

# Quality of Care for Chronic Diseases in a British Cohort of Long-Term Cancer Survivors

Nada F. Khan, MSc

David Mant, MD, FRCGP

Peter W. Rose, MD, FRCGP

Department of Primary Health Care,  
University of Oxford, United Kingdom

---

## ABSTRACT

**PURPOSE** Previous research has shown that long-term cancer survivors with other chronic diseases may receive poorer care for those diseases compared with the general population. We sought to establish the quality of care for chronic diseases among cancer survivors in the United Kingdom.

**METHODS** From the UK General Practice Research Database, we identified 21,366 adult patients who had survived 5 or more years after a diagnosis of breast, colorectal, or prostate cancer with a diagnosis of hypertension, coronary artery disease, diabetes, or cerebrovascular disease. For each patient, an age-sex matched noncancer control patient was selected from the same general practice and with the same chronic disease. We compared the chronic disease care in cancer survivors and their matched controls.

**RESULTS** The proportion of patients meeting quality standards for chronic disease care was high in both cancer survivors and control patients. Although cancer survivors were slightly less likely to receive blood pressure monitoring and cholesterol tests, this difference was no longer apparent if patients who died during the study period were excluded. For instance, 93% of breast cancer survivors received blood pressure monitoring compared with 94% of matched control patients. Similarly, control of disease was comparable among all patients, with the exception of diabetic prostate cancer survivors, who had fewer cholesterol readings under the control limit (17% reduction, 95% CI, 7%-26%) and diabetic colorectal survivors, who had fewer calendar quarters of glycated hemoglobin control (12% reduction, 95% CI, 2%-23%).

**CONCLUSIONS** Care of comorbidities is not neglected in the United Kingdom because people have had a previous diagnosis of cancer. One explanation is that in the United Kingdom, such care is provided through a robust primary care system.

*Ann Fam Med* 2010;8:418-424. doi:10.1370/afm.1162.

---

## INTRODUCTION

Cancer is primarily a disease affecting an older population. Currently, 1 in 8 people aged 65 years and older are living beyond a diagnosis of cancer in the United Kingdom.<sup>1</sup> Chronic disease management is an important issue for older, long-term survivors, many of whom will have 1 or more comorbid diseases.<sup>2</sup> Research from the United States has highlighted, however, the underuse of chronic disease monitoring in individuals with cancer.<sup>3-8</sup> Furthermore, cancer survivors with a comorbid condition have a substantially higher likelihood of poor health and disability than those without a history of cancer.<sup>9,10</sup> Now that more than one-half of all individuals with a diagnosis of cancer will live more than 5 years after the diagnosis, these chronic illnesses, not cancer, will contribute to a substantial proportion of the long-term morbidity and mortality in this population.<sup>11</sup>

*Conflicts of interest: none reported*

### CORRESPONDING AUTHOR

Nada F. Khan, MSc  
Rosemary Rue Bldg  
Old Road Campus  
University of Oxford  
Oxford, OX3 7LF UK  
nada.khan@dphpc.ox.ac.uk

Previous research has highlighted problems in delivering coordinated health care to cancer survivors. Patients and physicians report different beliefs about the role of primary and secondary care in the long term, resulting in uncertainty among patients wondering where to turn to for their routine preventative care.<sup>12</sup> In the United Kingdom, most cancer survivors are referred back to the care of their primary care physician 3 to 5 years after the diagnosis, and it is in primary care that these long-term cancer survivors will receive the bulk of their health care. It is unknown whether this population receives adequate care in the British primary health care system.<sup>13</sup>

The main aims of this work are to extend upon previous research and to investigate monitoring of chronic disease in a British primary care setting. Our purpose is to investigate whether cancer survivorship influences primary care physicians in the United Kingdom to deliver less-adequate disease monitoring for other chronic diseases compared with control patients who did not have cancer. One of the advantages of this study includes the ability to not only investigate receipt of care, but also to use individual monitoring test results to determine whether long-term cancer survivors have adequate disease maintenance.

