COMMENTARY

Declining Cancer Mortality in the United States

Philip Cole, M.D.[1]
Brad Rodu, D.D.S.[2]

[1] Department of Epidemiology, School of Public Health, University of Alabama at Birmingham, Birmingham, Alabama.
[2] Department of Diagnostic Sciences, School of Dentistry, University of Alabama at Birmingham, Birmingham, Alabama.

BACKGROUND. The overall age-adjusted cancer mortality rate had been increasing in the United States for as long as such statistics have been kept. This trend was reversed and a decline in cancer mortality began in 1991.

METHODS. Vital statistics of the United States provided annual age-adjusted mortality rates for all forms of cancer and for lung carcinoma. Information from the Surveillance, Epidemiology, and End Results Program was also used to evaluate the effects on mortality of declining 5-year cancer case fatality.

RESULTS. The overall age-adjusted cancer mortality rate declined in each succeeding year from 1990 to 1995 for a total reduction of about 3.1%. A major reduction occurred in lung carcinoma, which declined by 3.9%. Other smoking-related cancers declined by about 2%. The 5-year case fatality declined by approximately 0.5% per year from 1950–1954 to 1986–1991 for forms of cancer for which lead-time bias could be largely excluded.

CONCLUSIONS. Both cancer prevention activities, especially those directed against smoking, and improvements in medical care have produced an appreciable reduction in cancer mortality in the United States. The nature of these changes suggests that the now ongoing decline will be sustained for the immediately foreseeable future. [See Editorial on pages 2045–8, this issue.] ***Cancer* 1996; 78:2045–8.**

KEYWORDS: cancer, epidemiology, mortality, cancer control.

For as long as such statistics have been kept in the United States (US), the overall age-adjusted cancer mortality rate had been increasing. However, from 1990 to 1995, there occurred for the first time a continuous and sustainable decline in cancer mortality in the U.S. This article describes the decline and suggests major reasons for it.

METHODS

Three principal sources of information were used. The proportion of all deaths attributed to cancer (the cancer proportional mortality [CPM]) and mortality rates for 1970 to 1990 are from the Vital Statistics of the United States[1–3] and for 1991 to 1995 from the Monthly Vital Statistics Reports of the U.S. Centers for Disease Control and Prevention (CDCP).[4] Mortality rates for 1994 and 1995 only are based on the Current Mortality Sample, a 10% sample of all deaths in the U.S. All

Presented in part to the Executive Committee of the American Cancer Society, Baltimore Maryland, August 10, 1996.

Supported by an award from the Shell Oil Company Foundation.

Address for reprints: Dr. Philip Cole, 221 TH, University Station, Birmingham, AL 35294-0008.

Received August 16, 1996; revision received August 28, 1996; accepted August 30, 1996.

mortality rates in this report relate to the total U.S. population. Nearly all the rates are adjusted to the U.S. standard million age distribution of 1940.[5] The only exceptions are the three cancer rates for 1995; we estimated each of those rates from the crude rate for 1995 and from the relationship of the corresponding age-adjusted rate to the crude rate in 1994. The category "lung cancer" in this report relates to "malignant neoplasms of respiratory and intrathoracic organs," International Classification of Diseases, categories 160–165. Greater than 95% of deaths in this category are due to lung cancer and almost 4% are due to cancer of the larynx.

The 5-year case fatality statistics are from the Surveillance, Epidemiology, and End Results Program of the U.S. National Cancer Institute.[6,7] Information for the 12 most common forms of cancer (lung, colon and rectum, breast, prostate gland, pancreas, kidney, bladder, stomach, central nervous system, ovary, the leukemias, and non-Hodgkin's lymphoma) and for carcinoma of the cervix was used to evaluate the long term (1950–1954 to 1986–1991) decline in the cancer 5-year case fatality. These 13 forms of cancer account for approximately 80% of all cancer deaths. To try to separate the effects of improved medical care (including screening, diagnosis, and treatment) from lead-time bias, 9 forms (or subcategories of forms) of these 13 cancers were selected for which, in our judgment, lead-time bias would have been minimal during the 1950–1991 interval. These were: pancreas carcinoma, regional and local; lung carcinoma, regional; stomach carcinoma, regional and local; all forms of non-Hodgkin's lymphoma; central nervous system cancer; kidney carcinoma; and the leukemias.

RESULTS

The CPM was 4% in 1900, the first year for which a meaningful estimate is available. It increased steadily thereafter, at least until 1990.[1–3,5] Table 1 shows the CPM for 1970, 1980, and for 1990 through 1995. The CPM has currently stabilized at approximately 23%. The CPM is not age-adjusted and its long term increase was due largely to the aging of the population. The increase also reflected reductions in deaths from atherosclerotic heart disease and cerebrovascular disease. Nonetheless, the proportional mortality of a group of diseases indicates the group's relative importance to a society over any short time interval. The now nearly constant CPM indicates that the impact of cancer in the U.S. has stabilized.

