How many deaths have been avoided through improvements in cancer survival?

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Abstract

Objective To estimate how many deaths from cancer have been avoided in England and Wales because of recent improvements in survival.
Design Analysis of national statistics.
Setting England and Wales.
Subjects 1.5 million adults with diagnosis of one of 47 different cancers during 1981-5 or 1986-90.
Main outcome measures Reduction in number of cancer deaths within five years of diagnosis among patients with cancer diagnosed during 1986-90 compared with patients with cancer diagnosed during 1981-5.
Results 17 041 deaths were avoided within five years of diagnosis among patients with cancer diagnosed during 1986-90. This represents 3.3% of the cancer deaths that would have been expected if survival had been the same as for patients with cancer diagnosed during 1981-5. Two thirds of the avoided deaths arose from improvements in survival for just five cancers: female breast cancer (4822), cancers of the colon (2560), rectum (1090), and bladder (1157), and melanoma of the skin (1098). The largest proportionate reductions in excess deaths were for melanoma of the skin (23%) and cancers of the testis (17%) and bone (17%). About 12 000 (70%) of the avoided deaths arose among adults aged under 75 at death. Improvements in survival from cancers of lung, prostate, stomach, ovary, and brain were small: they accounted for 33% of all cancers but only 11% of avoided deaths.
Conclusions Small gains in survival from common cancers save more lives than larger gains for uncommon cancers. If recent rates of improvement in cancer survival continue, about 24 000 deaths within five years of diagnosis would be avoided in patents aged under 75 by the year 2010, representing about a quarter of the government's overall target of 100 000 fewer cancer deaths.

Introduction

In July 1999 the government set a target to reduce mortality from cancer in people aged under 75 in England by at least 20% by the year 2010, estimating that up to 100 000 deaths would be avoided over the next decade.[1] About half of all cancers in England arise in people under 75: in 1997, the baseline year for the target, the death rate for people under 75 was 150 per 100 000, and there were 68 400 deaths.[2] The technical supplement to the strategy suggests that improvements in cancer survival as a result of screening and better treatment would be expected to deliver about 40% of the total reduction in cancer deaths (Gina Radford, Public Health Development Unit, NHS Executive, personal communication). Cancer survival improved fairly steadily between 1971 and 1995,[3] and these survival trends can be used to estimate the potential contribution to the government's target of further gains in survival.

Subjects and methods

Trends in cancer survival up to 1995 have recently been reported for 2.9 million adults in England and Wales who had cancer diagnosed between 1971 and 1990.[3] Patients were categorised by type of cancer, sex, age at diagnosis (15-39, 40-49, 50-59, 60-69, 70-79, and 80-99 years), and deprivation category of their census enumeration district of residence at diagnosis (quintiles of the Carstairs score[4] for Great Britain around the 1981 and 1991 censuses). Relative survival up to five years after diagnosis was estimated for patients categorised by time of diagnosis (1971-5, 1976-80, 1981-5, and 1986-90) by means of a STATA algorithm based on methodology developed by Estève et al[5] and reported for each type of cancer, sex, age at diagnosis, and deprivation category.

We carried out further analyses of these results to estimate how many cancer deaths were avoided within five years of diagnosis among patients with cancer diagnosed during 1986-90 as a result of their survival rates being higher than those of patients who had cancer diagnosed during 1981-5. We calculated avoided deaths as the difference between the observed and expected excess cancer mortality. We estimated the observed excess mortality for each type of cancer, age, and sex as the complement of the five year relative survival for patients diagnosed during 1986-90 multiplied by the total number of patients and summed over all groups. We estimated the expected excess mortality in similar fashion using the survival rates for patients diagnosed during 1981-5 (for further details, see extended description of methods on the *BMJ*'s website).

Editorial by Dickinson

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Further details of the study methods and an extra table of results appear on the BMJ's website

Results

Of the 782 602 adults with one of 47 types of cancer diagnosed during 1986-90 in England and Wales, 541 976 died within five years of diagnosis. This represents 497 915 more deaths than would have been expected in the general population. An additional 17 041 cancer deaths would have been expected among these patients if there had been no improvement in cancer survival over the previous five years (see table). These deaths avoided within five years of diagnosis represent 3.3% of the overall excess mortality.

The largest number of avoided deaths arose for breast cancer in women (4822), representing an 11% reduction in the excess mortality that would have occurred within five years of diagnosis if survival had not improved. More than 1000 deaths were also avoided from cancers of the colon (2560, 6% of excess deaths), bladder (1157, 6%) and rectum (1090, 4%) and from melanoma of the skin (1098, 23%) (fig 1). Comparatively few deaths were avoided by improvements in survival from cancers of the lung (326 deaths, 0.2%), stomach (627, 1.6%), or prostate (294, 1%), for which survival had hardly improved since the previous five year period.