## METHODS

### Source of the Data

This study used the General Practice Research Database (GPRD), which is the world's largest source of anonymous longitudinal data from primary care. The GPRD currently contains information on a representative group of 3.6 million patients from more than 400 general practices in the United Kingdom.<sup>14</sup> Practices participating in the GPRD record data on individual-level clinical diagnoses, prescriptions, and quantitative results from tests and examinations conducted in primary care. The data undergo quality control procedures, and several validation studies have shown a high level of data completeness within the GPRD.<sup>15</sup>

### Participants and Inclusion and Exclusion Criteria

This report is part of a larger study that aims to examine the use of primary health care services by long-term survivors of breast, colorectal, and prostate cancer.<sup>16</sup> Cancer survivors were defined as those aged 30 years or older at the time of diagnosis with at least 5 years of postdiagnosis survival. The main cohort from which the participants for this analysis were chosen consists of 18,707 breast cancer survivors, 5,773 colorectal cancer survivors, and 4,856 prostate cancer survivors matched to 4 control patients who did not have cancer. This

analysis included only those patients with a chronic disease requiring monitoring; therefore, we included cancer survivors and matched controls with diabetes, hypertension, stroke or transient ischemic attack (TIA), myocardial infarction (MI), or coronary artery disease (CAD) diagnosed before the start of the analysis period. Because cancer survivors and control patients were not originally matched by chronic disease, for the purposes of this study, we restricted cases to those cancer survivors with a chronic disease, then randomly sampled within all available control patients on the basis of age, sex, primary care practice, and chronic disease on a one-to-one ratio to make comparisons between survivors and control patients with the same condition. Clinical codes for identification of disease status can be provided upon request. Survivors and control patients entered the analysis on September 1, 2003, with at least 1 day of follow-up until the end of the study period on August 31, 2006. Cancer survivors entered the analysis along with their matched controls only when they achieved 5 years survival, and the matched groups were censored from the analysis if the cancer survivor died or transferred out of the GPRD primary care practice.

### Statistical Analysis

We used national guidelines to determine whether patients with chronic disease achieved adequate levels of disease control. The English Quality and Outcomes Framework (QOF) is an incentive program with annual monetary rewards for primary care practices achieving nationally set indicators for clinical care.<sup>17</sup> We used levels for monitoring as indicated in QOF to define adequate control of disease for the indicators used in this study. Adequate control of blood pressure was defined as a measurement of 150/90 mm/Hg or less for patients with hypertension or 145/85 mm/Hg for patients with diabetes. We also used the QOF guidelines for total cholesterol levels, which defines less than 5 mmol/L (200 mg/dL) for patients with a history of coronary artery disease, diabetes, and cerebrovascular disease (stroke and transient ischemic attack). Adequate control of diabetes was defined as a glycated hemoglobin (HbA<sub>1c</sub>) reading of less than 7.5%. Cancer survivors with more than one chronic condition requiring monitoring were included in each of the relevant analyses. For instance, a cancer survivor with hypertension and diabetes was included twice, in both analyses examining blood pressure and HbA<sub>1c</sub> monitoring.

We initially compared receipt of monitoring in cancer survivors and control patients from September 1, 2003, to August 31, 2006, using  $\chi^2$  tests and binomial exact 95% confidence intervals for the proportions. Because patients at the end of life may be treated differently, we also compared the proportion of patients

receiving monitoring after excluding all matched pairs where either the survivor or control patient died during the study period. To account for the matched groups in multivariate models, we also used conditional logistic regression to report receipt of monitoring over the 3-year analysis window.

