The Elimination of Disease: A Mixed Blessing

Wayne J. Millar and Gerry B. Hill*

Abstract

The increase in life expectancy that would result from the elimination of certain diseases and the resulting change in hospital utilization vary, depending on the disease. In some cases, life expectancy would rise and total days spent in hospital would decline, while in others, the gain in life expectancy would be accompanied by an increase in hospital days.

For instance, if mental health disorders were eliminated, the increase in life expectancy at age 45 would be minimal: from 34.9 to 35.3 years, but time spent in hospital would decline from 168 to 151 days.

By contrast, if diseases of the circulatory system were eliminated, life expectancy at age 45 would rise from 34.9 to 41.6 years, but time spent in hospital would also rise: from 168 to 209 days.

Elimination of not only mental illnesses but also injuries and poisoning and diseases of the nervous system has the potential of both increasing life expectancy and reducing hospital use.

Keywords: *life table, cause-deleted life table, hospital utilization, health status*

Introduction

In recent decades, mortality rates in Canada have fallen at all ages, even among the elderly. The detailed life tables for 1991 indicate a continued increase in life expectancy.[1] But is a longer life necessarily a healthier life? There is a concern that life may be extended at the cost of increasing illness and the associated health care expenses.[2-4]

The hypothetical deletion of a particular cause of death, or group of causes, from the mortality rates of a life table increases life expectancy estimates (see *Methods)*. (For an overview of life tables and trends in life expectancy, see articles on pages 15 and 23.) The extent of the increase is a measure of the importance of that cause and the potential benefit that could be obtained by eliminating it.

Daniel Bernoulli was the first to use a life table for this purpose. In 1760, he estimated the benefit to be obtained by inoculation against smallpox.[5] A century later, William Farr estimated the effect of deleting various causes from the English life table.[6] The technique has since become well established in demographic and public health circles.[7-10]

If a disease or condition is eliminated, then the hospital days associated with it disappear. But although total life expectancy may increase, time spent in hospital may also rise. This is because the reduction in hospital utilization resulting from the removal of one disease or condition may be more than offset by increased time spent in hospital for others.

* *Wayne J. Millar (613-951-1631) is with the Health Statistics Division and Gerry B. Hill (613-951-4113) is with the Social and Economic Studies Division at Statistics Canada, Ottawa K1A 0T6.*

Methods

Deaths registered in Canada in 1990-92 and revised July 1 population estimates for 1991[11] were used to calculate the death rates. Death rates from all causes, by five-year age group beginning at age 45, were calculated. (Age 45 was chosen because the prevalence of chronic diseases rises substantially after that age.) These rates were then used to calculate life tables according to Greville's method. For selected chapters of ICD-9 and for specific causes of death at age 45 and over, the number of deaths was subtracted from the total number of deaths, and a cause-deleted life table was constructed.[12]

Causes of death are also causes of illness. The causes of all episodes of illness are difficult to capture statistically, but data on days spent in hospital are available by cause for Canada.[a,13] The expectation of life in hospital may be estimated by applying hospital-day utilization rates to the life table population. Thus, the estimates of the number of days in hospital after deleting a cause of illness are based on the mortality and hospital utilization rates experienced in 1991.

Hospital days from all admission diagnoses, by five-year age group beginning at age 45, were calculated. For selected chapters of ICD-9 and for specific causes of hospital admission at age 45 and over, the number of hospital days associated with the admission diagnosis was subtracted from the total number of hospital days. For each age group, disease-deleted hospital-day rates were calculated by dividing the number of hospital days by the population of the age group.

For each age group from 45 on, the product of the hospital-day rate times the life table population (the life table population is the ${}_nL_x$ column in the conventional abridged life table) yields the expected number of hospital days utilized by the age group. The cumulative sum of hospital days from age 45 on represents the total number of hospital days a 45-year-old would experience over his/her remaining lifetime. For example, if deaths from circulatory diseases were eliminated and a cause-deleted life table was constructed, hospital admissions associated with circulatory diseases would also be eliminated. The circulatory-diseases-deleted hospital-day rates would be applied to the population of the circulatory-diseases-deleted life table.

