*17*).

Other costs and data sources. Cooper and Rice, using Social Security Administration estimates of direct health expenses in the United States, were able to allocate 83 percent of these costs to the major diagnosis (*17*). Within each category of diagnosis, expenditures were attributed to hospital care, physicians' services, dentists' services, other professional services, drugs and drug sundries, eyeglasses and appliances, and nursing home care. The initial version of the DIS for Minnesota incorporates estimates for five of the seven types of expenditures. Our intent is to use data sources that relate directly to the population of the State. Currently, however, this criterion is met only with respect to the costs of

Method used to calculate disease impact

MORTALITY

$$\frac{\Sigma \text{ for all deaths due to disease X (100 years} - \text{age at death)}}{\text{population in 100,000s}} \times {}^{1}0.32 = \text{years of life lost before age 75 (adjusted to include causes of death after age 75) per 100,000 people per year}$$

MORBIDITY

$$\frac{\Sigma \text{ for all cases of disease X (duration of illness} \times \text{degree of disability—for example, 25, 50, or 100 percent)}}{\text{population in 100,000s}} = \text{years of helath lost (disability) per 100,000 people per year}$$

COST

$$\frac{\Sigma \text{ for all types of costs for disease X (amount of expenditures in a given year} \div \text{per capita income in a given year)}}{\text{population in 100,000s}} = \text{year equivalents of direct cost per 100,000 people per year}$$

OVERALL DISEASE IMPACT

Years of life lost + years of health lost + year equivalents of cost = disease impact in years lost per 100,000 people per year

[1] Deaths within each disease category were first assessed according to the following formulation: number of deaths × (100 − age at death). In this way virtually every death is considered to have some negative impact. However, when summed over all causes, the number of years of life lost short of age 100 is more than could reasonably be saved through even major advances in prevention and treatment. Consequently, a reference age of 100 years was used to obtain the distribution of the impact of mortality across disease categories, but the figure for the total years of life lost was adjusted downward to that based on a reference age of 75 years. The figure 0.32 is the ratio of the total years of life lost before age 75 to the total years of life lost before age 100.

hospital care and long-term care (nursing home care). In other areas, we have had to generate State-level cost estimates using national data. This is true for the cost estimates for physicians' services, dentists' services, and eyeglasses and appliances. Inclusion of physicians' services was clearly necessary, since it is a very large category of expense. Inclusion of the expenditures for dentists' services and for eyeglasses and appliances was also considered essential, since each is allocated completely to a single disease category, and omission of these items would have resulted in misleading rankings of the disease categories with respect to cost. The costs of drugs and other professional services are not presently included in the DIS pending the acquisition of disease-specific data relating directly to Minnesota. Exclusion of these expenditures, however, should not seriously bias the disease impact scale, as they are distributed over all of the major disease categories.

Within the next year, two sources of State-level cost data will be available for future editions of the DIS. These will include charges submitted to Medicaid for drugs by therapeutic class and hospital outpatient physicians' services by major disease category. In addition, Blue Cross and Blue Shield of Minnesota will provide information on hospital charges for inpatient and outpatient services and on charges for inpatient physician services by major disease category.

Conversion of cost to person-years. The dollar value of direct medical expense is divided by the annual per capita personal income in Minnesota to give the person-years of income expended, and this figure is then related to a population base by determining its value per 100,000 population.

Table 1. Morbidity

Rank	Disease categories and codes from the International Classification of Diseases, Adapted, Eighth Revision	1978 morbidity (person-years of disability per 100,000 people)	Percent of total
1	Circulatory system (390–458)	2,100	19.3
2	Musculoskeletal system and connective tissue (710–738)	1,880	17.3
3	Respiratory system (460–519)	1,573	14.4
4	Injury and poisoning (800–999)	1,164	10.7
5	Nervous system and sense organs (320–389)	763	7.0
6	Mental disorders (290–315)	718	6.6
7	Digestive system (520–577)	485	4.4
8	Endocrine, nutritional, and metabolic (240–279)	288	2.6
9	Genitourinary system (580–629)	233	2.1
10	Neoplasms (140–239)	212	2.0
11	Infective and parasitic (000–136)	200	1.8
12	Complications of pregnancy, childbirth/puerperium (630–687)	48	0.4
13	Skin and subcutaneous tissue (680–687)	46	0.4
14	Congenital anomalies (740–759)	21	0.2
15–17	Blood and blood-forming organs (280–289)	...	...
15–17	Symptoms and ill-defined conditions (780–796)	...	...
15–17	Perinatal causes (760–779)	...	...
	Unallocated	1,155	10.6
	Total	[1]10,885	[1]100.0