To examine disease control, we produced mean systolic and diastolic blood pressure, total cholesterol, and HbA<sub>1c</sub> measurements for each patient receiving monitoring based on readings in 3-month periods (quarterly) from September 1, 2003, to August 31, 2006. When a monitoring test was not conducted or not recorded, we assumed no change and used the same value as the previous time period. We compared the number of quarters with a test reading in the control range using *t* tests, and univariate associations (*P* < .05) were explored in multivariate models using conditional fixed-effects regression to account for the matched groups. All analyses were carried out using Stata MP statistical software, version 10.1 (StataCorp LP, College Station, Texas).

### Explanatory Variables

We adapted the Charlson comorbidity index and assigned each patient a comorbidity score based on their clinical history in the GPRD.<sup>16</sup> The original Charlson score assigns patients with cancer a weighted score of 2; however, we excluded cancer as a comorbid disease.<sup>18</sup> This score was added as an explanatory variable to all multivariate analyses. We also included the number of consultations during the study period, along with body mass index and a dichotomous variable indicating whether the patient died during the analysis period. Because patients nearing the end of their life may be treated differently in primary care, we tested for interactions between death and receipt of monitoring in all multivariate models.

### RESULTS

The final analysis was conducted on 15,800 patients with hypertension, 1,346 patients with diabetes, 1,066

patients with a history of cerebrovascular disease, including stroke and TIA, and 3,154 patients with a history of coronary artery disease (Table 1). Reflecting national trends in cancer incidence and survival, breast cancer survivors comprised the largest group of cancer survivors. The patient population was elderly, and most breast and colorectal cancer survivors were more than 10 years after their diagnosis. A significantly higher proportion of all cancer survivors died during the 3-year study period. Most patients in this study had only 1 of the chronic diseases indicating monitoring (*n* = 17,254, 89.7%), however, a small proportion of patients (*n* = 1,974, 10.3%) had more than 1 of the chronic conditions under investigation.

### Proportion of Patients Receiving Monitoring

We first examined the proportion of individuals who received at least 1 monitoring test during the 3-year period (Table 2). Almost all cancer survivors were significantly less likely to receive any monitoring tests. Compared with the control population, however, a considerably higher proportion of cancer survivors died during the study period. Because patients at the end of life may receive different levels of disease monitoring, we also considered the receipt of monitoring among matched pairs when neither the survivor nor

**Table 1. Patient Characteristics in Each Analysis**

Characteristic	Breast		Colorectal		Prostate	
	Survivor	Control	Survivor	Control	Survivor	Control
History of hypertension						
No. of patients	4,624	4,624	1,732	1,732	1,544	1,544
Patients who died, %	14.7	2.6	18.2	3.2	25	5.1
Age in 2003, years	73.7	73.7	77.1	77.1	77.0	77.0
Years from diagnosis	11.4	–	10.8	–	5.9	–
History of diabetes						
No. of patients	334	334	167	167	172	172
Patients who died, %	20.1	3.6	23.4	5.9	27.9	6.9
Age in 2003, years	73.3	73.3	75.7	75.7	76.3	76.3
Years from diagnosis	10.4	–	10.5	–	5.6	–
History of coronary artery disease, myocardial infarction						
No. of patients	499	499	478	478	600	600
Patients who died, %	25.2	7.4	24.5	8.8	27.3	6.2
Age in 2003, years	78.9	78.9	79.0	79.0	78.1	78.0
Years from diagnosis	12.4	–	10.6	–	6.4	–
History of cerebrovascular disease (eg, stroke or transient ischemic attack)						
No. of patients	229	229	156	156	148	148
Patients who died, %	34.5	10.5	33.3	11.5	39.2	15.5
Age in 2003, years	81.5	81.5	81.6	81.5	80.8	80.8
Years from diagnosis	12.9	–	11.1	–	6.2	–