The largest proportional reductions in excess deaths were for melanoma of the skin (23%) and cancers of the testis (17%) and bone (17%). For another five cancers (Hodgkin's disease and malignancies of the breast, thyroid, eye, and penis), better survival also led to a 10-12% reduction in excess deaths. For each of these cancers, five year survival for patients diagnosed during 1986-90 rose by a similar amount (3-4%) and to a figure in the range 66-72%. This led to over 4800 avoided deaths from breast cancer, but only 415 avoided deaths from the other four cancers combined, because they are much less common (table). The proportion of avoided deaths depends both on the initial survival rate and on the extent to which it improved with time. The actual number of avoided deaths also depends on the frequency of the cancer.

The pattern of avoided deaths by age at diagnosis varied widely for cancers of the breast, colon, and lung and melanoma (fig 2) (details for other cancers appear

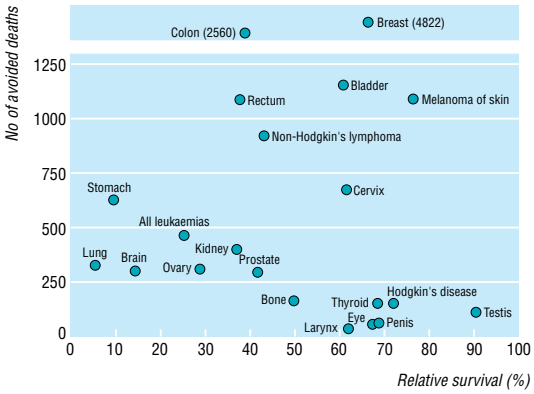

Fig 1 Five year survival for patients with cancer diagnosed in 1986-90 and number of deaths avoided within five years of diagnosis as a result of improvements in survival compared with patients with cancer diagnosed during 1981-5

Deaths from selected cancers within five years of diagnosis among adults in England and Wales with cancer diagnosed during 1986-90, and deaths avoided due to improved survival compared with patients with cancer diagnosed in 1981-5

		Five year survival rate (%)†		No of excess deaths‡		No (%) of avoided deaths§
Cancer (ICD-9 code)	No of patients*	1981-5	1986-90	Observed	Expected	
Breast (women) (174)	116 883	61.5	65.6	39 686	44 507	4 822 (10.8)
Colon (153)	68 481	34.9	38.7	42 083	44 643	2 560 (5.7)
Bladder (188)	49 318	58.3	60.7	19 413	20 570	1 157 (5.6)
Melanoma (172, 187.7)	15 940	69.6	76.4	3 756	4 855	1 098 (22.6)
Rectum (154)	44 388	35.0	37.5	27 818	28 907	1 090 (3.8)
Non-Hodgkin's lymphoma (200, 202)	23 719	38.9	42.8	13 583	14 509	926 (6.4)
Cervix (180)	19 108	57.7	61.3	7 401	8 080	679 (8.4)
Stomach (151)	43 585	8.0	9.5	39 500	40 127	627 (1.6)
All leukaemias (204-8)	17 757	22.2	25.1	11 577	12 042	465 (3.8)
Kidney (189)	15 170	34.1	36.8	9 605	10 004	400 (4.0)
Lung (162)	146 075	5.1	5.3	138 294	138 620	326 (0.2)
Ovary (183)	21 241	26.7	28.2	15 249	15 561	311 (2.0)
Brain (191)	12 001	11.4	13.9	10 156	10 454	298 (2.8)
Prostate (185)	51 910	40.8	41.4	30 431	30 725	294 (1.0)
Bone (170)	1 630	39.3	49.7	822	989	167 (16.9)
Hodgkin's disease (201)	5 021	68.8	72.0	1 406	1 558	151 (9.7)
Thyroid (193)	3 583	64.2	68.3	1 134	1 285	151 (11.8)
Testis (186)	5 581	88.2	90.2	544	656	112 (17.1)
Eye (190)	1 737	65.3	68.4	542	601	59 (9.8)
Penis (187.1-187.4)	1 325	63.2	67.3	433	487	54 (11.1)
Larynx (161)	8 787	61.5	61.9	3 351	3 380	30 (0.9)
All other malignancies¶	109 362			81 131	82 396	1 265 (1.5)
All malignancies (140-208)	782 602			497 915	514 957	17 041 (3.3)

*Adults (aged 15-99 years) with cancer diagnosed during 1986-90 who were included in survival analyses.
†Standardised for age and sex for patients with cancer diagnosed during 1981-5 and 1986-90.
‡Deaths in excess of general population mortality within five years of diagnosis among patients with cancer diagnosed during 1986-90. Observed=actual number; expected=estimated number if patients experienced same survival as those with cancer diagnosed during 1981-5 (see text for details).
§Difference between observed and expected excess deaths (percentage of expected deaths). Discrepancies in totals or subtractions are due to rounding of estimated numbers.
¶Breast cancer in men and 26 other cancers.