Expectation of life in hospital was calculated by dividing the total number of years in hospital by the total number of life table survivors at age 45 during their remaining life time. Total expectation of life out of hospital was obtained by subtracting the life expectancy in hospital from the cause-deleted life expectancy.

Codes for selected causes of death, International Classification of Diseases, ninth revision, 1975

Cause of death number	ICD
Infectious and parasitic diseases	001-139
Neoplasms	140-239
Colon cancer	*153*
Cancer of trachea, bronchus and lung	*162*
Cancer of breast	*174-175*
Cancer of prostate	*185*
Endocrine, nutritional and metabolic diseases and immunity disorders	240-279
Mental disorders	290-319
Diseases of the nervous system and sense organs	320-389
Diseases of the circulatory system	390-459
Ischaemic heart disease	*410-414*
Cerebrovascular disease	*430-438*
Diseases of the respiratory system	460-519
Diseases of the digestive system	520-579
Diseases of the genito-urinary system	580-629
Diseases of the musculo-skeletal system and connective tissue	710-739
Symptoms, signs and ill-defined conditions	780-799
Injury and poisoning	800-999

[a] *Expectation of life in hospital refers only to general and allied hospitals, which include most acute care, convalescence, and chronic care facilities.*

Extension of life

At age 45, a Canadian can expect to live 34.9 more years (or 12,749 more days) for a total life expectancy of 79.9 years (Table 1). Elimination of various diseases after age 45 would extend life to differing degrees. However, disappearance of the major causes of death—circulatory diseases or neoplasms (hereafter referred to as cancer)—would yield the greatest gains.

Table 1

Expectation of life after elimination of specific diseases or conditions, both sexes, Canada, 1990-92

Disease/condition eliminated	Expectation of life at age 45			
	Total	Out of hospital	In hospital	Ratio (out of hospital: in hospital)
	Days			
None	**12,749**	**12,581**	**168**	**74.9:1**
Mental disorders	12,877	12,726	151	84.3:1
Diseases of nervous system/sense organs	12,841	12,682	158	79.8:1
Injury and poisoning	12,903	12,742	161	79.1:1
Diseases of digestive system	12,899	12,736	163	78.1:1
Diseases of musculo-skeletal system/ connective tissue	12,779	12,617	162	77.9:1
Diseases of genito-urinary system	12,808	12,642	166	76.6:1
Diseases of respiratory system	13,093	12,922	171	75.6:1
Infectious and parasitic diseases	12,786	12,618	168	75.1:1
Endocrine and metabolic diseases and immunity disorders	12,863	12,694	169	75.1:1
Neoplasms	14,100	13,906	194	71.7:1
Diseases of circulatory system	15,173	14,964	209	71.6:1

Source: *Health Statistics Division*

Elimination of circulatory diseases would extend life an additional 6.6 years, so that life expectancy at age 45 would be 41.6 more years (to age 86.6). Elimination of cancer would result in 3.7 more years, and life expectancy at 45 would be 38.6 years (to age 83.6).

Other diseases have far less influence on life expectancy. For example, without diseases of the respiratory system, life expectancy at age 45 would increase by about one year. And for several major disease categories such as mental disorders and diseases of the digestive system, the potential gain amounts to less than half a year; for diseases of the musculo-skeletal system and connective tissue, and infectious and parasitic diseases, the potential increase in life expectancy is about one and a half months.

Quality time?

The relative extension of life potentially gained through the elimination of various diseases is not the whole picture. In some instances, increased life expectancy comes at the cost of more time in hospital.