**Table 2. Proportion of All Patients Receiving a Monitoring Test**

Type of Cancer	Blood Pressure		Total Cholesterol		HbA <sub>1c</sub>	
	History of Hypertension % (95% CI)	History of Diabetes % (95% CI)	History of CAD/MI % (95% CI)	History of Diabetes % (95% CI)	History of Cerebrovascular Disease % (95% CI)	History of Diabetes % (95% CI)
Breast						
Survivor	91.6 <sup>a</sup> (90.8-92.4)	90.7 <sup>a</sup> (87.1-93.6)	78.6 <sup>a</sup> (74.7-82.0)	84.4 <sup>a</sup> (80.0-88.1)	62.4 <sup>a</sup> (55.8-68.7)	86.2 (82.1-89.7)
Control	95.2 (94.5-95.8)	95.2 (92.3-97.2)	86.9 (83.7-89.8)	91.0 (87.4-93.9)	81.7 (76.0-86.4)	88.9 (85.1-92.1)
Colorectal						
Survivor	91.8 <sup>a</sup> (90.4-93.1)	89.8 (84.2-93.9)	79.1 <sup>a</sup> (75.2-82.6)	79.6 <sup>a</sup> (72.7-85.4)	66.0 <sup>a</sup> (58.0-73.4)	83.2 (76.7-88.6)
Control	95.4 (94.3-96.4)	92.2 (87.0-95.8)	87.5 (84.1-90.2)	89.8 (84.2-93.9)	80.7 (73.7-86.6)	87.4 (81.4-92.0)
Prostate						
Survivor	88.9 <sup>a</sup> (87.2-90.4)	86.6 <sup>a</sup> (80.6-91.3)	79.2 <sup>a</sup> (75.7-82.3)	79.7 <sup>a</sup> (72.9-85.4)	64.2 <sup>a</sup> (55.4-71.5)	80.2 <sup>a</sup> (73.5-85.9)
Control	93.4 (92.0-94.6)	94.2 (89.6-97.2)	88.7 (85.8-91.1)	89.5 (83.9-93.7)	78.4 (70.9-84.7)	90.1 (84.6-94.1)

CAD = coronary artery disease; CI = confidence interval; HbA<sub>1c</sub> = glycated hemoglobin; MI = myocardial infarction.

<sup>a</sup> P < .05 for univariate  $\chi^2$  comparison between cancer survivors and controls.

**Table 3. Proportion of All Patients Receiving a Monitoring Test, Excluding Patients Who Died**

Cancer Type	Blood Pressure		Total Cholesterol		HbA <sub>1c</sub>	
	History of Hypertension % (95% CI)	History of Diabetes % (95% CI)	History of CAD/MI % (95% CI)	History of Diabetes % (95% CI)	History of Cerebrovascular Disease % (95% CI)	History of Diabetes % (95% CI)
Breast						
Survivor	93.3 (92.5-94.1)	94.7 (91.2-97.7)	89.0 (85.3-91.9)	90.5 (86.3-93.8)	76.0 (68.3-82.7)	91.3 (87.2-94.4)
Control	94.8 (94.1-95.5)	95.8 (92.7-97.9)	89.5 (85.9-92.4)	92.1 (88.1-95.0)	84.2 (77.3-89.7)	88.6 (84.1-92.2)
Colorectal						
Survivor	93.9 (92.5-95.1)	93.5 (87.7-97.2)	86.2 (82.2-89.6)	84.7 (77.1-90.5)	74.7 (65.2-82.8)	86.3 (78.9-91.8)
Control	95.3 (94.1-96.4)	91.9 (85.7-96.1)	90.1 (86.6-93.0)	89.5 (82.7-94.3)	85.4 (77.1-91.6)	88.7 (81.8-93.7)
Prostate						
Survivor	92.5 (90.8-93.9)	90.2 (83.6-94.9)	88.7 (85.3-91.5)	86.9 (79.7-92.4)	77.0 (66.8-85.4)	83.7 (76.0-89.8)
Control	92.1 (90.3-93.6)	93.5 (87.6-97.2)	89.6 (86.3-92.3)	86.9 (79.7-92.4)	79.3 (69.3-87.3)	86.9 (79.7-92.4)

CAD = coronary artery disease; CI = confidence interval; HbA<sub>1c</sub> = glycated hemoglobin; MI = myocardial infarction.

the control patient died during the analysis window (Table 3). After excluding individuals who died, all cancer survivors and controls received at least the same level of disease monitoring.

