Using maps and funnel plots to explore variation in place of death from cancer within London, 2002–2007

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Abstract
London has a high proportion of hospital deaths, which health policy seeks to reduce. We explore variation and trends in place of death from cancer within London between 2002 and 2007. Mortality data based on death certificates were used to define deaths from cancer at home, hospice, hospital and nursing home and examine trends over time for London. Proportions of deaths in each place were presented in maps for 31 London primary care trusts (PCTs). Funnel plots were used to identify consistent performance outside the control limits of three standard deviations. There was little overall change in place of death for London, but consistent variation between PCTs. Outer London PCTs had higher proportions of home deaths and inner London PCTs higher proportions of hospice deaths. Funnel plots identified consistent high outlying performance for home, hospice and hospital deaths. No PCT showed a change of 10% or more in home deaths, but five showed decreasing hospital deaths and three increasing hospice deaths. Maps and funnel plots appear useful for identifying areas with differing performance for home, hospital, nursing home and hospice deaths. These methods may help further investigation of how local services may successfully support deaths outside hospital.

Keywords
End-of-life care, health policy, inequalities, place of death

Introduction
The English National Health Service (NHS) End of Life Care Strategy aims to enable more people to die in the place of their choice. One key area is care planning, so that the needs and preferences of individuals approaching the end of their life, including their wishes for care, advance directives and place of death, can be discussed and recorded. Although the NHS Cancer Reform Strategy indicated that many people who die from cancer receive high-quality end-of-life care, it identified gaps, especially in determining people's care preferences and taking action to support people to live and die in the place of their choice. Studies have found that the majority of people would prefer to die at home. However, mortality statistics for deaths from all causes registered in 2008 in England and Wales indicate that only 20% of deaths occurred at home. For neoplasms (ICD C00-D48), the figure was 26%.

Previous English studies have demonstrated geographical variation in home, hospice, nursing home and hospital deaths, which can be observed at electoral ward, primary care trust (PCT) and cancer network level. London has relatively high rates of death in hospital and low levels of death at home compared to the rest of England. Since 2001, 31 PCTs have been responsible for commissioning end-of-life services for their populations, and they were recently asked to
focus on enabling choice of place of death as part of the End of Life Care Strategy. Specific initiatives to help reduce the proportion of hospital deaths and increase the proportion of deaths outside hospital from 66% to 50% by 2013 were recently launched. In this study we aimed to investigate variation in place of death between London PCTs, and identify differences in their performance over the period 2002–2007. Our objectives were: (1) to explore cancer mortality data for deaths in home, hospice, hospital and nursing homes for 2002–2007 using maps and funnel plots; and (2) to compare year-on-year data to identify PCTs with consistently high or low performance or changes in place of death.

Methods
We used Office for National Statistics (ONS) mortality data for deaths registered between the years 2002 and 2007, extracting data for each year where the underlying cause of death was a malignant neoplasm (ICD10 C00-C97) and the death occurred in individuals who were resident in the London Government Office Region. We used the communal establishment data to define five types of place of death: home, hospice, hospital (including multifunctional sites), long-stay nursing and geriatric homes (from now on referred to as nursing homes) and other/unknown. Multifunction sites are generally those hospitals that fall into two or more types of communal establishment; for example, a hospital may include maternity, psychiatric and/or geriatric facilities. To determine if there was a change in the characteristics of the London sample across the six-year period that might account for the observed changes in place of death, we calculated the yearly proportion of deaths by sex, cancer grouping, deprivation quintile and the yearly mean age. The postcode of usual residence of the deceased was used at the lower super output area level to assign deprivation quintiles based on the income domain of the Indices of Multiple Deprivation 2004. New cancer groupings were created by recoding the 88 International Classification of Diseases (ICD) ‘C’ codes provided in the ONS mortality file into 15 categories of the most common malignant neoplasms.

