B5 2003/04: Cancer Survival Indicators For Primary Care Organisations In England – Feasibility Study

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Version 1
(The version number refers to the stage of the study in an iterative process, where the first line of investigation may lead to further issues and investigation before a final decision is made.)

National Centre for Health Outcomes Development

Compendium of Clinical and Health Indicators 2003

Report to the Department of Health

Contents Page

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1 Summary

1.1 Purpose

1.1.1 The purpose of this study is to explore the extent to which the Primary Care Organisation (PCO) of cancer patients' residence at diagnosis can reliably be used as the geographic basis for cancer survival indicators in the NHS.

1.2 Target Audience

1.2.1 Cancer Policy Team – Department of Health (DH).

1.3 Background

1.3.1 Cancer survival indicators are currently calculated for Government Office Regions (GORs), Strategic Health Authorities (SHAs) and old Health Authorities (HAs). Since April 2002, HAs have been superseded by Primary Care Organisations (PCOs) as the main organisational unit of the NHS for administrative and managerial purposes. The Department of Health has requested exploration of the utility of cancer survival indicators for PCOs.

1.3.2 Several limitations in using PCOs as the geographic basis of indicators were identified in advance:

- PCOs have an average population of approximately 165,000, so the statistical stability of survival indicators would be limited, even for the most common cancers.
- There are currently 303 PCOs (as of April 2003). If data for consecutive years are used to construct separate indicators, national rankings of a given PCO (from 1 to 303) would be likely to be very sensitive to even minor changes in the survival rates.
- PCOs are likely to be geographically unstable for several years (mergers, boundary revisions). This may make it difficult to create indicators that are sufficiently consistent over time and space to be managerially useful.

1.4 Methods

1.4.1 1-year and 5-year relative survival rates were produced for patients who were resident in each of the 303 PCOs in England at diagnosis with cancer of the breast (women) or colon (both sexes) during 1994-96. The methodology is identical to that used for previous analyses of survival for GORs, SHAs and HAs.

1.4.2 These two cancers were chosen because they are common, and represent an important public health problem in their own right. If survival indicators that are statistically robust

and managerially useful cannot be constructed for colon and breast, it will not be worth examining the data for less common cancers.

1.4.3 The impact of the size of the PCO population on the statistical stability of the relative survival estimates was explored, as was the extent to which neighbouring PCOs, particularly those within a given Strategic Health Authority, have similar survival rates.

1.5 Key Results

1.5.1 The main points revealed by the data are:

- relative survival for some PCOs cannot be estimated, particularly for colon cancer;
- survival varies widely between the PCOs situated within many of the SHAs;
- the standard error of many survival estimates is large;
- survival within many PCOs varies widely from year to year.

1.5.2 For PCOs, the variability of the survival estimates is very large, although it is difficult to say how much larger it is than the underlying real variation between PCOs. However, it is unlikely that 5-year survival for colon cancer could range from 20% to 60% in PCOs within the same SHA: in our previous research on cancer survival in England and Wales, the absolute differences in 5-year survival between the richest and poorest fifths of the population were always less than 15%, whether nationally or within any of the NHS Regions of England.

1.5.3 The random fluctuation (noise) in the survival estimates for PCOs is large because the number of patients included in each analysis is relatively small, even for common cancers such as those of breast and colon. This noise is likely to drown out any plausible degree of true geographic variation between PCOs and/or temporal variation in survival for a given PCO. For every analysis we carried out, i.e. for one-year and five-year survival for breast cancer and for colon cancer in each sex, the national ranking for more than half the PCOs changed by more than 60 (out of a possible 303) in each successive year. For about three-quarters of the PCOs – again, in every analysis - the national ranking changed by 30 or more between successive years of diagnosis.

1.6 Age-standardisation

1.6.1 Comparison of relative survival estimates that include patients of all ages may be misleading if the age distribution of the two groups of cancer patients differs markedly. If one summary measure of overall survival is needed, age-standardisation is desirable, particularly when large numbers of estimates need to be compared or ranked. It is also important for the analysis of time trends in relative survival, because survival varies markedly with age for most cancers, and a change in the age distribution of cancer patients over time can therefore produce spurious survival trends, or obscure real trends.