We explored all associations further in conditional multivariate models accounting for the matched groups. After adjusting for the matching, number of consultations, Charlson score, body mass index, and death, there were no significant differences between any cancer survivors and control patients in the odds

of receiving chronic disease monitoring. There was no formal evidence for an interaction between death and delivery of care; however, the numbers of patients who died and had a chronic disease were few in each separate analysis.

### Control of Disease

To investigate disease control, we compared the proportion of quarterly periods when cancer survivors and control patients had test readings in the indicated

**Table 4. Proportion of Calendar Quarters With Adequate Control of Disease**

Cancer Type	Blood Pressure		Total Cholesterol		HbA <sub>1c</sub>	
	History of Hypertension % (95% CI)	History of Diabetes % (95% CI)	History of CAD/MI % (95% CI)	History of Diabetes % (95% CI)	History of Cerebrovascular Disease % (95% CI)	History of Diabetes % (95% CI)
Breast						
Survivor	69.0 (68.1-70.1)	62.8 (58.9-66.6)	58.3 (54.1-62.6)	64.2 (59.7-68.8)	50.2 (43.0-57.4)	69.6 (59.6-68.7)
Control	68.1 (67.2-69.1)	57.9 (54.1-61.8)	56.5 (52.6-60.6)	70.4 (66.1-74.6)	49.5 (43.2-55.8)	64.1 (59.6-68.7)
Colorectal						
Survivor	69.6 (67.9-71.3)	63.7 (57.7-69.7)	74.4 (70.6-78.2)	75.3 (69.1-81.6)	65.4 (57.4-73.5)	63.7 <sup>a</sup> (57.2-70.4)
Control	68.3 (66.7-69.9)	63.6 (57.9-62.3)	73.1 (69.3-76.8)	78.6 (73.0-84.1)	69.4 (62.3-76.4)	73.3 (67.7-78.9)
Prostate						
Survivor	74.4 (72.7-76.1)	67.9 (61.7-74.0)	78.0 (74.7-81.3)	74.6 <sup>a</sup> (68.2-80.9)	66.7 (58.1-75.4)	72.5 (66.0-79.1)
Control	72.8 (71.1-74.5)	65.1 (59.7-70.5)	81.5 (78.7-84.2)	83.7 (78.6-88.7)	76.9 (70.4-83.3)	68.5 (62.1-74.9)

CAD = coronary artery disease; CI = confidence interval; HbA<sub>1c</sub> = glycated hemoglobin; MI = myocardial infarction.

<sup>a</sup>P < .05 for univariate  $\chi^2$  comparison between cancer survivors and control patients.

control range. The univariate analysis shows that most cancer survivors had similar adherence to the QOF clinical indicators for blood pressure, cholesterol, and HbA<sub>1c</sub> levels compared with control patients (Table 4). There were 2 exceptions, however; diabetic colorectal cancer survivors had significantly fewer quarterly periods with HbA<sub>1c</sub> levels under 7.5%, and diabetic prostate cancer survivors had significantly fewer periods with a total cholesterol reading under 5 mmol/L. These associations persisted after adjusting for the matching and covariates; diabetic prostate cancer survivors had a 17% (95% confidence interval [CI], 7%-26%) reduction in the proportion of cholesterol readings in the control range compared with matched controls. Colorectal cancer survivors also had a lower proportion of controlled HbA<sub>1c</sub> readings (12% reduction; 95% CI, 2%-23%). There was no evidence for effect modification for differential control of disease among patients who died within the study period.

## DISCUSSION

This study is the first of this type in the United Kingdom and the first to report comparisons between individual patient-monitoring results in cancer survivors and in control patients. Chronic disease is well managed in UK primary care; most cancer survivors who are not at the end of life receive the same level of care as noncancer patients. Of those who did receive monitoring, disease was generally controlled at the same level in both populations.

