Impact of deprivation and rural residence on treatment of colorectal and lung cancer

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For common cancers, survival is poorer for deprived and outlying, rural patients. This study investigated whether there were differences in treatment of colorectal and lung cancer in these groups. Case notes of 1314 patients in north and northeast Scotland who were diagnosed with lung or colorectal cancer in 1995 or 1996 were reviewed. On univariate analysis, the proportions of patients receiving surgery, chemotherapy and radiotherapy appeared similar in all socio-economic and rural categories. Adjusting for disease stage, age and other factors, there was less chemotherapy among deprived patients with lung cancer (odds ratio 0.39; 95% confidence intervals 0.16 to 0.96) and less radiotherapy among outlying patients with colorectal cancer (0.39; 0.19 to 0.82). The time between first referral and treatment also appeared similar in all socio-economic and rural groups. Adjusting for disease stage and other variables, times to lung cancer treatment remained similar, but colorectal cancer treatment was quicker for outlying patients (adjusted hazard ratio 1.30; 95% confidence intervals 1.03 to 1.64). These findings suggest that socio-economic status and rurality may have a minor impact on modalities of treatment for colorectal and lung cancer, but do not lead to delays between referral and treatment.

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Lung and colorectal cancers are two of the most commonly diagnosed cancers and the most common causes of cancer related death in Scotland (ISD, 2001). Several studies in different countries have found that survival from these cancers varies with socio-economic and geographical factors (Kogevinas and Porta, 1997; Campbell et al, 2000). In a recent analysis of Scottish cancer registry data, survival from lung and colorectal cancer was poorer for patients resident in the most deprived areas compared to those in the least deprived areas (McLaren and Bain, 1998). Another analysis of this data found that, compared with those living in towns and cities with cancer centres, adjusted survival for patients living in rural areas was 9% poorer for lung and 11% poorer for colorectal cancer (Campbell et al, 2000).

Stage at diagnosis and treatment are the principal determinants of cancer survival (Auvinen and Karjalainen, 1997). We and others have shown that patients in rural areas have more advanced disease at diagnosis (Liff et al, 1991; Launoy et al, 1992; Campbell et al, 2001) but the relationship between stage and socio-economic status remains unclear with conflicting results in different studies (Auvinen and Karjalainen, 1997; Ionescu et al, 1998). With regard to treatment, there are some indications that management is poorer for rural patients with lung cancer in North America (Greenberg et al, 1988) and colorectal cancer in France (Launoy et al, 1992). Similarly, deprived patients with colorectal cancer were found to have poorer treatment in Finland (Auvinen and Karjalainen, 1997). A study of computerised hospital discharge data in Scotland has suggested that patients with colorectal cancer from deprived areas are less likely to be treated with chemotherapy (McLeod, 1999). Overall, however, research findings have been conflicting and little has been reported in the United Kingdom (Auvinen and Karjalainen, 1997). In this study, we investigated whether there were variations in treatment of colorectal and lung cancer with socio-economic deprivation and urban/rural residence.

PATIENTS AND METHODS

This was a historical cohort study. Details of sampling and data collection have been described previously (Campbell et al, 2001). Briefly, all patients diagnosed with colorectal or lung cancer in north or northeast Scotland in 1995 and 1996 were identified by the Scottish cancer registry and a random sample of 1398 selected, weighted to ensure equal numbers of lung and colorectal cancers and urban and rural participants. Sets of case notes could be obtained from teaching and general hospitals in Grampian and Highland for 1323 (95%) of the cohort. Clinical data were abstracted in a standardised manner. There were no important differences in patient characteristics between cases whose notes were reviewed and those whose notes were not traced (Campbell et al, 2001). Nine patients died the same day that they were diagnosed so were excluded from follow up, leaving 1314 cases for analysis.