1.6.2 The statistical price to pay for age-standardisation of survival rates is that an estimate of survival is required for each of the age groups used in the standardisation. For this reason, the number of PCOs for which an age-standardised survival estimate can be made is much smaller than the number for which an overall (all ages) estimate can be made, even

for the most common cancers. Thus, even when a fairly coarse age-standardisation was carried out for triennial incidence data, using three age groups (15-49 years, 50-69, 70 and over), one-year survival could only be estimated for 177 of 303 PCOs for breast cancer, and for 49 and 46 of PCOs for colon cancer in men and women, respectively. Five-year age-standardised survival estimates would not be estimable for any PCO.

1.7 Conclusions

1.7.1 Given the statistical instabilities in relative survival rates observed for PCOs in this study, and the difficulty in age-standardisation of PCO-specific relative survival rates, it is concluded that, using the current methodology, PCOs are not suitable as the geographic basis for cancer survival indicators to be used in NHS performance management.

1.7.2 If PCO-level survival estimates are nevertheless to be used, for instance for descriptive epidemiological purposes, they should be issued with suitable caveats as to their statistical robustness for this purpose.

1.8 Recommendations

- *PCO survival estimates based on single years of diagnosis should NOT be used as a performance indicator to show year-on-year improvement.*
- *PCO survival estimates based on single years of diagnosis should NOT be used as a bench-marking indicator to show position relative to other PCOs.*
- *Trends in PCO survival estimates based on single years of diagnosis should NOT be used as a performance indicator to show average year-on-year improvement*.
- *Trends in PCO survival estimates based on three-year periods of diagnosis should NOT be used as a performance indicator to show year-on-year improvement.*
- *Triennial PCO survival estimates should NOT be used as a bench-marking indicator to show position relative to other PCOs.*
- *If PCO-level survival estimates are likely to be used by the NHS in the longer term, then additional research should be done into improving their robustness for this purpose.*

2 Background to the study

2.1 The 28 Strategic Health Authorities (SHAs) in England are currently expected to be the main geographic basis for cancer survival indicators required by the Department of Health (DH) and the National Health Service (NHS). They have an average population of around 2 million, and they have responsibility for the strategic development of healthcare services for their resident population, and the monitoring of performance and standards.

2.2 However, the 303 Primary Care Organisations (PCOs) covering the population of England have become the locus of much NHS policy-making. Since April 2002, PCOs have acquired responsibility to assess health needs, to improve the health of their populations and to plan and deliver healthcare services.

2.3 The Department of Health requested that we explore the creation of cancer survival indicators for PCOs. Methodological limitations had been identified in advance (see below), and these were acknowledged. The question was how useful such indicators could be made to be.

2.4 The Department of Health may in due course commission alternate analyses based on the 34 Cancer Treatment Networks (CTNs), which are responsible for the entire range of cancer treatment services in a defined area. They are in principle a more logical unit of analysis for this purpose, since for the vast majority of cancer patients, the entire pathway of referral, diagnosis and treatment will be contained within the territory of the CTN in which they reside. CTNs have defined territories, often co-terminous with those of SHAs.

2.5 For this project, we have examined the extent to which the PCO of residence of a cancer patient at diagnosis can be reliably used as a geographic basis for cancer survival indicators.

2.6 Several limitations in using PCOs as the geographic basis of indicators were identified in advance:

- PCOs have an average population of approximately 165,000, so the statistical stability of survival indicators would be limited, even for the most common cancers. Aggregation of several years of data will partially address this problem, but it is intended that the indicators will be updated annually, and the time period covered by successive annual indicators will therefore overlap. Aggregation of data would therefore be expected to limit the managerial usefulness of time trends in the indicator values. The robustness of indicators for a cross-sectional geographic comparison (for a single period) may be greater than for geographic comparison of temporal trends.

- There are currently 303 PCOs (as of April 2003). If data for consecutive years are used to construct separate indicators, national rankings of PCOs (from 1 to 303) are thus likely to be very sensitive to even minor changes in the survival rates.

- PCOs are likely to be geographically unstable for several years (mergers, boundary revisions). This may make it difficult to create indicators that are sufficiently consistent over time and space to be managerially useful.

2.7 The issue of whether PCOs can be said to have both a resident population and non-overlapping boundaries appears to have been resolved - PCO populations may be defined by residence, by catchment or by provider.

2.8 Currently cancer survival indicators are calculated for Government Office Regions (GORs) and SHAs. They are at present also calculated for the old Health Authorities (HAs): these have now been superseded by PCOs as the main organisational unit of the NHS for administrative and managerial purposes. PCOs are on average one-third of the size of the old HAs.