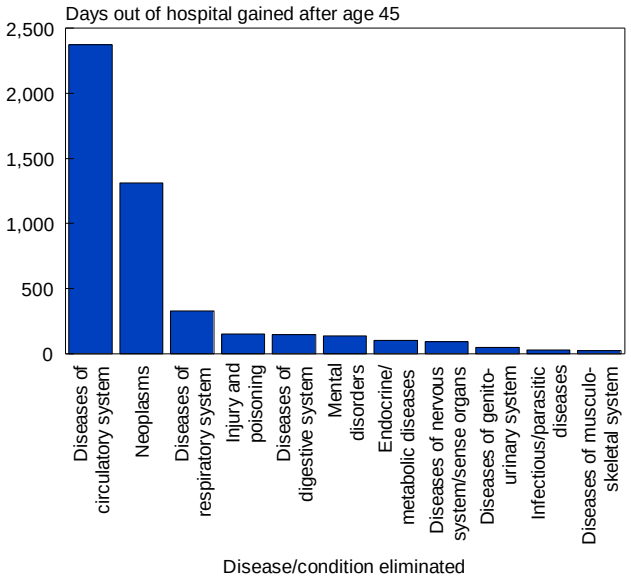
Of the 34.9 years or 12,749 days that a 45-year-old Canadian can expect to live without the elimination of any diseases, 12,581 of those days would be spent out of hospital, and 168 would be spent in hospital—a ratio of 75:1.

The extension of life that results from the elimination of some groups of diseases means that there is a lower ratio of time out of hospital to time in hospital. That is, for every day spent in hospital, there would be fewer out of hospital. This is the case with the two categories whose disappearance promises the greatest extension of life: diseases of the circulatory system and cancer.

Elimination of diseases of the circulatory system raises out-of-hospital life expectancy from 12,581 to 14,964 days, while time in hospital increases from 168 to 209 days (Charts 1 and 2). Thus, the out/in hospital ratio falls from 75:1 to 72:1. The overall extension of life that results from elimination of cancer is somewhat shorter, but this ratio, too, is 72:1.

Chart 1

Days out of hospital gained after elimination of specific diseases or conditions, both sexes, Canada, 1990-92



Source: *Health Statistics Division*

By contrast, the elimination of other groups of diseases or conditions not only prolongs life, but also results in higher out/in hospital ratios. The prime example is mental disorders. Deletion of this category of diseases adds just 128 days to life expectancy at age 45. However, time in hospital actually declines by 17 days (to 151 days), so that days out of hospital total 12,726, and the out/in hospital ratio rises substantially to 84:1. The potential extension of life from elimination of diseases of the nervous system and sense organs is less, but the pattern is the same, yielding an out/in hospital ratio of 80:1. As well, ratios of 78:1 or better result from the exclusion of injury and poisoning, diseases of the musculo-skeletal system and connective tissue, and diseases of the digestive system.

Finally, elimination of some diseases increases life expectancy, but leaves the out/in hospital ratio almost unchanged. For example, without endocrine diseases, life expectancy out of hospital rises to 12,694 days, and in hospital to 169 days, so that the ratio is maintained at 75:1. For infectious and parasitic diseases, diseases of the respiratory system, and diseases of the genito-urinary system, the ratio ranges from 75:1 to 77:1.

The out/in hospital ratios that result from eliminating broad disease categories do not necessarily reflect the ratios that prevail for specific diseases within these categories. For instance, the exclusion of ischaemic heart disease, a subcategory of diseases of the circulatory system, raises time out of hospital to 13,625 days and in hospital to 198 days (Table 2). The ratio is, therefore, 69:1, even lower than the ratio for the elimination of circulatory diseases overall (72:1). But at the same time, elimination of cerebrovascular disease, another subcategory of the same broad group, would increase time out of hospital to 12,881 days and actually reduce time in hospital to 160 days. The resulting ratio is 81:1.