## Possible Mechanisms and Implications for Clinicians or Policy Makers

The results of this study show that in British primary care, history of cancer is not associated with poorer management of hypertension, diabetes, cerebrovascular disease, or coronary artery disease. There seem to be some differences in the receipt of monitoring among patients at the end of life; however, there were not enough patients to conduct formal subgroup analyses in the multivariate models. Changes in disease maintenance strategies are likely to be appropriate in patients receiving palliative care.

These findings differ from previous research from the United States, which has shown deficiencies in care for long-term cancer survivors.<sup>4,8,19</sup> This divergence in quality of care is likely a result of differences in health care delivery in the United States and the United Kingdom. Specifically, the introduction of incentives for chronic disease monitoring, universal health care, and a clear role for primary care in the United Kingdom may play a role in ensuring appropriate provision of comprehensive care in older age.

The quality of British primary care has been improving steadily since the late 1990s as a result of the introduction of national initiatives and guidelines for the provision of improved health services.<sup>20,21</sup> The launch of the QOF in England in 2004 helped to accelerate and standardize clinical performance for many of the indicators included in the incentive program.<sup>22-24</sup> Under QOF, primary care practices can claim financial rewards upon meeting clinical indicators relating to

monitoring 10 chronic conditions, including coronary artery disease, stroke, hypertension, and diabetes.<sup>24</sup> These incentives have helped standardize delivery of care in England, and are likely to play a part in ensuring adequate chronic disease care for cancer survivors. The effect of incentivizing indicators for some conditions and not others means that the quality of care for some conditions not covered in QOF have not improved. Patients with conditions that are not indicated for financial incentives under QOF are at risk of poorer quality of care.<sup>25</sup>

The roles of primary care and specialist physicians can be unclear to both long-term cancer survivors and health care professionals in the US health care setting. Many patients expect both primary care physicians and oncologists to provide a proportion of care of other medical problems, and almost all studies comparing uptake of noncancer health care report that cancer survivors who see both a primary care physician and an oncologist received the best quality care.<sup>4-6</sup> The clearer role of primary and secondary care physicians in the United Kingdom means that fewer cancer survivors requiring monitoring should slip through the net. Long-term cancer survivors in the United Kingdom are unlikely to have regular contact with an oncologist; most are discharged from hospital follow-up 3 to 5 years after the diagnosis. Primary care physicians are the first point of contact for patients in the United Kingdom and act as gatekeepers to secondary care. Cancer survivors in the United Kingdom are therefore likely to receive most of their long-term comprehensive health care solely from a primary health care team experienced in the care of chronic conditions. As research from the United States suggests, however, individuals seeing an oncologist as well as a primary care physician will receive better care for cancer-related issues. It is possible that only being able to access a primary care physician in the first case may mean that fewer oncology issues are monitored in long-term cancer survivors in the United Kingdom. Our study did not specifically consider this issue.

### Strengths and Weaknesses

The strengths of this study include the large number of cancer survivors and control patients, and the representative nature of the population. Some of the limitations of this research are common to other studies using large administrative databases. First, because patient records were not primarily collected for research purposes, it is possible that some tests and diagnoses were not accurately or fully recorded. Because this analysis was conducted as case-control comparisons, completeness of recording should not affect our results; it is unlikely that the services con-

sidered in this report would be coded preferentially in either population. Second, because we are using a primary care database, we are unlikely to account for disease monitoring provided in the hospital or in specialized clinics. In the United Kingdom, however, most cancer survivors are discharged to the care of their primary care physician by 5 years after the diagnosis. Most of their care will therefore occur in primary care and is likely to be captured in this cohort of long-term survivors in the GPRD.