Analysis
We produced maps to illustrate the proportion of deaths in PCT populations in the four settings, home, hospice, hospital and nursing home, for each year from 2002 to 2007. We excluded deaths in the other/not known setting due to small numbers. Data were presented in quartiles, giving approximately equal numbers of PCTs in each category. To compare PCTs, we plotted the proportion of home, hospice, hospital and nursing home deaths in funnel plots for each of the six years. These were produced using spreadsheets developed by the Eastern Public Health Observatory. Using data on home deaths in 2007 as an example (Figure 1(b)), the observed proportion of home deaths for each PCT was plotted against the total number of cancer deaths in London, with 95% (approximately two standard deviations) and 99.8% (approximately three standard deviations) prediction limits superimposed around the average proportion for London. The funnel plots allow identification of performance outside control limits, which is referred to as ‘special cause variation’. We considered PCTs that lay outside of the 99.8% limits as exhibiting special cause variation and warranting further investigation. Finally, year-on-year performance in each of the four settings was examined for each PCT by comparing the yearly funnel plots and highlighting PCTs that fell below or above the 99.8% limits in 4 or more of the 6 years. To assess consistent changes in place of death we calculated Chi-squared tests for trend across the years 2002–2007, but we draw attention only to those where the absolute change was equal to or greater than 10 percentage points. The large samples sizes meant that small changes could reach statistical significance that may not be of practical interest for those implementing palliative care policies. Investigation of areas exhibiting particularly marked patterns or consistent changes in place of death are likely to be reveal most useful insights.

Ethical approval
Cancer registries in England carry out surveillance using the data they receive under Section 251 of the NHS Act 2006. Therefore separate ethical approval was not sought for this study.

Results
Table 1 shows there were between 13,277 and 14,681 cancer deaths in each year. The mean age and proportion of males remained stable across the six-year period at approximately 72 years and 52%, respectively. Similarly, the proportion of individuals falling into each national quintile of deprivation remained stable at approximately 11%, 14%, 19%, 26% and 30% for quintiles one through five. The proportion of deaths in each setting changed only slightly. Deaths in the hospital setting were the most common (50%–56%), followed by deaths in hospice (18%–20%), home (17%–19%), nursing homes (6%–8%) and other/not known (1%–2%). The overall distribution of patients by cancer type did not change (data not shown).
**Home deaths**

Figure 1(a) shows the proportion of home deaths in London in 2007 mapped by PCT of residence. The lowest proportion of home deaths occurred in Tower Hamlets (12%) and the highest in Havering (27%). The map shows a tendency for higher proportions in outer London PCTs, and this was observed in each of the other five years (maps not shown). Figure 1(a) also shows that some PCTs with a high proportion of
home deaths lie adjacent to PCTs with a low proportion, for example, Barking and Dagenham, and Redbridge. Again, this situation was observed in the maps for each of the other five years. Figure 1(b) shows the funnel plot for the proportion of home deaths in London in 2007. This indicates significant variation in these proportions, with three PCTs falling above the upper limit of three standard deviations of the distribution of the funnel and two falling below the lower limit. Funnel plots for the other five years revealed that no PCTs fell below the lower limit in four or more of the six years. Three PCTs (Bexley, Bromley and Hillingdon) fell above the upper limit of three standard deviations in at least four of the years (data not shown). Six PCTs showed a significant trend in the proportion of home deaths across the period, but the overall changes were less than 10 percentage points.