The mortality rate for all causes of death in Table 1 describes the well established reduction in overall mortality and gives perspective to the drop in cancer rates. From 1990 to 1995, the rate for all causes declined from 520 to 503 deaths per 100,000 person-years (py), a reduction of approximately 0.7% per year. The all-cancer mortality rate peaked at 135.0 in 1990 and declined in each subsequent year to 130.8 in 1995. The total drop in cancer mortality of 4.2 deaths per 100,000 py represents an average reduction of 0.6% per year. Table 1 indicates that 40% of the decline in the cancer mortality rate, or 1.6 deaths per 100,000 py, resulted from a reduction in lung carcinoma mortality. The remainder was due to declines in many other forms of cancer, a fall of 2.6 deaths per 100,000 py in the mortality rate for "other cancer."

From 1950–1954 to 1986–1991 (36 years, midpoint to midpoint) the 5-year case fatality for all forms of cancer declined by about one-third from 70% to 50%. A reduction in case fatality is difficult to interpret for several reasons, the major one being that cases diagnosed more recently tend to be diagnosed earlier in their course.[7] This produces both a real survival advantage and a lead-time bias when the survival of recently diagnosed patients is compared with that of patients diagnosed decades earlier. That is, the more recent patients actually do survive longer because they are diagnosed earlier and because they receive more advanced medical treatment.[8] However, the gain in survival is exaggerated because earlier diagnosis introduces "lead-time bias," the result of starting the clock earlier in estimating the duration of survival. This bias was addressed by evaluating the 5-year case fatality among a subgroup of 9 cancers (or forms of cancer) that are least likely to have come to be diagnosed earlier. Among these 9 disease entities, there was a reduction in case fatality from 84% in 1950–1954 to 68% in 1986–1991. This amounts to a 19% decline in case fatality over 36 years, or approximately 0.5% per year. This rate of improvement would have reduced the all-cancer mortality rate annually by about 0.6 deaths per 100,000 py, or 3 deaths from 1990 to 1995.

DISCUSSION

Smoking is the major known cause of cancer, particularly lung carcinoma, and its prevalence began a long term downward trend in 1965. It was inevitable that lung cancer incidence and mortality rates would begin to decline some 20 or so years later. In fact, lung cancer mortality peaked in 1990 and by 1995 had declined by 1.6 deaths per 100,000 py. This reduction in lung carcinoma underlies the downturn in the all-cancer mortality rate because other-cancer mortality has been declining since at least the early 1970s.[7]

Reductions in smoking reduce mortality from other cancers as well as from lung carcinoma. The CDCP estimated the contribution of smoking to the causation of several forms of cancer.[9] Based on those

TABLE 1
Cancer Proportional Mortality and Age-Adjusted Mortality Rates[a] by Cause and Year: U.S. Total Population

Year	CPM (%)	All causes	All cancer	Lung cancer	Other cancer
1970	17	714	129.9	28.4	101.5
1980	21	586	132.8	36.4	96.4
1990	24	520	135.0	41.4	93.6
1991	24	514	134.5	41.1	93.4
1992	24	505	133.1	40.8	92.3
1993	23	513	132.6	40.8	91.8
1994	24	508	132.1	40.1	92.0
1995	23	503	130.8	39.8	91.0
1990–1995 Reduction					
Total[a]	—	17	4.2	1.6	2.6
Annual[a]	—	3.4	0.8	0.3	0.5
Annual (%)	—	0.7	0.6	0.7	0.5

CPM: cancer proportional mortality.
[a] Deaths per 100,000 person-years.

estimates, and on the observed reduction in lung carcinoma, we suggest that the decline in smoking reduced deaths from other cancers by about 0.4 deaths per 100,000 py from 1990 to 1995. Cancer prevention activities other than smoking control also have had an effect on cancer mortality. For example, Landrigan et al. recently described successful cancer prevention in the workplace.[10] The effects of these other prevention activities have not been quantified. However, we suggest that those effects are real but modest and would represent a decline of approximately 0.4 deaths per 100,000 py over the 1990–1995 interval. This is consistent with the recent estimate of Trichopoulos et al. that cancer prevention in the workplace has lowered overall cancer mortality by approximately 5% over the last 40 years or so.[11] The collective improvements in medical care reduced cancer case fatality and produced an estimated decline of about 3 deaths per 100,000 py from 1990 to 1995.

