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Estimating the cost of caring for people with cancer at the end of life: A modelling study

Jeff Round¹, Louise Jones² and Steve Morris³

Abstract
Background: People with advanced cancer require a range of health, social and informal care during the final phases of life. The cost of providing care to this group as they approach the end of their lives is unknown, but represents a significant cost to health and social care systems, charities patients and their families.

Aim: In this study, we estimate the direct and indirect costs for lung, breast, colorectal and prostate cancer patients at the end of life (from the start of strong opioids to death) in England and Wales.

Methods: We use a modelling-based approach to estimate the costs of care. Data are estimated from the literature and publicly available data sets. Probabilistic sensitivity analysis is used to reflect uncertainty in model estimates.

Results: Total estimated costs for treating people with these four cancers at the end of life are £641 million. Breast and prostate cancer patients have the highest expected cost per person at £12,663 (95% credible interval (CI): £1249–£38,712) and £14,859 (95% CI: £1391–£46,424), respectively. Lung cancer has the highest expected total cost (£226m). The value of informal care giving accounts for approximately one-third of all costs.

Conclusion: The cost to society of providing care to people at the end of their lives is significant. Much of this cost is borne by informal care givers. The cost to formal care services of replacing this care with paid care giving would be significant and demand for care will increase as the demographic profile of the population ages.

Keywords
Palliative care, cancer, costs, burden of illness, economics

What is already known about the topic?
- Only a small number of studies have considered the cost to society of providing end of life care.
- The costs of providing care to people with cancer at the end of their lives is significant.
- No single study has considered the broad range of health, social and informal care that is provided to people at the end of life.

What this paper adds?
- This study is the first to include the costs of health and social care as well as the cost of informal care giving when estimating the cost to society of providing care at the end of life.
- Using a modelling-based approach, we estimate a total cost to society of caring for people with cancer as they approach the end of life.

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We find that the costs of providing care are significant, with up to one-third of that cost being borne by informal care givers. 

Sensitivity analysis reveals the limitations of the available data for estimating costs and planning services.

Implications for practice, theory or policy

- Replacing informal care giving with formal services would represent a significant cost to public service providers.
- Service planners should be aware of the role of informal care giving in meeting the care needs of people at the end of their lives.
- Improved data collection and categorisation would allow for more informative international comparisons to drive service improvements.

Background

Cancer is responsible for over 141,000 deaths in England and Wales every year. It is a significant burden to individuals and society in terms of morbidity and mortality. The cost of providing care to people who die with and from cancer as they approach the end of their lives is unknown, yet clearly represents a significant cost to the health care systems, social services, charities and, importantly, patients and their families. In this study, we estimate the cost to society of providing care at the end of life to patients who die from lung, colorectal, breast or prostate cancer. The four cancers included here account for approximately 45% of all cancer-related deaths in England and Wales.

Care for people with cancer in the advanced stages is provided by a wide range of specialist and generalist providers of health and social services. Health care will usually focus on maximising symptom control. It may encompass courses of palliative chemotherapy to reduce tumour size and spread, radiotherapy for localised bone pain or to manage acute emergencies such as superior vena caval obstruction or spinal cord compression. Drugs are commonly used to control the most widespread symptoms such as pain and nausea and vomiting. As illness progresses, fatigue and frailty lead to falls in global functioning and assistance with daily living may be needed. As death approaches, general nursing care support may be required provided by a mixture of generalist and specialist nursing services, either in the patient’s home or other care settings. Additional supportive care may be offered by a broad range of physicians with advice from specialist palliative care providers or perhaps sharing care between palliative and oncology specialists. Individuals or their families may be required to pay for residential or nursing home care, imposing significant financial burden and may also provide informal care at significant personal cost, particularly through foregone employment.

The aim of this study is to estimate the total direct and indirect costs of the broad range of care described above provided to lung, colorectal, breast and prostate cancer patients in England and Wales during the end-of-life period – that is, the period in people’s lives where death is expected in the near future and the primary aims of treatment are no longer curative.

Methods

Systematic review

To understand what is already known on this topic and to plan the methodology for our model-based approach, we began with a systematic review of the literature. We searched MEDLINE, Embase, PsycINFO, EconLit, CINAHL and NHSEED databases for studies published between 1990 and 1 April 2015. Grey literature was also searched for UK government or statutory agency reports, reports by non-governmental agencies or academic working papers. The review search strategy and further details are provided in the supplemental material.

We chose UK-based studies that included cancer patients for detailed review given the UK National Health Service (NHS) cancer care was the focus of our analysis. We included four UK-based studies that considered the cost of providing any type of care to patients with cancer at the end of life. All of the studies included in the review estimated the costs of providing health care, while three also included estimates of the costs of providing social care and none included the costs of privately provided care, charity provided care or informal care provision (Table 1). What little evidence is available suggests that there are significant direct and indirect costs in caring for patients at the end of their lives that are not met by public health and social care providers. These additional costs are a significant burden to individuals and society and need to be counted.