3 Methods

3.1 We have produced 1-year and 5-year relative survival rates for patients resident in each of the 303 PCOs in England who were diagnosed with cancer of the breast (women) or colon (both sexes) during 1994-96. We used data from the National Cancer Registry at ONS, with follow-up to 31 December 2001. Data on at least five years of follow-up were thus available for all patients included in the analyses.

3.2 These two cancers were chosen because they are common and important public health problems in their own right. If survival indicators that are statistically robust and managerially useful cannot be constructed for colon and breast, it will not be worth examining the data for less common cancers.

3.3 We estimated relative survival rates for England by age and calendar year of diagnosis. Relative survival is the ratio of the observed (absolute) survival of the cancer patients and the survival that would have been expected if those patients had had only the same age- and sex-specific mortality rates (background mortality) as the general population from which they are drawn. Complete life tables by single year of age (up to 99 years) and sex were derived from the numbers of deaths in each region in England and Wales during the period 1997-99, with estimated population denominators for 1998. These life tables were used to represent background mortality in each region of England by age and sex during the period 1994-2001. The methodology is identical to that used for previous analyses of survival for SHAs and HAs.

3.4 We have applied the maximum likelihood approach for individual records to estimate both observed and relative survival, using an algorithm developed for previous analyses[1]. This approach requires that at least one death has been observed in each interval for which an estimate of the probability of survival is required. Survival probabilities were estimated at 3 months, 6 months, one year, two years, three years and five years. Cumulative probabilities of relative survival are reported at one year and five years after diagnosis.

3.5 We have explored the impact of the size of the PCO population on the statistical stability of the relative survival estimates, and the extent to which neighbouring PCOs, particularly those within a given Strategic Health Authority, have similar survival rates. To do this, summary measures of survival for PCOs (mean, standard error) were calculated *within* each of the 28 SHAs. The national average values given for PCOs are then the average across all 28 SHAs of these estimates: these reflect the within-SHA

variation of PCO survival rates, and are much less variable than the simple average of all 303 estimates for the individual PCOs.

4 Results

4.1 One-year and 5-year relative survival estimates for breast cancer and colon cancer are presented in annex tables, by SHA and by PCO, for each year of incidence 1994, 1995 and 1996 and for the entire three-year period 1994-96.

4.2 The main points revealed by these data are:

- relative survival for some PCOs cannot be estimated, particularly for colon cancer
- survival varies widely between PCOs within many SHAs
- the standard error of many survival estimates is large
- survival within many PCOs varies widely from year to year

4.3 Number of deaths by sex and year of diagnosis in PCOs and SHAs

4.3.1 The statistical precision of survival estimates depends essentially on the number of events (deaths) that contribute to the estimate. In turn, this depends on both the number of patients who are diagnosed (the incidence rate, and the size and age(-sex) structure of the underlying population) and the lethality of the tumour, which also varies with age and sex, and over time, as well as between geographic areas.

4.3.2 The range and variability in the number of deaths included in the analyses for each cancer and in each PCO are important guides to the precision of the estimates, and in turn to the reliability of the indicators as comparative measures of performance.

4.3.3 *PCOs*

4.3.4 Among patients resident in each of the 303 PCOs in each of the calendar years 1994, 1995 and 1996, an average of about 30 deaths arising within 5 years of the diagnosis were included in the analyses for women with breast cancer, and 30 deaths for colon cancer (both sexes combined) (Tables 1a and 1b). For a quarter of PCOs, however, fewer than 10 deaths were observed among colon cancer patients by sex and year of diagnosis, and for 5 to 12 PCOs in each of the three years of diagnosis, no deaths at all were recorded.

4.3.5 For women with breast cancer, at least 10 deaths were included in the analyses for each year of diagnosis in more than 95% of PCOs, and only one PCO had no death for a given year of diagnosis.

4.3.6 *SHAs*

4.3.7 In contrast, the average number of deaths within five years of diagnosis that could be included in the analyses at SHA level for each year of diagnosis was much larger: about

168 in each sex for colon cancer and 302 for women with breast cancer, with a minimum of 60 and 156 deaths, respectively.