The mortality reductions just described are summarized in Table 2. The estimated total reduction in the cancer mortality rate, 5.4 deaths per 100,000 py from 1990 to 1995, is greater than that observed, namely 4.2. The discrepancy of 1.2 deaths per 100,000 py may have been produced by our overestimation of some of the effects, particularly that ascribed to reduced case fatality. Whether or not some effects have been overestimated, it is likely that real declines in mortality from reduced case fatality were offset by a concomitant increase in cancer incidence rates. Recent reports point to increases in cancer incidence in the U.S.[7,12] However, the magnitude of the increases and inconsistencies among the reports suggest that the specific figures available are unreliable. Furthermore, recent incidence rates reflect, at least to some degree, the increasing use of more sensitive cancer screening tests[12] and other difficulties inherent to measuring cancer incidence.[13,14] Nonetheless, a plausible true increase of only 0.2% per year in the incidence rate would have been sufficient to increase cancer mortality by approximately 1.2 deaths per 100,000 py over the interval 1990–1995 and so explain the discrepancy in Table 2.

TABLE 2
Estimated Reduction in Cancer Mortality Rate by Source: U.S. Total Population: 1990–1995

Source	Reduction[a]
Reduced smoking	−2.0
Lung cancer (−1.6)	
Other cancer (−0.4)	
Other prevention	−0.4
Reduced case fatality	−3.0
Total estimated	−5.4
Observed	−4.2
Discrepancy	−1.2

[a] Deaths per 100,000 person-years.

In 1992 Doll reviewed the war against cancer using data primarily from the United Kingdom.[15] He concluded that genuine but slow progress was being made. He also suggested that progress due to advances in medical care had been minimal and that efforts at prevention should be increased. The more recent information from the U.S., presented here, suggests that progress against cancer may now be described as at least moderate, and that both prevention and improved medical care have made major contributions. These observations are fully consistent with

those of Doll. Furthermore, unless there is a surge in incidence rates, the decline of cancer mortality now proceeding in the U.S. is likely to continue for at least 20 years and may accelerate. It will continue because we are just beginning to see the effects of long term reductions in smoking and of reduced exposure to other lifestyle carcinogens (e.g., alcohol and solar radiation) and to some industrial agents. The decline may accelerate as the now rising lung carcinoma mortality rates among women stabilize and then decline and as further advances in cancer screening, diagnosis, and treatment occur and become more widely available.

NOTE ADDED IN PROOF

Updated information from the CDCP indicates that the age-adjusted mortality rates for all-cancer for the years 1994 and 1995 are 131.5 and 129.8 per 100,000 py, respectively.

REFERENCES

1. Vital Statistics of the United States. Volume II- Mortality, Part A, 1970. Rockville, MD: U.S. Department of Health, Education, and Welfare, National Center for Health Statistics, 1974.
2. Vital Statistics of the United States. Volume II- Mortality, Part A, 1980. Hyattsville, MD: U.S. Department of Health and Human Services, National Center for Health Statistics, 1985.
3. Vital Statistics of the United States. Volume II- Mortality, Part A, 1990. Hyattsville, MD: U.S. Department of Health and Human Services, National Center for Health Statistics, 1994.
4. Monthly Vital Statistics Report, Volumes 42–45. Hyattsville, MD: U.S. Department of Health and Human Services, National Center for Health Statistics, 1993 to 1996.
5. Grove R, Hetzel A. Vital Statistics Rates in the United States 1940–1960. Washington DC: National Center For Health Statistics, Public Health Service, 1968.
6. End Results in Cancer. Report No. 3. Bethesda, MD: National Cancer Institute, 1968.
7. Ries L, Miller B, Hankey B, Kosary C, Harras A, Edwards B, editors. SEER Cancer Statistics Review, 1973–1991: Tables and Graphs. Bethesda (MD): National Cancer Institute; 1994. NIH Pub. No. 94-2789.
8. Cole P, Morrison A. Basic issues in population screening for cancer. *J Natl Cancer Inst* 1980;64:1263–72.
9. Cigarette smoking-attributable mortality and years of potential life lost—United States 1990. *MMWR Morb Mortal Wkly Rep* 1993;42:645–8.
10. Landrigan P, Markowitz S, Nicholson W, Baker D. Cancer prevention in the workplace. In: Greenwald P, Kramer B, Weed D, editors. Cancer prevention and control. New York: Marcel Dekker, Inc., 1995:393–410.
11. Trichopoulos D, Li FP, Hunter DJ. What causes cancer? *Sci Am* 1996;275:80–7.
12. Devesa S, Blot W, Stone B, Miller B, Tarone R, Fraumeni J Jr. Recent cancer trends in the United States. *J Natl Cancer Inst* 1995;87:175–82.
13. Bailar JC, Smith EM. Progress against cancer? *N Engl J Med* 1986;314:1226–32.
14. The cancer epidemic: fact or misinterpretation? *Lancet* 1992;340:399–400.
15. Doll R. Are we winning the war against cancer? A review in memory of Keith Durrant. *Clin Oncol* 1992;4:257–66.