The main outcomes of the study were surgery, radiotherapy and chemotherapy within 1 year of diagnosis and the length of time between first referral (date of referral letter, or first contact with hospital if there was no referral) and first treatment with surgery, radiotherapy or chemotherapy. The main independent variables were material deprivation (as a proxy for socio-economic status) and urban-rural status. Indicators of deprivation and urban-rural status were assigned to cases according to their ‘output area’ of residence. Output areas, which

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are the smallest unit of population on which census data are available in Scotland (median population 130), are more sensitive than larger areas when measuring socio-economic deprivation and geographical location in rural areas (Reading et al., 1993; Campbell et al., 2000). Carstairs deprivation scores were calculated from 1991 census data at the output area level and grouped into population quintiles (Carstairs and Morris, 1990). Distance to the nearest cancer centre (in Aberdeen or Inverness) was used as the basis of the indicator of urban-rural status because it has been found to be associated with poorer survival in previous research in Scotland (Campbell et al., 2000). Patients were assigned to one of four predefined categories: 0 to 5 km, 6 to 37 km, 38 to 57 km and $\geq$ 58 km (Campbell et al., 2001). Other variables considered in the analysis were sex, age, settlement size, health board of residence, previous history of cancer, and presentation (emergency hospital admission or not). Cancer site (colon or rectum) and Dukes stage were considered in the analysis of colorectal cancer, and tumour histology (non-small cell or small cell) and ISS stage in the analysis of lung cancer.

Data were managed using Microsoft Access and analysed using SPSS for Windows release 9. Data on the two cancers were analysed separately. Proportions of cases receiving surgery, radiotherapy and chemotherapy were compared using the chi-square test and modelled using logistic regression. Differences in time between referral and first treatment were compared using Kaplan–Meier curves and the log rank test and modelled using Cox regression.

### RESULTS

In all, 661 cases with lung cancer and 653 with colorectal cancer were included in the analysis. Selected characteristics are shown in Table 1. For both types of cancer, more than 80% of patients were included in the analysis. Selected characteristics are shown in Table 1. For both types of cancer, more than 80% of patients were included in the analysis.

#### Table 1

| Characteristic                  | Lung (n=661) | Colorectal (n=653) |
|--------------------------------|--------------|--------------------|
| **Distance to centre**         |              |                    |
| $\leq$5 km                     | 223 (34)     | 195 (30)           |
| 6 – 37 km                      | 101 (15)     | 127 (19)           |
| 38 – 57 km                     | 150 (23)     | 161 (25)           |
| $\geq$ 58 km                   | 187 (28)     | 170 (26)           |
| **Sex**                        |              |                    |
| Male                           | 412 (62)     | 337 (52)           |
| Female                         | 249 (38)     | 316 (48)           |
| **Age band**                   |              |                    |
| $\leq$59                       | 104 (16)     | 121 (19)           |
| 50 – 69                        | 212 (32)     | 159 (24)           |
| 70 – 79                        | 248 (38)     | 216 (33)           |
| $\geq$ 80                      | 97 (15)      | 157 (24)           |
| **Settlement size**            |              |                    |
| > 100 000                      | 194 (29)     | 165 (25)           |
| 10 000 – 100 000               | 133 (20)     | 119 (18)           |
| 100 000 – 10 000               | 205 (31)     | 221 (34)           |
| 500 – 1000                     | 32 (5)       | 30 (5)             |
| $< 500$                        | 97 (15)      | 118 (18)           |
| **Health board of residence**  |              |                    |
| Grampian                       | 473 (72)     | 476 (73)           |
| Highland                       | 188 (28)     | 177 (27)           |
| **First primary tumour**       | 596 (90)     | 596 (91)           |
| **Place of first referral**    |              |                    |
| General practice               | 534 (81)     | 557 (85)           |
| Hospital                       | 59 (10)      | 35 (6)             |
| Screening                      | 0            | 4 (< 1)            |
| Emergency (no referral)        | 28 (5)       | 19 (3)             |
| Not known                      | 40 (6)       | 38 (6)             |
| Emergency hospital admission   | 228 (34)     | 220 (34)           |
| **Lung histology**             |              |                    |
| Small cell                     | 91 (14)      |                    |
| Non small cell                 | 417 (63)     |                    |
| Not known                      | 153 (23)     |                    |
| **ISS stage (excluding small cells)** |          |                    |
| I                              | 97 (17)      |                    |
| II                             | 26 (5)       |                    |
| III                            | 192 (31)     |                    |
| IV                             | 169 (30)     |                    |
| Not known                      | 81 (14)      |                    |
| **Colorectal site**            |              |                    |
| Colon                          | 447 (68)     |                    |
| Rectum                         | 206 (32)     |                    |
| **Dukes stage**                |              |                    |
| A                              | 61 (9)       |                    |
| B                              | 249 (38)     |                    |
| C                              | 185 (28)     |                    |
| D                              | 117 (18)     |                    |
| Not known                      | 41 (6)       |                    |
### Table 3: Adjusted odds ratios (95% confidence intervals) for treatment with surgery, radiotherapy and chemotherapy within one year of diagnosis