**Hospice deaths**

Figure 2(a) shows the proportion of hospice deaths in London in 2007 mapped by PCT of residence with the geographical locations of individual hospices added to aid interpretation. Again there was variation between PCTs in the proportion of hospice deaths in 2007. Hillingdon had the lowest (0.4%), and Tower Hamlets the highest (38%). However, in contrast to home deaths, there was a tendency towards a higher proportion of hospice deaths in inner London PCTs. This pattern was observed in the other five years (maps not shown). Of the seven PCTs with the highest proportion of hospice deaths, four contained a hospice. Conversely, of the eight PCTs with the lowest proportion of hospice deaths, only one contained a hospice, although this finding was not statistically significant (Fisher’s exact p-value = 0.12). The corresponding funnel plot for the proportion of deaths in hospice in London in 2007 is shown in Figure 2(b). This indicates that five PCTs fell above the upper limit of three standard deviations, and five PCTs below the lower limit. No PCT fell above the upper limit of three standard deviations on both home and hospice deaths, although one PCT fell below the lower limit of three standard deviations on both (Waltham Forest). Funnel plots for each of the six years indicated that three PCTs (Hillingdon, Redbridge and Waltham Forest) fell below the lower limit of three standard deviations in at least four of the years. Three PCTs (Camden, Tower Hamlets and Westminster) fell above the upper limit of three standard deviations on both (Waltham Forest). Funnel plots for each of the six years indicated that three PCTs (Hillingdon, Redbridge and Waltham Forest) fell below the lower limit of three standard deviations in at least four of the years. Three PCTs (Camden, Tower Hamlets and Westminster) fell above the upper limit of three standard deviations in at least four of the years. Nine PCTs showed a significant trend in hospice deaths, although in only three was the change of 10 percentage points or greater. These were Camden (from 24% to 35%, \( \chi^2 \) trend = 7.2, \( p = 0.008 \)), Tower Hamlets (from 25% to 38%, \( \chi^2 \) trend = 14.2, \( p < 0.001 \)) and Westminster (from 17% to 32%, \( \chi^2 \) trend = 15.1, \( p < 0.001 \)).

### Table 1. Yearly comparison of age, gender, deprivation and place of cancer death in London, 2002–2007

<table>
<thead>
<tr>
<th>Year</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<tr>
<td>Age mean (SD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>71.8 (13.7)</td>
<td>72.0 (13.7)</td>
<td>71.9 (13.8)</td>
<td>72.0 (13.7)</td>
<td>72.0 (13.9)</td>
<td>72.1 (14.0)</td>
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<tr>
<td>Number %</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Male</td>
<td>7,570</td>
<td>51.6</td>
<td>7,362</td>
<td>51.0</td>
<td>7,276</td>
<td>51.8</td>
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<tr>
<td>Female</td>
<td>7,111</td>
<td>48.4</td>
<td>7,071</td>
<td>49.0</td>
<td>6,771</td>
<td>48.2</td>
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<tr>
<td>Most affluent 1</td>
<td>1,595</td>
<td>10.9</td>
<td>1,588</td>
<td>11.0</td>
<td>1,634</td>
<td>11.6</td>
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<tr>
<td>2</td>
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<td>3</td>
<td>2,648</td>
<td>18.0</td>
<td>2,705</td>
<td>18.7</td>
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<tr>
<td>4</td>
<td>3,810</td>
<td>26.0</td>
<td>3,688</td>
<td>25.6</td>
<td>3,558</td>
<td>25.6</td>
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<tr>
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<td>4,375</td>
<td>30.3</td>
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<tr>
<td>Home</td>
<td>2,655</td>
<td>18.1</td>
<td>2,537</td>
<td>17.6</td>
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<td>17.9</td>
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<tr>
<td>Hospice</td>
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<td>18.2</td>
<td>2,814</td>
<td>19.5</td>
<td>2,754</td>
<td>12.7</td>
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<tr>
<td>Hospital</td>
<td>8,232</td>
<td>56.1</td>
<td>7,860</td>
<td>54.5</td>
<td>7,716</td>
<td>54.9</td>
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<td>Nursing home</td>
<td>900</td>
<td>6.1</td>
<td>1,021</td>
<td>7.1</td>
<td>925</td>
<td>6.6</td>
</tr>
<tr>
<td>Other/not known</td>
<td>226</td>
<td>1.5</td>
<td>201</td>
<td>1.4</td>
<td>143</td>
<td>1.0</td>
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<tr>
<td>Number of deaths</td>
<td>14,681</td>
<td>14,433</td>
<td>14,047</td>
<td>13,858</td>
<td>13,770</td>
<td>13,277</td>
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</table>