Table 1a:
Number of deaths within five years among women diagnosed with breast cancer, by geographic unit of residence and year of diagnosis, England, 1994-96

Year	Number of deaths					
	PCO[1]			SHA[1]		
	Mean	Range[2]		Mean	Range[2]	
1994	29	12	57	315	159	474
1995	30	13	54	321	190	495
1996	30	13	52	322	195	482
1994-96	88	43	159	958	541	1463

[1] Primary Care Organisation and Strategic Health Authority

[2] Range: 5th and 95th percentile values

No death in one PCO

Table 1b:
Number of deaths within five years among patients diagnosed with colon cancer, by sex, geographic unit of residence and year of diagnosis, England, 1994-96

Year	Sex	Number of deaths					
		PCO[1]			SHA[1]		
		Mean	Range[2]		Mean	Range[2]	
1994	**M**	15	5	30	166	70	281
	F	15	5	30	169	84	274
1995	**M**	15	5	32	168	89	280
	F	15	5	30	168	87	281
1996	**M**	16	5	30	171	75	298
	F	16	4	31	171	81	283
1994-96	**M**	46	20	87	504	249	850
	F	47	20	84	508	261	827

[1] Primary Care Organisation and Strategic Health Authority

[2] Range: 5th and 95th percentile values

No death in 5 to 12 PCOs in a given year

4.4 "External reliability" of relative survival estimates

4.4.1 *PCOs*

4.4.2 For breast cancer, it was possible to estimate 1-year and 5-year relative survival rates for nearly all the PCOs for women diagnosed in each of the three years 1994-96 (Tables 2a and 2b). For colon cancer, 1-year survival estimates for either men or women could not be obtained for up to 15 PCOs, and 5-year survival could not be estimated for up to 60 (20%) of the 303 PCOs.

4.4.3 Tables 2a and 2b also show the average survival rates for PCOs at one and five years, and the average survival rates for the 28 SHAs, for each year 1994, 1995 and 1996 and for the three-year period 1994-96. The tables also show a range that includes 90% of all the values observed (between the 5th and 95th percentiles). For both breast cancer in women and colon cancer in both sexes, the mean 1-year and 5-year survival rates are fairly stable across the three years of incidence.

Table 2a:
Distribution of one-year and five-year relative survival estimates for women with breast cancer, by geographic unit of residence and year of diagnosis, England, 1994-96

	One-year relative survival (%)							
	PCO[1]				SHA[1]			
Year	N	Mean	Range[2]		N	Mean	Range[2]	
1994	301	92.6	86.0	98.2	28	93.1	87.0	97.7
1995	302	93.0	85.9	98.0	28	93.4	89.8	97.0
1996	302	93.4	87.4	98.3	28	93.6	89.4	96.5
1994-96	302	93.2	88.9	97.2	28	93.4	89.5	96.5

	Five-year relative survival (%)							
	PCO[1]				SHA[1]			
Year	N	Mean	Range[2]		N	Mean	Range[2]	
1994	301	76.0	65.2	86.1	28	76.6	71.0	82.3
1995	302	76.5	66.9	85.9	28	77.1	71.5	81.7
1996	302	77.7	66.3	87.3	28	78.0	72.0	82.3
1994-96	302	77.1	70.2	84.5	28	77.3	71.2	80.7

[1] Primary Care Organisation and Strategic Health Authority
[2] Range: 5th and 95th percentile values
PCO estimates are adjusted for SHA

4.4.4 For breast cancer, 90% of the 5-year survival estimates for PCOs in each year of diagnosis were included in an absolute range of approximately 20% (67-86%), or 10% on either side of the average value (around 77%). For 5-year survival from colon cancer in each sex, this range exceeds 35%; e.g. for men diagnosed in 1994, 90% of the values were in the range 20.8% to 60.9% around the mean of 41.1%. This means that, for the 303 PCOs, the 5-year survival rates for patients diagnosed with breast cancer and colon

cancer in a single year span a range of more than 20% and 35%, respectively, around the national average value.

Table 2b:
Distribution of one-year and five-year relative survival estimates for patients with colon cancer, by sex, geographic unit of residence and year of diagnosis, England, 1994-96

One-year relative survival (%)

		PCO[1]				SHA[1]			
Year	**Sex**	**N**	**Mean**	**Range[2]**		**N**	**Mean**	**Range[2]**	
1994	**M**	289	65.7	43.8	83.9	28	67.4	59.4	73.1
	F	288	65.1	44.1	82.9	28	65.5	57.5	72.7
1995	**M**	288	66.3	49.6	84.8	28	67.2	58.6	73.8
	F	290	63.6	45.6	79.1	28	65.2	57.8	74.7
1996	**M**	285	67.5	51.3	83.3	28	68.6	59.8	77.8
	F	280	65.3	46.6	83.6	28	66.3	59.2	72.7
1994-95	**M**	301	67.1	55.2	78.5	28	67.8	60.5	73.1
	F	300	65.1	54.1	75.6	28	65.6	57.9	72.4