Defining the end-of-life period

Defining what constitutes end-of-life care is difficult, with different views taken at times by health service planners, researchers and the wider public. Within England and Wales, the definition used in practice is that contained in the Gold Standards Framework guidance document produced by the Royal College of General Practitioners and the National Institute for Health and Care Excellence (NICE) Quality Standards for end-of-life care. These state that a person is approaching the end of life when it is considered by health care professionals that they are likely to die within the next 12 months. This includes ‘People...
whose death is imminent… as well as those with advanced, progressive, incurable conditions, general frailty and co-existing conditions that mean they are expected to die within 12 months…’.12

This definition has limitations for research purposes. In our view, in order for a definition of the end of life period to be useful in a research context where service use or costs are to be estimated, it must satisfy two criteria, at least partially. First, there must be a defined period of time over which the research will be conducted. Second, it should reflect as far as possible the clinical needs of the patient. Using the 12 month time frame as above fails to satisfy this second criterion, as it may lead to an:

- underestimate of costs for patients who may have palliative needs longer than 12 months, yet
- overestimate of costs for those patients who are expected to die in under 12 months.

For this study, we consider that the most appropriate definition of the end of life should include patients who are at increased risk of death during the time period measured and should account for the varying lengths of time patients with different illnesses may spend with palliative care needs. This approach also has the advantage that it is based on the clinical needs of the patient, rather than an indiscriminate fixed length of time, which reflects the recommendations of the Palliative Care Funding Review.13 We have chosen to follow the approach of Guest et al.8 in defining the end of life period as the point at which a patient begins the use of strong opioids. The use of strong opioids is the principal treatment for pain associated with advanced, progressive cancer.14 At this stage of disease, the primary intention of treatment is often the management of symptoms as cure is no longer likely.

### The model

This analysis takes a novel approach to estimating a population estimate of the cost of an illness. Using data available in the literature, a model has been developed to estimate the cost of providing care to a typical patient during the end of life period. This estimate (along with associated estimates of uncertainty) is then aggregated to derive a population-level estimate. The model comprises counts of the resources used by an individual in the last period of life combined with an estimate of the unit cost for each of those resources. An estimated cost for an individual patient is calculated by summing the resources used during the end of life period multiplied by the unit cost of the resource. Monte Carlo simulations are conducted to generate an expected mean cost for an individual patient, reported with associated Bayesian credible intervals (posterior probability interval).15 We conduct 10,000 simulations for each of the four cancers studied. This approach generates a plausible estimate of the overall cost based on the existing data; this is an improvement over existing cost of care methods.

### Table 1. Overview of studies included in review.

| Study | Population, study type | Direct costs | Indirect costs | Results (mean cost) |
|-------|------------------------|--------------|----------------|---------------------|
| Nuffield (2014)9 | All deaths, with cancer subgroup analysis. Retrospective cohort analysis. | Primary and community care, social care, inpatient hospice care, secondary care used in the 90 days prior to death. | None | Per death – £6015 Per cancer death – £7287 |
| Nuffield (2012)6 | Patients with long-term conditions (including cancer, chronic obstructive pulmonary disease, ischaemic heart disease, organ failure and mental disorders). Retrospective cohort analysis. | Inpatient care, nursing care, residential care, home care, respite care, equipment, day care and direct payments in the 12 months prior to death. | None | Per death – £10,130 Per cancer death – £10,844 |
| RAND (2008)7 | Incidence-based population of patients who died from cancer or organ failure. Modelling study. | Hospital inpatient stays; hospice inpatient stays; home care costs per day in the 12 months prior to death. | None | Cancer, per patient: £14,236 Organ failure, per patient: £18,771 |
| Guest et al. (2006)8 | Incidence-based population of patients with advanced cancer. Retrospective cohort analysis. | Prescriptions, GP use; palliative physician use (home and outpatient) and hospital admissions from the time of strong opioid use being instigated until death. | None | Per patient: Breast – £1.75k Colon – £1.54k Lung – £2.24k Uterus – £2.69k Ovaries – 4.79k Prostate – £3.77k Stomach – 3.49k |

GP: general practitioner.
the supplementary material. Derived the estimates used in our analysis are provided in the costs of providing end of life care. Details of how we approach (which aggregates data at the system level), it is more resource intensive than the alternative top-down approach (which aggregates data at the system level), it is the only practical way to arrive at a meaningful estimate of the costs of providing care to people with these four cancers is £642 million (Table 6). Health care and informal care providing care to people with these four cancers is £4254 and £1829, respectively. Our final estimated costs, which result from combining health, social care, and informal care costs, are £275.3 million, compared to total health care costs for all cancer care provision in the United Kingdom of £5.24 billion.24