There are 2 main methodological limitations to this research. Although some of the individuals had a history of more than 1 of the chronic diseases considered in this report, we have treated them separately in each analysis. A higher proportion of all cancer survivors had more than 1 chronic disease, which possibly may have introduced a bias, as patients with multiple morbidities may receive better care.<sup>26,27</sup> Even so, we believe that it was appropriate to analyze the patients with 2 or more chronic diseases similarly to those with only 1 chronic disease, as the QOF guidelines that were used as the benchmark of care are specific to each condition regardless of multimorbidity. Second, although we have conducted numerous statistical tests for the proportion of individuals receiving monitoring and quarterly control of disease, we have not adjusted for multiple comparisons. It is not always necessary to make adjustments for multiple comparisons, especially as these results are based on observed, and not random data.<sup>28</sup>

### Unanswered Questions and Future Research

There are several unanswered questions arising from this research. Our results suggest that primary care physicians may change disease-monitoring practices in dying cancer survivors. It was not possible, however, to access additional information to determine which patients were specifically receiving end-of-life care. The GPRD will soon be linked to death registration data from the Office for National Statistics (ONS), which will allow us to investigate cause of death and primary care provision in those cancer survivors dying from cancer. We also considered chronic disease care in cancer survivors at least 5 years after the diagnosis only, when their disease monitoring was likely to be reported in a primary care database. Further work should be conducted to explore whether shorter-term cancer survivors in the United Kingdom, who are seeing a cancer specialist on a regular basis, are receiving adequate care of other health concerns.

In an aging and growing population with increasing cancer survival rates, it is important to manage not only the cancer-specific needs of long-term survivors, but also to ensure the adequate management of comorbid disease. This research shows that care

of these specific comorbidities is not neglected in the United Kingdom because people have had a previous diagnosis of cancer.

Previous research showing disparities in chronic disease care among long-term cancer survivors in the United States may possibly be due to health system effects. Our research adds to the existing literature in this area, but is the first study to examine use of primary care services in a UK setting.

**To read or post commentaries in response to this article, see it online at <http://www.annfammed.org/cgi/content/full/8/5/418>.**

**Key words:** Neoplasms; chronic disease; comorbidity; primary health care; continuity of patient care

Submitted December 8, 2009; submitted, revised, April 10, 2010; accepted April 19, 2010.

**Funding support:** This work has been funded by Macmillan Cancer Support through its Research Capacity Development Programme and by Cancer Research UK (CR-UK) grant number C23140/A8854.