Five-year relative survival (%)

		PCO[1]				SHA[1]			
Year	**Sex**	**N**	**Mean**	**Range[2]**		**N**	**Mean**	**Range[2]**	
1994	**M**	254	41.1	20.8	60.9	28	43.5	34.3	51.3
	F	252	42.6	22.2	60.7	28	45.0	30.7	54.7
1995	**M**	243	42.0	23.7	60.1	28	43.6	31.9	50.8
	F	245	42.4	23.8	59.9	28	44.3	36.8	51.1
1996	**M**	258	43.2	24.4	61.3	28	46.1	36.5	53.5
	F	252	44.1	22.9	63.3	28	46.0	36.9	53.1
1994-95	**M**	295	43.3	29.7	56.0	28	44.4	37.8	50.1
	F	298	44.0	30.5	57.0	28	45.1	35.9	51.4

[1] Primary Care Organisation and Strategic Health Authority
[2] Range: 5th and 95th percentile values
PCO estimates are adjusted for SHA

4.4.5 It is noticeable that, even when we estimated survival for three years of incident cases (1994-96) for PCOs, the range that contained 90% (technically the 5^{th}-95^{th} percentile range) of all the observed values around the national average value for 1-year and 5-year survival remained wide. Thus for women with breast cancer, this 90% range is 8% around the mean of 93% for 1-year survival and 14% around the national mean of 77% for 5-year survival. For colon cancer, this 90% range still encompasses about 22% around the national mean 1-year survival rate of 66% or so in each sex, and about 26% around the national mean 5-year survival of 43-44% in each sex.

4.4.6 *SHAs*

4.4.7 For SHAs, a survival estimate could be made in every case. For women diagnosed with breast cancer in each of the three years 1994-96, the 90% range of estimates spans about 8% around the average value of 93% for one-year survival, and 10% around the average

value of 77% or so for five-year survival. For men or women diagnosed with colon cancer in each year, the corresponding figures are a range of about 13-15% around the mean value of 66% or so for one-year survival, and a range of 15-17% around the mean value of about 45% for 5-year survival.

4.4.8 In short, survival rates among the 28 SHAs show less inherent variability, as would be expected. The 90% range of SHA survival estimates around the national mean is usually one-third to one-half smaller for breast cancer and 40-60% smaller for colon cancer, compared to the corresponding range for the survival estimates among the 303 PCOs.

4.4.9 Another way of expressing this would be to say that random fluctuation (noise) in the survival estimates for PCOs is large because the numbers of patients included in the analyses is relatively small, even for common cancers such as those of breast and colon. This noise is likely to drown out any plausible degree of (true) geographic variation in survival between PCOs.

4.5 **"Internal reliability" of relative survival estimates**

4.5.1 We used two measures to document the statistical precision of survival estimates for PCOs and SHAs, and thus of their reliability or robustness for each of these alternative geographic units of analysis - the distribution of the standard error of the relative survival estimates, and the coefficient of variation (CV) (Tables 3a and 3b). The CV expresses the standard deviation of a survival estimate in a given area as a percentage of the overall mean value: it is independent of the numerical value of the survival rate. Again, the PCO results have been adjusted for SHA.

4.5.2 *Standard errors*

4.5.3 For annual estimates in PCOs, the mean of the standard errors of 1-year and 5-year survival ranges between 3.2 and 5.7 for women with breast cancer, and between 10 and 12 for colon cancer in each sex.

4.5.4 For annual estimates in SHAs, the mean of the standard errors of 1-year and 5-year survival ranges between 1.0 and 1.7 for women with breast cancer, and between 3.2 and 4.0 for colon cancer in each sex.

4.5.5 *Coefficient of variation*

4.5.6 Variability in the annual estimates of 5-year survival represents 8% of the mean survival in PCOs for breast cancer (2% in SHAs) and 30% for colon cancer (9% in SHAs).

4.5.7 Use of three years of data (1994-96) reduces this substantial variability for PCOs. For breast cancer, the CV falls from 4% to 2% for 1-year survival and from 8% to 4 % for 5-year survival. For colon cancer, however, the CV remains as high as 10% for 1-year survival and 18% for 5-year survival.

4.5.8 With three years of data (1994-96), the coefficient of variation of survival estimates for SHAs is 1% for breast cancer and 3-5% for colon cancer in each sex.