[1] Totals in this and subsequent tables may not be the sum of the components because of rounding off.

Data sources used to calculate the mortality, morbidity, and cost components of the disease impact scale

MORTALITY

Certificates of death. Deaths among Minnesota residents by underlying cause, obtained from Minnesota Center for Health Statistics, Minnesota Department of Health.

MORBIDITY

1. National Health Interview Survey (*7,8,10,11*). A house-to-house survey conducted by the National Center for Health Statistics.
2. Periodic Medical Review and Independent Professional Review. An ongoing record review survey, conducted by the Minnesota Department of Health, of all patients eligible for medical assistance payments who are residents in skilled nursing homes, State mental hospitals, and intermediate care facilities.
3. Hospital discharge data. Obtained from the Minnesota Foundation for Health Care Evaluation.

COST

1. Patient Origin Study. A statewide survey of all hospital discharges in Minnesota for the month of November 1976. A 1978 study limited to the Minneapolis-St. Paul Metropolitan area providing the distribution of primary diagnoses underlying acute care hospitalizations.
2. Aggregate hospital budget for Minnesota. Obtained from the Hospital Rate Review Program of the Minnesota Department of Health.
3. Medicaid payments for hospital admissions in Minnesota. From the Minnesota Department of Public Welfare.
4. Periodic Medical Review and Independent Professional Review (see above).
5. Medicaid payments for institutionalized persons (*15*).
6. National health expenditures. Overall expenditures (*16*) and distribution of expense by major disease category (*17*).
7. Minnesota's average annual per capita income (*5*).
8. Hospital discharge data (see above).

Table 2. Mortality

Rank	Disease categories and codes from the International Classification of diseases, Adapted, Eighth Revision	1978 loss of life (mortality)—person-years of life lost before age 75 per 100,000 people [1]	Percent of total
1	Circulatory system (390–458)	3,270	41.0
2	Neoplasms (149–239)	1,711	21.4
3	Injury and poisoning (800–999)	1,170	14.7
4	Respiratory (460–519)	446	5.6
5	Perinatal causes (750–779)	288	3.6
6	Digestive (520–577)	257	3.2
7	Symptoms and ill-defined conditions (780–796)	169	2.1
8	Congenital anomalies (740–759)	164	2.1
9	Endocrine, nutritional and metabolic (240–279)	138	1.7
10	Nervous system and sense organs (320–389)	131	1.6
11	Infective and parasitic (000–136)	73	0.9
12	Genitourinary (580–629)	62	0.8
13	Mental disorders (290–315)	52	0.6
14	Musculoskeletal and connective tissue (710–738)	26	0.3
15	Blood and blood-forming organs (280–289)	17	0.2
16	Skin and subcutaneous tissue (630–709)	5	0.1
17	Complications of pregnancy, childbirth/puerperium (630–687)	3	0.04
	Total	7,981	100.0

[1] Allocated to disease according to years of life lost short of 100 years. See text for further explanation.