Table 2

Expectation of life after elimination of specific circulatory diseases or neoplasms, both sexes, Canada, 1990-92

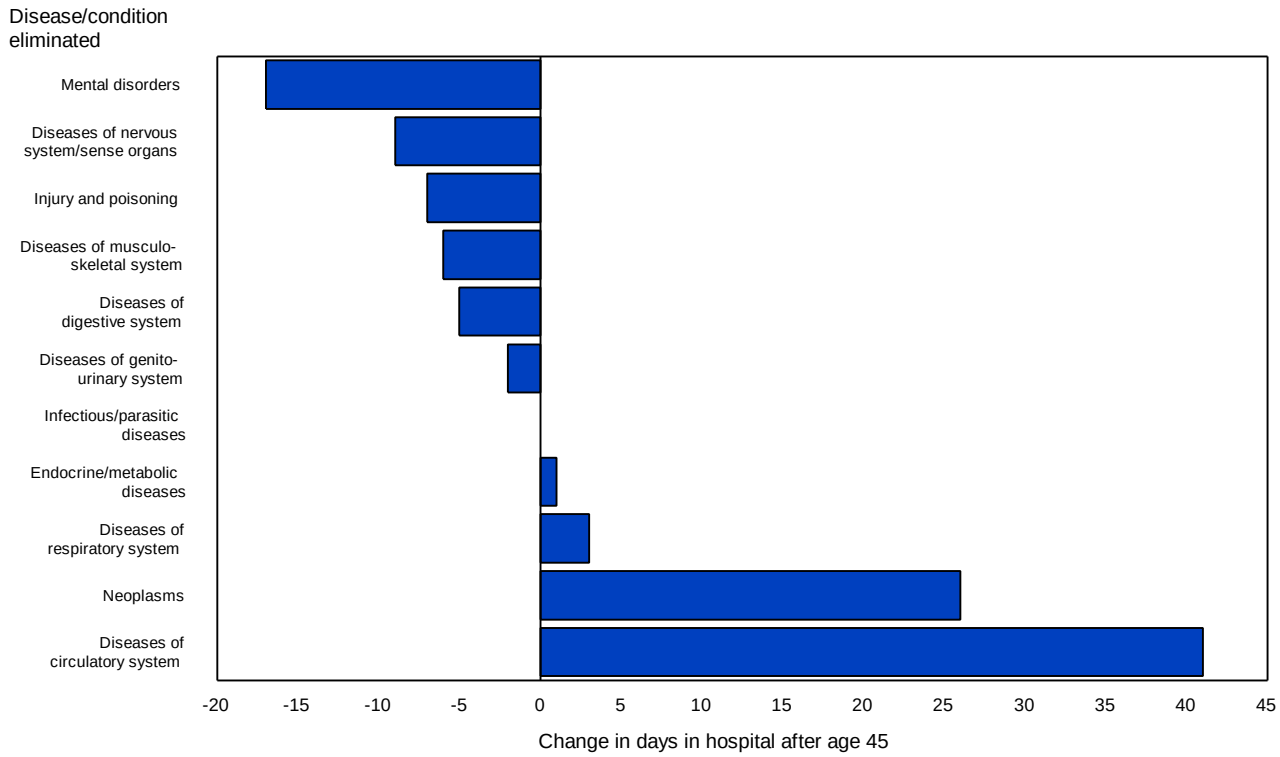
Disease eliminated	Expectation of life at age 45			
	Total	Out of hospital	In hospital	Ratio (out of hospital: in hospital)
	Days			
None	**12,749**	**12,581**	**168**	**75.0:1**
Diseases of circulatory system	15,173	14,964	209	71.6:1
Ischaemic heart disease	13,823	13,625	198	68.8:1
Cerebrovascular disease	13,041	12,881	160	80.5:1
Neoplasms	14,100	13,906	194	71.7:1
Lung cancer	13,089	12,913	176	73.4:1
Breast cancer*	12,855	12,685	170	74.6:1
Colon cancer	12,848	12,678	170	74.6:1
Prostate cancer*	12,815	12,646	169	74.8:1

Source: *Health Statistics Division*

* *Breast cancer and prostate cancer are sex-specific. The analysis was conducted separately for males and females. However, since the focus is on broad implications for hospital use, the data are presented for both sexes combined.*

Chart 2

Change in days in hospital after elimination of specific diseases or conditions, both sexes, Canada, 1990-92



Source: *Health Statistics Division*

On the other hand, the ratios resulting from the exclusion of lung, colon, breast, and prostate cancer all exceed the ratio for cancer overall (72:1).