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Figure 2. Proportion of patients dying from cancer in a hospice by primary care trust (PCT) of residence, London 2007 (a) Map (b) Funnel plot.
Hospital deaths
Figure 3(a) shows the proportion of hospital deaths in London in 2007 mapped by PCT of residence. There was variation between PCTs in the proportion of hospital deaths: Westminster had the lowest (38%), and Waltham Forest the highest (75%). Unlike home and hospice deaths, there was no clear geographical pattern. The corresponding funnel plot for the proportion of deaths in hospital is shown in Figure 3(b). This indicates that four PCTs fell above the upper limit, and two PCTs fell below the lower limit, of three standard deviations. Funnel plots for each of the six years indicated that three PCTs (Bexley, Bromley and Croydon) fell below the lower limit of three standard deviations in at least four of the years. Three PCTs (Hillingdon, Redbridge and Waltham Forest) fell above the upper limit of three standard deviations in at least four of the years. These same PCTs were previously found to have low proportions of hospice deaths, and further investigation showed that there were palliative care units within the hospital serving them. Twelve showed a significant decrease in hospital deaths across the period, and in five the decrease was of 10 percentage points or greater. These were Hammersmith and Fulham (from 66% to 55%, $\chi^2$ trend = 7.2, $p = 0.007$), Havering (from 55% to 45%, $\chi^2$ trend = 23.3, $p < 0.0001$), Hounslow (from 65% to 52%, $\chi^2$ trend = 21.2, $p < 0.0001$), Sutton and Merton (from 55% to 44%, $\chi^2$ trend = 32.2, $p < 0.0001$) and Westminster (from 64% to 38%, $\chi^2$ trend = 40.6, $p < 0.0001$).

Nursing homes
Figure 4(a) shows the proportion of nursing home deaths in London in 2007 mapped by PCT of residence. Haringey (2%) had the lowest, and Hillingdon (17%) the highest, proportion of nursing home deaths. The corresponding funnel plot for the proportion of deaths in nursing homes is shown in Figure 4(b). It shows that one PCT fell above the upper limit, and five PCTs fell below the lower limit, of three standard deviations. Funnel plots for each of the six years indicated that two PCTs (Haringey and Islington) fell below the lower limit of three standard deviations in at least four of the years. No PCT fell above the upper limit of three standard deviations in four or more of the six years. Twelve PCTs showed a significant trend in the proportion of nursing home deaths across the period but in only one was it 10% (Hillingdon, from 7% to 17%, $\chi^2$ trend = 32.0, $p < 0.0001$).

Discussion
Main findings of the study
This large study considers 84,066 cancer deaths occurring in London over the six years from 2002 to 2007. During this period the overall distribution of patients by age, sex, deprivation and cancer type did not change. However, in each year the proportion of deaths occurring in each of the four settings varied between PCTs. There was a tendency for outer London PCTs to have higher proportions of home deaths and for inner London PCTs to have higher proportions of hospice deaths, but there was no discernable pattern in the distribution of hospital or nursing home deaths. PCTs with a hospice in their area tended to have higher proportions of hospice deaths and PCTs with a high proportion of deaths in each of the four settings lay adjacent to PCTs with low proportion of deaths in the same setting. An encouraging finding is that five PCTs showed a significant decrease of 10 percentage points or more in the proportion of hospital deaths and three PCTs showed a significant increase of 10 percentage points or more in the proportion of hospice deaths. There was no comparable change in the proportion of home deaths, although one PCT showed a 10% increase in nursing home deaths. Plotting yearly proportions of deaths within funnel plots revealed consistently good performance for high home deaths in three PCTs, two of which also had consistently low hospital deaths. A further three PCTs had consistently high performance on hospice deaths. Conversely, three PCTs appeared to perform poorly, in policy terms, with consistent high hospital deaths, but they were in fact served by hospitals containing palliative care units. However, in the majority of the funnel plots the bulk of the PCTs lay within the 95% limits.