#### Lung cancer

| Deprivation quintile | Surgery | Radiotherapy | Chemotherapy |
|----------------------|---------|--------------|--------------|
| 1                    | 0.76 (0.28 – 2.09) | 2.08 (1.11 – 3.91) | 0.58 (0.21 – 1.57) |
| 2                    | 0.70 (0.27 – 1.84) | 2.27 (1.24 – 4.16) | 0.72 (0.29 – 1.78) |
| 3                    | 0.88 (0.35 – 2.22) | 1.47 (0.83 – 2.60) | 0.41 (0.16 – 1.00) |
| 4                    | 0.59 (0.23 – 1.53) | 1.86 (1.05 – 3.28) | 0.39 (0.16 – 0.96) |
| 5                    | 0.791 | 0.056 | 0.189 |
| P value (trend)      | 0.423 | 0.378 | 0.208 |
| P value (global)     | 0.791 | 0.056 | 0.189 |

#### Distance to centre

| Distance to centre | Surgery | Radiotherapy | Chemotherapy |
|--------------------|---------|--------------|--------------|
| ≤5 km              | 1.66 (0.73 – 3.78) | 1.18 (0.70 – 1.98) | 1.38 (0.61 – 3.14) |
| 6 – 37 km          | 1.24 (0.61 – 2.51) | 1.52 (0.97 – 2.38) | 1.93 (0.98 – 3.83) |
| ≥38 km             | 1.61 (0.80 – 3.23) | 0.99 (0.65 – 1.53) | 1.43 (0.71 – 2.85) |

#### Other variables adjusted for:

- **Health Board**: A
- **Emergency admission**: No
- **Age (per year)**: 0.91 (0.89 – 0.94)
- **Tumour**: ISS stage I

#### Colon cancer

| Deprivation quintile | Surgery | Radiotherapy | Chemotherapy |
|----------------------|---------|--------------|--------------|
| 1                    | 0.48 (0.15 – 1.58) | 0.27 (0.10 – 0.72) | 0.86 (0.41 – 1.81) |
| 2                    | 0.70 (0.20 – 2.37) | 0.61 (0.28 – 1.32) | 0.64 (0.32 – 1.30) |
| 3                    | 0.51 (0.16 – 1.58) | 0.84 (0.40 – 1.76) | 0.65 (0.33 – 1.27) |
| 4                    | 0.52 (0.14 – 1.87) | 0.85 (0.38 – 1.91) | 0.49 (0.22 – 1.10) |
| 5                    | 0.718 | 0.050 | 0.425 |
| P value (trend)      | 0.394 | 0.504 | 0.059 |
| P value (global)     | 0.316 | 0.014 | 0.517 |

#### Other variables adjusted for:

- **Health Board**: A
- **Emergency admission**: No
- **Age (per year)**: 0.96 (0.93 – 0.99)
- **Tumour – Dukes stage**: A

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 were referred from general practice and a third were emergency hospital admissions.