Table 3. Medical cost

Rank	Disease categories and codes from the International Classification of Diseases, Adapted, Eighth Revision	1978 Direct costs in person-years of annual income per 100,000 people	Percent of total
1	Digestive system (520–477)	1,213	16.8
2	Circulatory system (390–458)	821	11.4
3	Nervous system and sense organs (320–389)	627	8.7
4	Mental disorders (290–315)	533	7.4
5	Injury and poisoning (800–999)	520	7.2
6	Genitourinary system (580–629)	430	6.0
7	Neoplasms (140–239)	417	5.8
8	Respiratory system (460–519)	409	5.7
9	Musculoskeletal system and connective tissue (710–738)	382	5.3
10	Symptoms and ill-defined conditions (780–796)	332	4.6
11	Endocrine, nutritional, and metabolic (240–279)	272	3.8
12	Complications of pregnancy, childbirth/puerperium (630–687)	214	3.0
13	Skin and subcutaneous tissue (680–709)	152	2.1
14	Infective and parasitic (000–136)	78	1.1
15	Congenital anomalies (740–759)	76	1.0
16	Blood and blood-forming organs (280–289)	38	0.5
17	Perinatal causes (760–779	25	0.3
	Unallocated	677	9.4
	Total	7,216	100.0

Overall disease impact. A summary account of how components of the DIS are calculated and combined to give an overall measure of disease impact for the State is shown in the box, page 41. Data sources are summarized in another box on page 42. The person-years for the impact due to morbidity, mortality, cost, and the combination of all three components for Minnesota in 1978 are shown in the tables.

The year 1978 will be used as the reference point against which to compare annual revisions of the disease impact scale. An index value of 1.0 can, accordingly, be assigned to the total disease impact in Minnesota in 1978, with overall morbidity contributing 0.417, mortality 0.306, and cost 0.277. In future years, index values greater than or less than 1.0 will indicate the increasing or decreasing absolute disease impact per 100,000 population. Further analysis would be required to determine the actual basis for a change in disease impact. Thus, an increase in the index value due to disorders of the circulatory system might simply reflect an aging population and would not necessarily indicate the declining effectiveness of efforts to control disease. However, adjustments for age or other demographic changes should be made after, rather than before, the initial calculation of the index value, so that the DIS will first measure absolute changes in disease impact. Disease impact values can be age adjusted in the same way as crude mortality rates.

Results

The total loss of life, health, and income in Minnesota in 1978 through disease and injury was calculated to be 26,082 person-years per 100,000 population. Theoretically, a population could lose in a single year, 1 year per person due to disability, could lose 1 year of income due to medical expenses, and all members of the population group could die, resulting in a per capita loss equal to 75 years minus the age at death. Since the average age of Minnesotans in 1978 was 33, it was possible to have a maximum of 42 years of life lost per person had all resi-

dents died during the year. To achieve this maximum, the entire population would have had to become seriously ill on January 1, to have spent the year in bed or in a hospital, and to have perished suddenly on December 31.

The total impact of disease for 1978 was about 0.6 percent of the maximum loss possible. Since the potential loss due to death is so great that it overshadows the other two loss categories, it is more meaningful to say that during a 1-year period, Minnesotans lost 11 percent of their useful days, spent 7 percent of their personal incomes on medical expenses (excluding drugs and "other professional services"), and lost 0.2 percent of the total years of life that they had left short of age 75. Of course, changing the arbitrarily selected target age of 75 years—for example, to 100 years—would alter the proportion of the maximum possible loss accounted for by the years of life lost.

The individual components of disease impact are shown in tables 1–3 in person-years per 100,000 population and as percentages of the total. Their sum—"disease impact"—is given in table 4.

Circulatory diseases rank at the top of the disease lists in all four tables, partly because we chose to combine heart disease and stroke to emphasize their common etiology. The relative importance of circulatory diseases is greater for mortality (41.0 percent), however, than it is for morbidity (19.3 percent) or for cost (16.8 percent). Circulatory diseases appear to be represented more fairly by the (still enormous) 23.7 percent figure for overall disease impact. After the first category, each of the four lists varies, not only in the rankings of disease categories, but in the degree of difference among categories.