Table 3a:
Distribution of the standard error of relative survival rates for women with breast cancer, by geographic unit of residence and year of diagnosis, England, 1994-96

	Standard error of one-year relative survival							
	PCO[1]				SHA[1]			
Year	Mean	Range[2]		Mean of CV[3] (%)	Mean	Range[2]		Mean of CV[3] (%)
1994	3.4	2.0	5.1	4	1.0	0.7	1.3	1
1995	3.3	2.0	5.0	4	1.0	0.8	1.3	1
1996	3.2	1.9	4.9	3	0.9	0.7	1.3	1
1994-96	1.9	1.2	2.7	2	0.6	0.4	0.7	1

	Standard error of five-year relative survival							
	PCO[1]				SHA[1]			
Year	Mean	Range[2]		Mean of CV[3] (%)	Mean	Range[2]		Mean of CV[3] (%)
1994	5.7	4.0	8.0	8	1.7	1.3	2.1	2
1995	5.7	4.0	8.2	8	1.7	1.3	2.1	2
1996	5.6	3.9	7.9	7	1.6	1.3	2.1	2
1994-96	3.2	2.3	4.4	4	1.0	0.8	1.2	1

[1] Primary Care Organisation and Strategic Health Authority

[2] Range: 5th and 95th percentile values

[3] CV: coefficient of variation

PCO estimates are adjusted for SHA

Table 3b:
Distribution of the standard error of relative survival rates for patients with colon cancer, by sex, geographic unit of residence and year of diagnosis, England, 1994-96

Standard error of one-year relative survival

Year	Sex	PCO[1] Mean	PCO[1] Range[2]		PCO[1] Mean of CV[3] (%)	SHA[1] Mean	SHA[1] Range[2]		SHA[1] Mean of CV[3] (%)
1994	**M**	10.9	7.5	15.6	18	3.4	2.5	4.9	5
	F	10.5	7.6	14.2	17	3.3	2.5	4.6	5
1995	**M**	10.8	7.4	14.8	17	3.3	2.5	4.7	5
	F	10.7	7.7	14.9	18	3.3	2.5	4.4	5
1996	**M**	10.5	7.6	14.3	16	3.2	2.5	4.3	5
	F	10.4	7.2	14.2	17	3.2	2.4	4.3	5
1994-95	**M**	6.4	4.6	8.9	10	1.9	1.5	2.6	3
	F	6.3	4.5	8.4	10	1.9	1.4	2.5	3

Standard error of five-year relative survival

Year	Sex	PCO[1] Mean	PCO[1] Range[2]		PCO[1] Mean of CV[3] (%)	SHA[1] Mean	SHA[1] Range[2]		SHA[1] Mean of CV[3] (%)
1994	**M**	12.3	8.6	17.0	35	4.0	3.0	6.0	9
	F	11.8	8.5	16.0	33	3.8	2.8	5.1	9
1995	**M**	12.0	8.3	15.9	32	3.9	2.9	5.4	9
	F	11.8	8.5	16.2	31	3.8	2.9	5.0	9
1996	**M**	12.2	9.0	16.0	31	3.9	2.8	5.6	9
	F	11.9	8.5	16.6	30	3.7	2.7	4.9	8
1994-95	**M**	7.4	5.3	10.0	18	2.3	1.7	3.1	5
	F	7.2	5.2	9.7	17	2.2	1.6	2.9	5

[1] Primary Care Organisation and Strategic Health Authority
[2] Range: 5th and 95th percentile values
[3] CV: coefficient of variation
PCO estimates are adjusted for SHA

4.6 "Temporal reliability" of relative survival estimates

4.6.1 Tables 4a and 4b present the year-to-year fluctuation of the annual estimates of one-year and five-year survival for PCOs and SHAs. For each PCO or SHA, this is quantified as the average of the two successive absolute differences between the survival rates for patients diagnosed in 1994 and 1995, and those diagnosed in 1995 and 1996. Thus for three successive estimates of 26%, 39% and 30%, the value would be 11% (the mean of 13% and 9%, ignoring the sign of the difference).

4.6.2 The mean of the year-to-year differences is about 3 times larger for PCOs than for SHAs, for both cancers, each sex and both survival estimates (1-year or 5-year survival).

4.6.3 On average, the year-to-year fluctuation in 1-year or 5-year survival for colon cancer was 14% in each sex for PCO-based estimates, but less than 5% for SHA-based estimates. Five per cent of PCOs experienced year-to-year fluctuations greater than about 30% (about 7-10% for SHAs). Conversely, in the 5% of PCOs with the smallest fluctuations, the average year-to-year shift was only 3-5% for colon cancer and about 1% for breast cancer.