Of 653 patients with lung cancer, 85 (13%) had surgery, 412 (63%) radiotherapy and 124 (19%) chemotherapy in the first year after diagnosis (details of treatment were incomplete for eight patients). For colorectal cancer, 583 out of 642 (91%) patients had surgery, 145 out of 642 (23%) chemotherapy and 82 out of 643 (13%) radiotherapy (data on surgery and chemotherapy were incomplete for 11 patients and on radiotherapy for 10 patients). On univariate analysis, there were few differences in proportions of patients receiving surgery, chemotherapy and radiotherapy by either deprivation or rurality (Table 2). Of the potential confounding variables, disease stage was strongly associated with the likelihood of all three forms of treatment for both cancers. Age, health board of residence, mode of presentation (emergency admission or otherwise), and cancer site (colon or rectum) were associated with some treatments. Table 3 shows the adjusted odds ratios for treatment with surgery, radiotherapy and chemotherapy within 1 year of diagnosis. A least deprived is ‘1’ and most deprived ‘5’.

**DISCUSSION**

We found that in the north and northeast of Scotland, there was limited evidence that deprivation and rurality were associated with differences in treatment. There may be some impact on treatment modalities, but no worsening of treatment delay.

This study has a number of strengths and limitations. The Scottish Cancer Registry has high levels of case ascertainment over a long period, being reported as at least 96% complete (Brewster et al, 1997). In this study, the rate of case note retrieval (95%) was high and we have previously shown that there were no important differences between cases whose notes were retrieved and those whose notes were not (Campbell et al, 2001). The setting for the study had two cancer centres located in the two main cities, whose notes were not (Campbell et al, 1997). In this study, the rate of case note retrieval (95%) was high and we have previously shown that there were no important differences between cases whose notes were retrieved and those whose notes were not (Campbell et al, 2001). The setting for the study had two cancer centres located in the two main cities, reasonably close to about half their populations, but with the remainder spread over a large rural area. This made the comparison of rural and urban areas relatively straightforward. On the other hand, comparison of deprivation categories was more difficult. North and Northeast Scotland do not have the same high levels of deprivation seen in some other areas (for example, the central industrial belt of Scotland)—there are, however, significant pockets of deprivation and overall the area is less affluent than, for example, England and Wales (Carstairs and Morris, 1990). A second problem is that levels of deprivation are more difficult to assess in rural areas where affluence and poverty can coexist in close proximity. In an attempt to improve sensitivity, we calculated deprivation scores at the level of the smallest area possible—this

![Figure 1](image-url)

*Figure 1 Adjust odds ratios (95% confidence intervals) for treatment with surgery, radiotherapy and chemotherapy within 1 year of diagnosis. *Least deprived is ‘1’ and most deprived ‘5’.*
Table 4  Time between first referral and first treatment (surgery, chemotherapy or radiotherapy)