Table 4. Disease impact

Rank	Disease categories and codes from the International Classification of Diseases, Adapted, Eighth Revision	Overall disease impact in person-years per 100,000 people	Percent of total
1	Circulatory system (390–458)	6,191	23.7
2	Injury and poisoning (800–999)	2,854	10.9
3	Respiratory system (460–519)	2,428	9.3
4	Neoplasms (140–239)	2,340	9.0
5	Muskuloskeletal system and connective tissue (710–738)	2,288	8.8
6	Digestive system (520–577)	1,955	7.5
7	Nervous system and sense organs (320–389)	1,521	5.8
8	Mental disorders (290–315)	1,303	5.0
9	Genitourinary system (580–629)	725	2.8
10	Endocrine, nutritional, and metabolic (240–279)	698	2.7
11	Symptoms and ill-defined conditions (780–796)	501	1.9
12	Infective and parasitic (000–136)	351	1.3
13	Perinatal causes (760–779)	313	1.2
14	Complications of pregnancy, childbirth/puerperium (630–687)	265	1.0
15	Congenital anomalies (740–759)	260	1.0
16	Skin and subcutaneous tissues (680–709)	202	0.8
17	Blood and blood-forming organs (280–289)	55	0.2
	Unallocated	1,832	7.0
	Total	26,082	100.0

Discussion

Death, disability, and direct costs emerge as components of roughly comparable importance in the disease impact scale. We adopted the scale with the realization that questions of societal values cannot be settled in a precise, quantitative way. Other approaches to weighting might be taken, such as determining the opinions of a random sample of citizens on the relative importance of a year of life lost, a year of total disability, or a year's income paid for medical expenses. A search of the Congressional Record could produce the number of times that each parameter was mentioned on the floor of Congress. Rather than resort to such artifically precise quantitation, we prefer to use the values for 1978 as displayed, in which roughly one-third of the total negative impact of disease falls into each category. The actual proportions are 0.42 for morbidity, 0.31 for mortality, and 0.28 for direct medical cost. Economic models require similar decisions in the course of converting deaths and disability to dollar figures.

The allocation of certain conditions into categories such as injury (as described under "Methods") conforms generally with other data on the subject, although the allocation is basically arbitrary. As Minnesota-specific morbidity information becomes available, these allocations will no longer be necessary.

In constructing the DIS, no attempt was made to include the costs for public programs of disease prevention. Only the costs for personal medical care have been used. These also include, however, the costs of preventive care in the form of physical examinations, normal obstetrics, office-based counseling, and other services. We considered it more practical to define "direct medical costs" in terms of the lines of cleavage of the usual data sources, rather than to combine personal medical care costs with the cost of public health programs. The boundaries of such programs are not at all clear if the cost of

clean water, food, and air and of other preventive programs is included. In using the DIS for planning purposes, therefore, the impact of disease must be balanced against the cost of proposed public programs designed to prevent this impact, along with estimates of program efficacy.

Calculation of the years of life lost due to mortality requires that a target age be chosen. A target age reasonably close to the average age at death for Minnesotans seems the most realistic expectation. To avoid changing this figure yearly, however, the age of 75 years was adopted. It is a round figure very close to the actual present life expectancy, and it has been used in at least one major Federal publication (*6*). It also has the advantage of producing a total of years of life lost that is of similar magnitude to the totals for morbidity and cost. On the negative side, however, use of a target age of 75 means that all cause-of-death information for persons dying after age 75 are ignored. A health program that completely prevented cardiovascular deaths in citizens over age 75 would not have any influence on statistics compiled in this way even if all the participants lived to age 100. We chose, therefore, to modify the years-of-life-lost calculation and to impose the distribution of years of life lost by specific cause up to age 100 (essentially all deaths) on the total years of life lost up to age 75.

The DIS as formulated does appear to measure overall disease impact in a way that is consistent with other models encompassing morbidity, mortality, and direct medical cost. For example, the rank order of disease categories in Minnesota in 1978 as determined by the DIS was similar to that in a model assessing the economic impact of morbidity, mortality and the direct cost of medical care in the United States in 1975 (*18*). Spearman rank correlation coefficients between the results of DIS calculations and three versions of the economic model ranged from 0.93 to 0.96 (where a coefficent of 1.0 indicates complete agreement in rank order). The DIS was, however, calculated without having to consider future discount rates and the salaries for individual occupational groups. For many disease control purposes, the loss of years of life, health, or income equivalents is more easily appreciated than the same loss expressed in dollars.