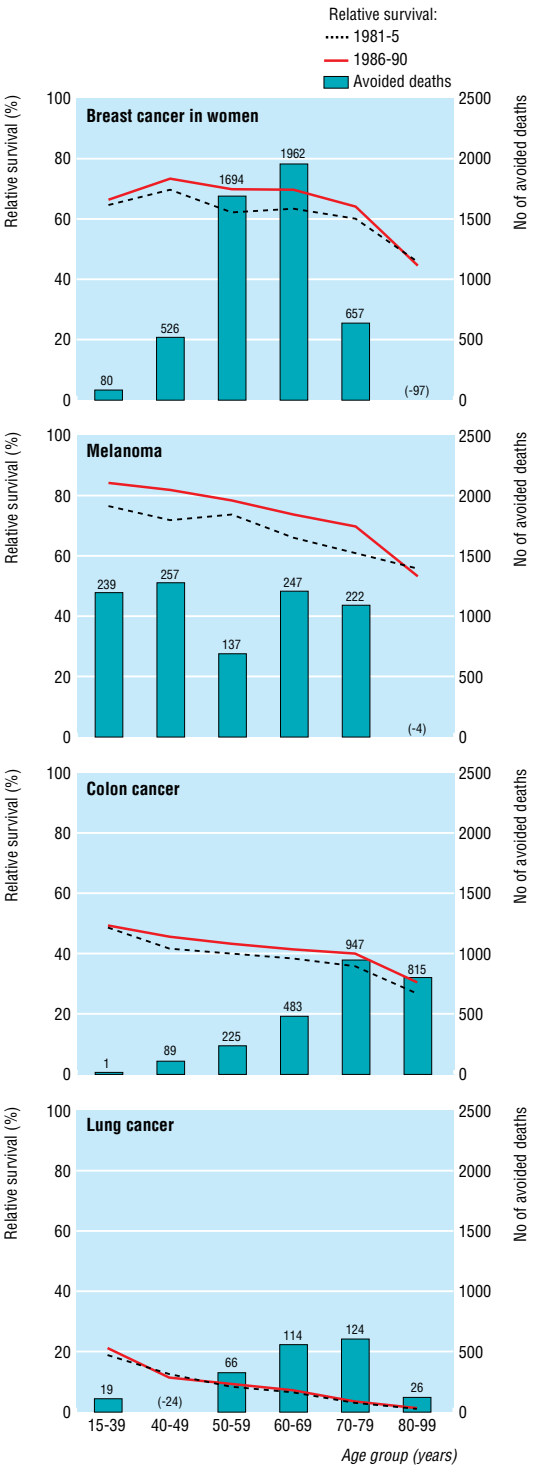

Fig 2 Changes in five year survival and number of deaths avoided within five years of diagnosis for patients with cancer diagnosed in 1986-90, by patients' age for selected cancers

in an extra table on the *BMJ*'s website). Three quarters (76%) of the 4822 deaths avoided among women with breast cancer arose among those aged 50-69 at diagnosis, for whom excess mortality within five years of diagnosis fell by 18-19%, proportionately about twice as much as for either younger or older patients. The increase in survival from colon cancer was similar in all age groups over 40, but more deaths were avoided in older patients, in whom the disease is much more common. For all cancers combined, about 12 000 of the 17 000 deaths avoided arose among adults aged under 75 at diagnosis (the age range targeted by government).

For the less common cancers, there were too few deaths in many subgroups to obtain stable estimates of avoided deaths by sex, age, and deprivation category. For the most common cancers, adjustment for trends in age-specific survival rates within each deprivation category reduced the estimated total of avoided deaths by about 10% (data not shown).

Discussion

Cancer patients have higher mortality than the general population, but they do not all die from cancer. Improvements in cancer survival save lives, in the sense that more cancer patients will turn out to have a normal life expectancy after treatment. Improvements in survival can therefore be measured by the extent to which this excess mortality—the number of deaths among cancer patients in excess of normal mortality—falls with time.