| Lung cancer | Median (Interquartile range)a | Adjusted hazard ratio (95% CI)b |
|-------------|------------------------------|--------------------------------|
| Deprivation quintile | | |
| 1 | 33 (15, 104) | 1 |
| 2 | 38 (11, 78) | 1.12 (0.79 – 1.59) |
| 3 | 39 (17, 81) | 1.08 (0.78 – 1.51) |
| 4 | 42 (16, 121) | 0.94 (0.68 – 1.30) |
| 5 | 25 (13, 77) | 1.07 (0.78 – 1.49) |
| P value (global) | 0.152 | 0.702 |
| P value (trend) | 0.480 | 0.813 |
| Distance to centre | | |
| ≤5 km | 38 (15, 118) | 1 |
| 6–37 km | 40 (16, 87) | 1.06 (0.80 – 1.40) |
| 38–57 km | 25 (13, 55) | 1.34 (1.06 – 1.70) |
| ≥58 km | 39 (14, 87) | 1.11 (0.88 – 1.40) |
| P value (global) | 0.073 | 0.092 |
| P value (trend) | 0.280 | 0.146 |
| Other variables adjusted for: | | |
| Tumour | | |
| ISS stage I | 61 (23, 147) | 1.26 (0.78 – 2.03) |
| ISS stage II | 52 (25, 118) | 1.55 (1.18 – 2.03) |
| ISS stage III | 33 (14, 72) | 1.43 (1.07 – 1.90) |
| ISS stage IV | 30 (14, 81) | 1.38 (1.06 – 1.70) |
| Not known | 78 (18, 200) | 1.24 (0.93 – 1.67) |
| Small cell | 18 (12, 40) | 2.19 (1.59 – 3.02) |
| Age | | |
| <60 | 22 (12, 47) | 1 |
| 60–69 | 35 (16, 72) | 0.71 (0.55 – 0.91) |
| 70–79 | 33 (13, 115) | 0.62 (0.48 – 0.80) |
| 80 or over | 97 (19, 200) | 0.41 (0.28 – 0.58) |
| Health board | | |
| A | 30 (14, 76) | 0.73 (0.60 – 0.89) |
| B | 44 (18, 115) | | |
| Colorectal cancer | | |
| Deprivation quintile | | |
| 1 | 50 (20, 88) | 1 |
| 2 | 36 (13, 77) | 1.27 (0.96 – 1.69) |
| 3 | 35 (18, 67) | 1.30 (0.99 – 1.70) |
| 4 | 38 (16, 86) | 1.13 (0.87 – 1.48) |
| 5 | 37 (11, 76) | 1.24 (0.93 – 1.67) |
| P value (global) | 0.445 | 0.333 |
| P value (trend) | 0.264 | 0.363 |
| Distance to centre | | |
| ≤5 km | 43 (20, 84) | 1 |
| 6–37 km | 43 (19, 89) | 1.03 (0.81 – 1.31) |
| 38–57 km | 27 (14, 66) | 1.31 (1.05 – 1.67) |
| ≥58 km | 44 (14, 77) | 1.30 (1.03 – 1.64) |
| P value (global) | 0.230 | 0.027 |
| P value (trend) | 0.220 | 0.006 |
| Other variables adjusted for: | | |
| Dukes stage | | |
| A | 55 (27, 118) | 1 |
| B | 35 (16, 76) | 1.33 (0.99 – 1.78) |
| C | 33 (12, 72) | 1.48 (1.07 – 2.01) |
| D | 31 (14, 79) | 1.03 (0.74 – 1.45) |
| Not known | 66 (44, 200) | 0.32 (0.18 – 0.57) |
| Emergency admission | | |
| No | 54 (27, 95) | 1 |
| Yes | 15 (3, 36) | 2.05 (1.70 – 2.48) |

aCalculated using the Kaplan-Meier method and analysed with the log rank test.
bCalculated using Cox regression (a higher hazard ration indicates quicker treatment).
With regard to patients in rural areas, we have previously reported that they have more advanced disease at diagnosis (Campbell et al., 2001). In a qualitative study, they expressed concern that their route from referral to diagnosis and treatment was more complicated (involving peripheral hospitals and outreach clinics) and therefore slower (Bain and Campbell, 2000). In this study, however, we found no evidence of increased delays between referral and treatment—in fact, treatment appeared to be quicker for patients from outlying areas after adjusting for disease stage and emergency admissions. The only difference in treatment we detected was less radiotherapy for colorectal cancer. This finding is in line with research in the United States which suggested that travelling distance was taken into account when considering treatment options of uncertain benefit (Greenberg et al., 1988). Radiotherapy was not a standard treatment in Scotland for the majority of patients with colorectal cancer at the time patients in this study were diagnosed (1995–1996) (SIGN, 1997). On the other hand, where radiotherapy was a standard treatment (in lung cancer (SIGN, 1998)), there were no differences in treatment rates. We have previously reported that more advanced disease at diagnosis in rural patients is probably the main reason for their poorer survival (Campbell et al., 2001). Our current findings suggest that they are not substantially disadvantaged after diagnosis in terms of the treatment they receive, and that any delays in diagnosis occur before the point of referral.

In conclusion, deprivation and rural factors may have some impact on treatment of colorectal and lung cancer. It seems unlikely, however, that they are the most important factors contributing to inequalities in survival, at least in Scotland. For patients in outlying areas, more advanced stage at diagnosis remains the most important factor. For the socio-economically deprived, the reasons for poor survival remain unclear, but are likely to involve more complex factors than stage at diagnosis and treatment.

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