Table 4a:
Year-to-year fluctuation in one-year and five-year relative survival estimates for women with breast cancer, by geographic unit of residence and year of diagnosis, England, 1994-96

	Annual fluctuation (%) in survival over 1994-96					
	PCO[1]			SHA[1]		
Year of follow-up	Mean	Range[2]		Mean	Range[2]	
1	3.8	0.9	8.6	1.3	0.6	2.2
5	7.0	1.6	14.4	2.1	0.4	3.9

[1] Primary Care Organisation and Strategic Health Authority

[2] Range: 5th and 95th percentile values

Table 4b:
Year-to-year fluctuation in one-year and five-year relative survival estimates for patients with colon cancer, by sex, geographic unit of residence and year of diagnosis, England, 1994-96

		Annual fluctuation (%) in survival over 1994-96					
		PCO[1]			SHA[1]		
Year of follow-up	Sex	Mean	Range[2]		Mean	Range[2]	
1	M	13.3	2.9	30.1	4.3	1.0	8.2
	F	13.7	2.3	29.6	3.8	0.9	7.3
5	M	14.2	2.5	32.5	4.8	1.7	8.7
	F	14.5	3.0	33.6	4.5	1.5	10.0

[1] Primary Care Organisation and Strategic Health Authority

[2] Range: 5th and 95th percentile values

5 Statistical issues

5.1 Year-to-year fluctuations

5.1.1 The results show that estimates of cancer survival based on patients diagnosed in a single year in PCOs may not be sufficiently reliable for use as indicators because of small numbers of deaths, even though we looked at two of the most common cancers in England.

5.1.2 Survival (especially 5-year survival) rates are not even estimable for all 303 PCOs if the analyses are restricted to a single year of diagnosis.

5.1.3 For PCOs, the variability of the survival estimates is very large, although it is difficult to say how much larger it is than the underlying real variation between PCOs.

5.1.4 However, it is also unlikely that 5-year survival for colon cancer could range from 20% to 60% in PCOs within the same SHA: in our previous research on cancer survival in England and Wales, the absolute differences in 5-year survival between the richest and poorest fifths of the population were always less than 15%, whether nationally or within any of the NHS Regions of England.

5.1.5 The observation of such large year-to-year fluctuations in survival within a small area such as the PCO may be due to: (i) statistical instability; (ii) changes in the PCO age structure of cancer patients in a given PCO as a result of random fluctuation in incidence; (iii) changes in health care system. The impact on cancer survival at PCO level of any modification in local health care policy, even successfully and rapidly applied, is likely to become undistinguishable from this background noise. Thus the national average survival rate for England has changed by less than 5-8% in any five-year period in the last 15 years[2]. This magnitude of change in survival over time is smaller than the range of estimates between PCOs.

5.2 Impact on national ranking of PCOs in England

5.2.1 The impact on national ranking of PCOs in England of fluctuation in the survival estimates between successive years of diagnosis (1994, 1995 and 1996) was evaluated. A given PCO could be ranked from 1 to 303 in any given year. For every analysis we carried out, i.e. for one-year and five-year survival for breast cancer and for colon cancer in each sex, the ranking for more than half the PCOs changed by more than 60 in each successive year. For about three-quarters of the PCOs – again, in every analysis - the national ranking changed by 30 or more between successive years of diagnosis.

5.2.2 Even survival estimates for larger areas (the 95 Health Authorities of England as defined in 2001) were affected by instability of ranking, even though these estimates were based on three years of incidence data (1993-95). We have reported on this previously[3].

5.3 **Age-standardisation**

5.3.1 The issue of the age distribution of cancer patients included in survival analysis requires comment here. A relative survival rate is not age-adjusted *per se*. It adjusts for age-specific mortality from other causes, but as with most biological and clinical risks, the relative survival from cancer is *itself* often age-dependent. For many cancers, the difference in relative survival between young and old patients may be large.

5.3.2 Comparison of relative survival estimates that include patients of all ages may therefore be misleading if the age distribution of the two groups of cancer patients differs markedly. Age-specific relative survival rates can and should be examined, but if one summary measure of overall survival is needed, age-standardisation is desirable (the effect of age can also be modelled). This is particularly so when large numbers of estimates need to be compared or ranked, and it is impractical to include more than one estimate for a given area in the comparison. The rationale for age-standardisation of survival comparisons is thus the same as for incidence or mortality comparisons, but here it is the age distribution of *cancer patients* that is important, not the age distribution of the general population.