Discussion

Historically, the view has been that disease prevention will reduce the need for health care, but the experience of the last 50 years indicates that as the importance of some diseases as causes of death declines, others—typically chronic diseases and conditions—take their place and entail higher health care costs.[14] Thus, if health promotion programs successfully reduce the prevalence of some leading causes of death, there is potential for an increased burden of chronic illness. But from the point of view of the public, the gain of six and a half years of life that might result from the elimination of diseases of the circulatory system would almost certainly be worth the additional 41 days spent in hospital.

These results are consistent with a British study that assigned varying reductions in mortality and hospital morbidity within a life table model to assess future health care costs.[15] Although there was an implied increase in the number of hospital days, the study concluded that the size of the increase would not necessarily overwhelm existing resources.

These findings also suggest that injuries and mental disorders are under-recognized public health problems. The prevention or effective treatment of these two disease categories provides opportunities for reducing morbidity and mortality and for realizing savings in both financial and human terms.[16,17]

However, some potential problems with this analysis must be stressed. The deletion of various causes of death and hospitalization is a mechanical procedure based on a set of assumptions. People may suffer from several diseases, especially at older ages, and it is often difficult to be sure which was the underlying cause of death or hospital admission.

Moreover, the cause-deleted life tables are based on the assumption that elimination of mortality and morbidity associated with one disease leaves an individual at unchanged risk for other diseases. In practice, this may not be tenable.[18] Some diseases are risk factors for others, so their elimination would result in lower death rates than those appearing in the cause-deleted tables. For example, prevention of atherosclerosis may enhance brain function in later life, with a consequent reduction in behavioural pathology and mental deficit at older ages. Similarly, prevention of cerebrovascular disease could reduce the prevalence of the physical disabilities associated with it.[19]

As well, the greater the hypothetical extension of life, the weaker the estimate may be. For instance, the relatively short estimated gain from elimination of deaths due to injuries may be more accurate than the much longer gains resulting from elimination of circulatory diseases or cancer.

Another underlying assumption is that current age-specific hospital-day utilization rates will persist. This is unlikely, as changes in medical technology, drug therapy, and health care economics may shorten hospital stays. Many surgical procedures that previously required lengthy hospitalization have been modified, resulting in much shorter stays.[20] In addition, day surgery, which does not entail hospital admission, is increasing.

This analysis does not assess the quality of life beyond making the assumption that days out of hospital have higher quality than those in hospital. However, all hospital days are not equal in terms of individual suffering or financial cost, and being in hospital is not the only form of morbidity. It is possible to suffer considerable disability outside hospital. For example, arthritis, the most common chronic condition in middle and late life, is also the most frequently cited cause of limitations, but it does not appear prominently in hospital care statistics.[21]

To overcome limitations in life table methodology, it would be necessary to develop measures of disability for the various stages of each disease, capture the corresponding statistics at the population level, and formulate plausible assumptions about the development of treatment strategies that could influence overall hospital-day utilization.[22]

The use of current mortality and hospital morbidity rates to develop cause-deleted life table models implicitly assumes that mortality and morbidity rates will remain unchanged in the future, except for the hypothetical deletions. Therefore, this analysis applies only to the current situation.

Ideally, estimates of the costs and benefits of disease elimination should be based on a longitudinal rather than a cross-sectional design. In the long run, policymakers will need such information if they are to address the balance between quantity and quality of life and the willingness or capacity to pay the health care costs associated with the choices that are made.

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