Ideally, the health status of a population should be measured in terms of suitable indicators of health or wellness rather than in negative measures such as premature death and disability. This concept is embodied in the World Health Organization definition of health as "a state of complete physical, mental and social well-being and not merely the absence of disease and illness" (*19*). In discussing the need for improved indices of health status, Sullivan has noted, however, that the negative aspects of health, illness, and premature death are still major problems in our society, and that illness-related events may reasonably continue to determine the allocation of resources for public health programs (*20*). Our view is that the conflict between measures of illness and wellness is not a serious one when dealing with rates, since rates apply to both the ill and well in the population. Algebraic manipulation suffices to convert one into the other: the illness rate = number ill ÷ (number ill + number well); the wellness rate = number well ÷ (number well + number ill). Because the disease impact scale is intended primarily for use in disease control programs, it was designed to reflect barriers to wellness, rather than to reflect wellness itself.

Indices, such as those of Sullivan (*2*) and Chen (*3*), that measure both mortality and morbidity are more sensitive than mortality statistics alone in reflecting the health status of populations in countries where chronic diseases have supplanted acute diseases as problems of major public health importance. Such indices should be more useful than mortality alone for the intelligent allocation of resources and the evaluation of programs for disease prevention. However, the scales of Sullivan and Chen as presently formulated give assessments for populations only at the national or regional level. Programing for public health, however, also occurs at the State level or within smaller areas such as HSAs (health service areas) or counties. Furthermore, programs usually have some particular orientation, such as a disease or a group of diseases, a target population, risk factor intervention, or a health service or procedure. To establish and evaluate such programs, information is needed that is relevant to the area and the population to be served. The disease impact scale, since it can be calculated for any set of diagnoses by specific time, place, and person categories, should be useful in this respect.

Are all three components of the DIS—morbidity, mortality, and cost—really essential in order for the scale to be a comprehensive measure of disease impact? The combination of the three does give a different perspective than that derived from mortality data alone. This difference in perspectives is reflected in the correlation coefficient obtained by comparing the overall rank order of disease categories when the DIS is used with the order based on mortality alone, which was only 0.66. Disparities in the

overall disease impact and the impact due to mortality will be especially great for diseases like arthritis, (in which most of the impact is in morbidity), and for visual refractive errors (in which the principal impact would stem from the cost of care and eyeglasses). Clearly, all three components make unique contributions to the DIS. For example, the correlation of morbidity with cost was 0.76, whereas the correlation of mortality with cost was only 0.37.

In Minnesota, as in most other States and communities, data on morbidity are less available than cost and mortality information. Although the gap could be filled by using hospital discharge data (available for more than half of Minnesota) together with a State-level household interview survey, this alternative would be expensive. It is estimated that interviewing 3,000 households would cost $600,000 to $800,000.

We intend, therefore, to obtain morbidity data primarily from a statewide system resembling the National Ambulatory Medical Care Survey (*21*). Each day a randomly selected sample of physicians in Minnesota is asked to provide information on all patients seen in the 24-hour period. By asking about the interval since the last physician encounter and the number of previous encounters for the same diagnosis, estimates of incidence, prevalence, and days of disability can be calculated from the encounter data. A computer system for processing the data has been set up, and data collection in Minnesota began in January 1981. It is anticipated that the information thus collected, when supplemented by results of a random telephone survey of households, will replace extrapolations from the national morbidity data in the DIS for Minnesota and that calculations can be carried down to the level of the eight health districts and seven HSAs for the more common disease categories. The smaller counties will be provided with extrapolations from regional data.