5.3.3 Age-adjustment is also important for the analysis of time trends in relative survival, since if survival varies markedly with age, a change in the age distribution of cancer patients over time can produce spurious survival trends or obscure real trends.

5.3.4 The age-standardised relative survival is interpretable as the overall survival rate that would have occurred, given the observed survival rate at each age, if the age distribution of the patient group under study had been the same as that of the standard population. The numerical value of the survival rate does not change greatly with standardisation when the age distributions of the cancer patients and that of the standard population are similar, but the conceptual advantage of standardisation even when the numerical effect is small is that any effect of different age distributions of the cancer patients can be largely discounted when interpreting any remaining differences in survival between the groups being compared.

5.3.5 The statistical price to pay for age-standardisation of survival rates is that an estimate of survival is required for each of the age groups used in the standardisation. For this reason, the number of PCOs for which an age-standardised survival estimate can be made is much smaller than the number for which an overall (all ages) estimate can be made, even for the most common cancers. Thus, even when a fairly coarse age standardisation is carried out, with incidence data covering three years, and using three age groups (15-49 years, 50-69, 70 and over), one-year survival could only be estimated for 177 of 303 PCOs for breast cancer, and for 49 and 46 of PCOs for colon cancer in men and women, respectively. Five-year age-standardised survival estimates would not be estimable for any PCO. The difference in availability of estimates for one-year and five-year survival is due to the fact that many more deaths occur in the first year after diagnosis than in later years.

6 Conclusions

6.1 Given the current methodology PCOs are not suitable as the geographic basis of cancer survival indicators to be used in NHS performance management.

6.2 If PCO-level survival estimates are nevertheless to be used, for instance for descriptive epidemiological purposes, they should be issued with suitable caveats as to their statistical robustness for this purpose.

6.3 If PCO-level survival estimates are likely to be used by the NHS in the longer term, then additional research should be done into improving their robustness for this purpose. This could include:

- Development of formal approaches for estimating survival in PCOs while taking due account of spatial auto-correlation (i.e. the likelihood that survival in a given PCO is more likely to be similar to that in neighbouring PCOs than to survival in PCOs some distance away, or in another region). Bayesian approaches to this problem are likely to be the most suitable[4].

- Age-standardisation of cancer survival estimates is not universally practicable even for SHAs, which are larger areas than PCOs. It would be more judicious to model the effect of age on geographic variations in survival. This will require due account to be taken of missing data (e.g. with multi-level modelling: see our earlier report[5]), since some age bands do not contain sufficient information for routine estimation.

7 Recommendations

- ***PCO survival estimates based on single years of diagnosis should NOT be used as a performance indicator to show year-on-year improvement.*** Cancer survival estimates for single years of diagnosis within such small areas are not statistically robust enough to enable real change to be reliably distinguished from random fluctuation, even for some of the most common cancers.

- ***PCO survival estimates based on single years of diagnosis should NOT be used as a bench-marking indicator to show position relative to other PCOs.*** Cancer survival estimates for single years of diagnosis within such small areas are not statistically robust enough to enable real change to be reliably distinguished from random fluctuation, even for some of the most common cancers. In addition, the estimates cannot all be age-standardised to facilitate comparison, given that the age distribution of cancer patients varies between PCOs.

- ***Trends in PCO survival estimates based on single years of diagnosis should NOT be used as a performance indicator to show the average year-on-year improvement.*** Random year-to-year fluctuation of cancer survival estimates for such small areas is too great to enable real change to be reliably distinguished from random fluctuation, even for some of the most common cancers.

- ***Trends in PCO survival estimates based on three-year periods of diagnosis should NOT be used as a performance indicator to show year-on-year improvement.*** The

trends are not robust enough to discern real changes from random fluctuation, even when three years of incidence data are used for each estimate. In addition, the estimates cannot all be age-standardised to facilitate comparison, given that the age distribution of cancer patients varies between PCOs.

- ***Triennial PCO survival estimates should NOT be used as a bench-marking indicator to show position relative to other PCOs.*** The estimates are not robust enough to discern real changes from random fluctuation, even when three years of incidence data are used for each estimate. In addition, the estimates cannot all be age-standardised to facilitate comparison, given that the age distribution of cancer patients varies between PCOs.

- ***If PCO-level survival estimates are likely to be used by the NHS in the longer term, then additional research should be done into improving their robustness for this purpose.***

A Annex 1 – Data Tables
[51pp: available on request to Cancer Survival Group, LSHTM]

Breast and colon_PCO_RS.xls

B References

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