What is already known on this topic
Previous English studies have demonstrated geographical variation in place of death from cancer, for example, in home deaths at electoral ward (5%–75%); hospital deaths at PCT level (46%–77%); hospital deaths at cancer network level (10%–28%). However, these studies have generally presented their findings as ranges or in tabular form, an approach that can be criticized as leading to a spurious focus on ranking order. We used funnel plots to present variation, as these have been proposed as a more appropriate technique for investigating performance. In addition, previous studies have reported on a single year’s data...
Figure 3. Proportion of patients dying from cancer in hospital by primary care trust (PCT) of residence, London 2007 (a) Map (b) Funnel plot.
or on data aggregated over a number of years. We assessed performance across six years, determining whether those PCTs that fell outside the funnel in a particular year did so consistently. The finding that the presence of a hospice in an area of residence increases the proportion of hospice deaths was also observed in a study in the North West of England.\(^8\)

**What this study adds**

Funnel plots appear an attractive way of presenting data on place of death and of investigating differences in care patterns. They can be produced easily using available spreadsheet programmes, quickly identify outliers, and allow PCTs to reflect on their position.
within the plot and so trigger further investigation and action. Although most of the PCTs were performing within the limits specified by the funnel plots, the findings indicate a mismatch between where people wish to die (mostly at home) and actual place of death (mostly in hospital). However, the funnel plots do allow the identification of PCTs with ‘desirable’ profiles, for example, where the proportion of home deaths is above the upper limit and the proportion of acute hospital deaths is below the lower limit. Identifying the factors associated with such a profile, especially if they relate to service provision and sharing this practice, could help improve end-of-life care in London. One London study is currently investigating end-of-life care in four selected areas by gathering information from bereaved relatives and friends. Further investigations are planned by the National End of Life Care Intelligence Network, which is bringing together a wide range of datasets about service use.

Implications for policy and research

Although current UK health policy seeks to increase home deaths and decrease hospital deaths, further research is needed to explore individual preferences. Part of the widespread desire for a death at home may reflect the negative perceptions of death in hospital—from experience of loved ones dying in hospital, negative media stories or published research. While reducing the number of inappropriate hospital admissions is desirable, there will be instances where a hospital death is necessary and desirable; improving the quality and perceptions of end-of-life care in this setting is therefore important. Another consideration for the provision of end-of-life care is affordability. Cost will have to be set against an increasing demand for end-of-life care as the population of the UK ages, and possible reductions in NHS budgets and the charitable sector. One study has suggested that increasing home deaths may also reduce costs for end-of-life care. Boston PCT, which has a population of 150,000, has been the first place in the UK to have fully implemented the Marie Curie Delivering Choice Programme. This innovation resulted in an increase in home deaths from 17% to 42%, a decrease in deaths in hospital from 63% to 45% and a decrease by 8% in the total costs for end-of-life care. Further research is needed to explain the variation in place of death for cancer patients by PCT. Differences in place of death may occur as a result of differences in case mix (for example, age, cause of death, sex), differences in service delivery models (for example, hospice at home services, out of hours cover, access to controlled pain relief drugs, timely access to equipment to allow death at home like commodes and hospital beds) and differences in living conditions (tower blocks, small rooms). In addition, as cancer deaths accounted for only 28% of deaths in London in 2007, it would be useful to expand our analysis to other disease groups.

Limitations of the study

Although funnel plots appear a useful technique for investigating performance for place of death, it is important to remember that crossing the threshold of three standard deviations does not in itself imply good or poor performance, but simply acts as a trigger for further investigation. The use of maps to explore variation in place of death is an attractive visual method of presentation; however, identifying patterns in place of death is subjective. In addition, adding hospice location to aid interpretation is useful but does not take into account factors such as hospice catchment areas, number of beds or local service models. Information on communal establishments contained within the annual mortality data file is key in defining place of death, but these data do not identify deaths that take place within hospital palliative care units, or with the support of these services, or at home with the support of hospice community services. Finally, the analysis concerns place of death and not place of care during the dying phase and it does not contain any information on quality of care.

Acknowledgements

We thank Jagdip Kang for generating maps, colleagues for their comments on previous presentations and the Eastern Public Health Observatory for making the funnel plot software available.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

This work was carried out by the Thames Cancer Registry, King’s College London, which receives funding from the Department of Health; the views expressed in this publication are those of the authors and not necessarily those of the Department of Health.

Competing interests

The authors declare that they have no competing interests.

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