An objection sometimes raised to synthetic indices such as the DIS is that the final figure (for example, total years of life lost due to disease X) is too general to be useful, and that a better feeling for the data can be obtained from individal morbidity, mortality, and cost figures. This, of course, is true. Planning and evaluation require examination of the data at many levels, just as in examining a book one proceeds from the title to the table of contents to the text itself. Computation of the DIS does not exclude examination of the component parts. On the contrary, it provides a common structure within which the absence of any component is readily apparent. A book gains focus by having a title, and no one would think of publishing a volume with individual chapter headings displayed on the front page but no overall title. The DIS, as a summary statistic, is meant, then, to point to and illuminate the other levels of data, including morbidity and mortality rates and total costs, age-, sex-, and race-adjusted rates, specific rates and costs, numbers of cases, and other details on which both scientific and political decisions rest. In the end, the deciding element may not be overall disease impact, but rather the cause of disability in a leading rock singer. The disease impact scale does, however, represent an attempt to examine systematically the importance of disease to society before a decision is reached in the planning or evaluation of health programs.

Construction of the DIS requires making more assumptions than in dealing with separate morbidity, mortality, and cost figures but, in return, the DIS allows the ranking of disease states with respect to all three areas at once. Those who disagree with the details of our version may wish to revise the analysis while maintaining two basic concepts: (*a*) the consideration of all three major omponents of disease impact in a uniform framework and (*b*) the use of units that require as few assumptions about the economy as possible. The usefulness and popularity of the DIS will have to be demonstrated over time. We believe its greatest appeal will be to public health workers who are not economists and to decision makers of all kinds who wish to establish their own values for human life and health in different population groups rather than incorporate the assumptions required by economic models.

One proponent of economic measures of health stated, "The value to society of a prime-age worker is different than a retired person's." Those who disagree or wish to re-examine this issue may find the DIS more useful than cost-of-illness estimates, which must incorporate in their final results the economic assumptions of the society that is being measured. The idea that a transfer of dollars accompanies every worthwhile activity of the human race is one assumption that should not be embedded in health statistics.

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SYNOPSIS

DEAN, ANDREW G. (Minnesota Department of Health), WEST, DAVID J., and WEIR, WILLIAM M.: *Measuring loss of life, health, and income due to disease and injury. A method for combining morbidity, mortality, and direct medical cost into a single measure of disease impact, Public Health Reports, Vol. 97, January–February 1982, pp. 39–47.*

The impact of disease on a population includes illness, death, and medical care cost. Information on all three may be combined in a disease impact scale. The disease impact for a given condition can be defined as the sum of (*a*) the years of life lost before age 75 per 100,000 population (adjusted to reflect causes of death up to age 100); (*b*) the person-years of complete disability per 100,000 population, and (*c*) the direct medical costs in years of average annual personal income per 100,000 population.

The sum of (*a*), (*b*), and (*c*)—disease impact in person years per 100,000 population—can be used to compare one disease with another, to estimate the potential effect of programs for risk alteration, and to measure the outcome of planned or accidental changes in society. The data necessary to calculate disease impact are becoming available in many States.

In Minnesota, the total disease impact in 1978 was approximately 26,000 person-years per 100,000 population per year. The disease categories in the International Classification of Diseases, Adapted, Eighth Revision, with the highest disease impact in the State were circulatory diseases (23.7 percent), injury and poisoning (10.9 percent), respiratory system (9.3 percent), neoplasms (9.0 percent), musculoskeletal system and connective tissue (8.8 percent), digestive system diseases (7.5 percent), and nervous system and sense organ diseases (5.8 percent). Circulatory diseases ranked first in morbidity, mortality, and cost, but the rankings for several other categories varied according to the parameter being considered.

Use of a disease impact scale such as the one developed in Minnesota avoids dependence on a single parameter such as mortality or cost in making program decisions. In contrast to economic analyses of disease impact, it does not require estimates of discount rates, future rates of inflation, or salaries for homemakers, students, and children. Although the results of present calculations are only approximate, they provide a methodological framework within which correctable deficiencies in data collection methods are readily apparent. The disease impact scale is intended to be a component of a comprehensive disease surveillance system that includes measures of disease impact, the prevalence of risk factors for diseases, and the availability of health resources.