For those common cancers that are still almost invariably fatal (such as lung and stomach), there will have to be a fall in incidence if the target reduction in deaths is to be achieved. Some progress will occur without any further action by government, however, because death rates from three of the most common cancers are already falling. Survival from lung and stomach cancer has changed little, but fewer new cases are occurring.[2] Improvements in survival can also lead to fewer cancer deaths even when the annual number of new cases is stable or rising. The fall in deaths from breast cancer,[6] for example, is occurring despite an underlying rise in incidence. This is due to improved survival from a combination of earlier diagnosis[7] and (for women aged 50-64) the breast screening programme (S M Moss, personal communication), and better treatment.[8]

Our analyses suggest that the higher survival rates experienced by patients in England and Wales with cancer diagnosed during 1986-90 (compared with survival rates for patients with cancer diagnosed five years earlier) led to a reduction of 3% in excess mortality, or about 17 000 fewer deaths within five years of diagnosis.

Future gains in survival cannot be predicted with any certainty: even a small improvement in survival for one or more common cancers—such as those of lung, stomach, oesophagus, or prostate—would have a major impact on avoided deaths. Conversely, if no such gains occur and if the recent pace of improvement in survival for other cancers is not maintained, the future reduction in cancer deaths would be much smaller. However, given the overall regularity with which survival for all cancers combined has improved during the 25 years up to 1995,[3] recent gains can be used as the basis for a rough estimate of the extent to which future improvements in survival might contribute to the government's target of fewer cancer deaths by 2010. If excess mortality were to continue falling for patients diagnosed during 1996-2010 as it has done for patients diagnosed during 1981-90—that is, by about 3% every five years—then a further 6% fall would

What is already known on this topic

Survival is known to be improving for many (but not all) cancers in England and Wales

There have been no previous estimates of the number of deaths avoided as a result of improvements in cancer survival

What this study adds

Higher survival rates experienced by patients in England and Wales with cancer diagnosed during 1986-90 (compared with those for cancers diagnosed five years earlier) reduced excess mortality by 3%, or about 17 000 fewer deaths within five years of diagnosis

If recent rates of improvement in cancer survival continue, there should be some 24 000 fewer deaths in people aged under 75 by 2010, representing about a quarter of the government's target of 100 000 fewer cancer deaths in people under 75 by the year 2010

occur, leading to some 34 000 fewer deaths overall within five years of diagnosis by the year 2010, of which some 24 000 would be in people aged under 75. This represents about a quarter of the government's overall target "to reduce the death rate from cancer in people under 75 years by at least a fifth by 2010—saving up to 100 000 lives in total."[1]

It is too early to assess the impact on national cancer survival rates of the reorganisation of cancer treatment services under way since 1995 (the "Calman-Hine process"[9]), but if inequalities in cancer survival were substantially reduced by this process, it would have a major additional impact on avoided deaths. Survival rates for patients with cancer diagnosed in England and Wales during 1986-90 and followed up to the end of 1995 suggest that some 12 700 deaths within five years of diagnosis would be avoided over five years if there were no socioeconomic inequalities in survival.[3] Eliminating these inequalities would greatly improve the chances of achieving the government's target of 100 000 fewer deaths in cancer patients aged under 75 by 2010.

Contributors: MAR and MPC developed the initial idea for estimating avoided deaths. PB and DS contributed substantially to the study design and carried out all the analyses. All four authors wrote the paper. MPC is the guarantor for the study.

Competing interests: None declared.

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Relation between income inequality and mortality in Canada and in the United States: cross sectional assessment using census data and vital statistics

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Abstract

Objective To compare the relation between mortality and income inequality in Canada with that in the United States.

Design The degree of income inequality, defined as the percentage of total household income received by the less well off 50% of households, was calculated and these measures were examined in relation to all cause mortality, grouped by and adjusted for age.

Setting The 10 Canadian provinces, the 50 US states, and 53 Canadian and 282 US metropolitan areas.

Results Canadian provinces and metropolitan areas generally had both lower income inequality and lower mortality than US states and metropolitan areas. In age grouped regression models that combined Canadian and US metropolitan areas, income inequality was a significant explanatory variable for all age groupings except for elderly people. The effect was largest for working age populations, in which a hypothetical 1% increase in the share of income to the poorer half of households would reduce mortality by 21 deaths per 100 000. Within Canada, however, income inequality was not significantly associated with mortality.

Conclusions Canada seems to counter the increasingly noted association at the societal level between income inequality and mortality. The lack of a significant association between income inequality and mortality in Canada may indicate that the effects of income inequality on health are not automatic and may be blunted by the different ways in which social and economic resources are distributed in Canada and in the United States.

Introduction

A large body of research reports an association between income distribution and health[1–14] and a range of hypotheses articulates possible mechanisms operat-