## References

- Maddams J, Brewster D, Gavin A, et al. Cancer prevalence in the United Kingdom: estimates for 2008. *Brit Jf Cancer*. 2009;101:541-547.
- Ramsey SD, Berry K, Moinpour C, Giedzinska A, Andersen MR. Quality of life in long term survivors of colorectal cancer. *Am J Gastroenterol*. 2002;97(5):1228-1234.
- Earle CC, Burstein HJ, Winer EP, Weeks JC. Quality of non-breast cancer health maintenance among elderly breast cancer survivors. *J Clin Oncol*. 2003;21(8):1447-1451.
- Earle CC, Neville BA. Under use of necessary care among cancer survivors. *Cancer*. 2004;101(8):1712-1719.
- McBean AM, Yu X, Virnig BA, McBean AM, Yu X, Virnig BA. The use of preventive health services among elderly uterine cancer survivors. *Am J Obstet Gynecol*. 2008;198(1):86-88, e1-e8.
- Snyder CF, Earle CC, Herbert RJ, Neville BA, Blackford AL, Frick KD. Preventive care for colorectal cancer survivors: a 5-year longitudinal study. *J Clin Oncol*. 2008;26(7):1073-1079.
- Snyder CF, Earle CC, Herbert RJ, Neville BA, Blackford AL, Frick KD. Trends in follow-up and preventive care for colorectal cancer survivors. *J Gen Intern Med*. 2008;23(3):254-259.
- Snyder CF, Frick KD, Peairs KS, et al. Comparing care for breast cancer survivors to non-cancer controls: a five-year longitudinal study. *J Gen Intern Med*. 2009;24(4):469-474.
- Hewitt M, Rowland JH, Yancik R. Cancer survivors in the United States: age, health, and disability. *J Gerontol A Biol Sci Med Sci*. 2003;58(1):82-91.
- Meyerhardt JA, Catalano PJ, Haller DG, et al. Impact of diabetes mellitus on outcomes in patients with colon cancer. *J Clin Oncol*. 2003;21(3):433-440.
- Cancer Research UK. CancerStats. Survival - UK. <http://info.cancer-researchuk.org/cancerstats/survival/>. 2006. Accessed Sep 3, 2009.
- Cheung WY, Neville BA, Cameron DB, Cook EF, Earle CC. Comparisons of patient and physician expectations for cancer survivorship care. *J Clin Oncol*. 2009;27(15):2489-2495.
- Khan NF, Ward A, Watson E, Austoker J, Rose PW. Long-term survivors of adult cancers and uptake of primary health services: a systematic review. *Eur J Cancer*. 2008;44(2):195-204.
- The GPRD practice and patient populations. [http://www.gprd.com/\\_docs/GPRD%20Practice%20Patient%20Populations.pdf](http://www.gprd.com/_docs/GPRD%20Practice%20Patient%20Populations.pdf). 2009. Accessed Sep 2, 2009.
- Khan NF, Harrison SE, Rose PW. Validity of diagnostic coding within the General Practice Research Database: a systematic review. *Br J Gen Pract*. 2010;60(572):e128-e136.
- Khan NF, Perera R, Harper S, Rose PW. Adaptation and validation of the Charlson Index for Read/OXMIS coded databases. *BMC Fam Pract*. 2010;11:1.
- Department of Health. Quality and Outcomes Framework. [http://www.dh.gov.uk/en/Healthcare/Primarycare/Primarycarecontracting/QOF/DH\\_099079](http://www.dh.gov.uk/en/Healthcare/Primarycare/Primarycarecontracting/QOF/DH_099079). 2006.
- Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. *J Chronic Dis*. 1987;40(5):373-383.
- Snyder CF, Frick KD, Kantsiper ME et al. Prevention, screening, and surveillance care for breast cancer survivors compared with controls: changes from 1998 to 2002. *J Clin Oncol*. 2010;21(1)29-30.
- Campbell S, Reeves D, Kontopantelis E, Middleton E, Sibbald B, Roland M. Quality of primary care in England with the introduction of pay for performance. *N Engl J Med*. 2007;357(2):181-190.
- Campbell SM, Roland MO, Middleton E, Reeves D. Improvements in quality of clinical care in English general practice 1998-2003: longitudinal observational study. *BMJ*. 2005;331(7525):1121.
- National Primary Care Research and Development Centre. Spotlight: what difference has QOF made? Manchester, UK: University of Manchester; 2009. <http://www.npcrdc.ac.uk/Publications/QOFSpotlight2009.pdf>.
- Crosson JC, Ohman-Strickland PA, Campbell S, et al. A comparison of chronic illness care quality in US and UK family medicine practices prior to pay-for-performance initiatives. *Fam Pract*. 2009; 26(6):510-516.
- Roland M. Linking physicians' pay to the quality of care—a major experiment in the United Kingdom. *N Engl J Med*. 2004;351(14): 1448-1454.
- Campbell SM, Reeves D, Kontopantelis E, Sibbald B, Roland M. Effects of pay for performance on the quality of primary care in England. *N Engl J Med*. 2009;361(4):368-378.
- Bae S, Rosenthal MB. Patients with multiple chronic conditions do not receive lower quality of preventive care. *J Gen Intern Med*. 2008;23(12):1933-1939.
- Higashi T, Wenger NS, Adams JL, et al. Relationship between number of medical conditions and quality of care. *N Engl J Med*. 2007;356(24):2496-2504.
- Rothman KJ. No adjustments are needed for multiple comparisons. *Epidemiology*. 1990;1(1):43-46.