Our results show that the costs of providing care to people with breast, prostate, colorectal or lung cancer at the end of life are significant. Our expected total direct and indirect costs for providing care for just 5% of the population will die in a hospice and will have spent a relatively short period of time there. But charities also provide care through other means, often paid for in part by local authorities and the health service – these costs will have been captured. We have found that charities provide just £30 million pounds of care across all four cancer types. The financial value of charity care provision varies across different settings, and the need to include an estimate of the costs of providing care to people with breast, prostate, colorectal or lung cancer at the end of life is clearly significant. Our estimated costs differ from those studies included in our review (Table 1). In our study, the expected cost of care for each cancer type is £9914, with expected costs considered for the four cancers alone is nearly £650 million. This is clearly a significant cost to health and social care services. About 33% (£219 million) of the total costs of care are borne by the health and social care services, patients and their carers. We include direct costs only for health and social care providers. The alternative top-down approach (which aggregates data at the system level) is the only practical way to arrive at a meaningful estimate of the costs of providing care to people with these four cancers. The financial value of charity care provision represents the highest cost areas across all four cancer types. The financial value of charity care provision is £97.5 million, compared to total health care costs for all cancer care provision in the United Kingdom of £5.24 billion.24

Un师资 costs have been estimated using publicly available data. Both direct and indirect costs are considered for each cancer type. Direct costs are those borne directly by the health or social care services, or patients and their carers. Indirect costs are those costs arising from the illness but not directly borne by the health or social care services, or patients and their carers. We have identified four main indirect costs: care provided by informal carers in terms of the value of the care they provide; lost employment income; informal care costs for all cancer care provision in the United Kingdom; and the value of the care patients and their informal carers would have provided if they were not ill. Our study estimated that 89% (£2.75 million) of the total costs of care are borne by the health or social care services. The financial value of charity care provision is £97.5 million, compared to total health care costs for all cancer care provision in the United Kingdom of £5.24 billion.24

Results

Results are presented in Tables 5 and 6. As would be expected, the patients with the longest expected survival in the four cancer types (Table 5) have the highest expected total costs of the period of their lives (Table 6). The total estimated cost of the 365-day period considered as end of life in the Nuffield study is £10,841, with health care accounting for £9498 and social care £136. The Nuffield study estimated that around 10% of patients are estimated to have survived for at least 3 months after diagnosis. Our expected costs are £9914 for each cancer type, with health care accounting for £9498 and social care £136. By comparison, the Nuffield study identified that just 5% of the population will die in a hospice and will have spent a relatively short period of time there. But charities also provide care through other means, often paid for in part by local authorities and the health service – these costs will have been captured. We have found that charities provide just £30 million pounds of care across all four cancer types. The financial value of charity care provision varies across different settings, and the need to include an estimate of the costs of providing care to people with breast, prostate, colorectal or lung cancer at the end of life is clearly significant. Our estimated costs differ from those studies included in our review (Table 1). In our study, the expected cost of care for each cancer type is £9914, with expected costs considered for the four cancers alone is nearly £650 million. This is clearly a significant cost to health and social care services. About 33% (£219 million) of the total costs of care are borne by the health and social care services, patients and their carers. We include direct costs only for health and social care providers. The alternative top-down approach (which aggregates data at the system level) is the only practical way to arrive at a meaningful estimate of the costs of providing care to people with these four cancers.
| Category                          | Mean  | Distribution | $\alpha$ | $\beta$ | Source                  |
|----------------------------------|-------|--------------|----------|---------|-------------------------|
| **Expected survival (days)**     |       |              |          |         |                         |
| Breast cancer                    | 372   | Gamma        | 1.00     | 372     | Guest et al.⁸           |
| Colorectal cancer                | 201   | Gamma        | 1.00     | 201     | Guest et al.⁸           |
| Lung cancer                      | 180   | Gamma        | 1.00     | 180     | Guest et al.⁸           |
| Prostate cancer                  | 360   | Gamma        | 1.00     | 360     | Guest et al.⁸           |
| **Health care resource use**     |       |              |          |         |                         |
| **Estimates used for all cancers**|       |              |          |         |                         |
| Probability any hospital care    | 0.99  | Beta         | 19,828   | 106     | Georghiou et al.⁶       |
| Mean annual elective inpatient admissions² | 2.51  | Gamma        | 1.00     | 2.51    | Georghiou et al.⁶       |
| Mean annual non-elective inpatient admissions² | 1.95  | Gamma        | 1.00     | 1.95    | Georghiou et al.⁶       |
| Outpatient attendances           | 10.80 | Gamma        | 1.00     | 10.80   | Georghiou et al.⁶       |
| A&E attendances                  | 1.39  | Gamma        | 1.00     | 1.39    | Georghiou et al.⁶       |
| **Breast cancer**                |       |              |          |         |                         |
| Probability non-emergency admission³ | 0.97  | Beta         | 172,504  | 5010    | Hospital Episode Statistics (C50)¹⁸ |
| Probability emergency admission³ | 0.03  | Beta         | 4810     | 172,704 | Hospital Episode Statistics (C50)¹⁸ |
| Mean days per inpatient admission | 3.00  | Gamma        | 1.00     | 3.00    | Hospital Episode Statistics (C50)¹⁸ |
| GP contacts (at surgery)         | 15.75 | Gamma        | 1.00     | 15.75   | Guest et al.⁸           |
| District Nurse contacts          | 15.75 | Gamma        | 1.00     | 15.75   | Guest et al.⁸           |
| **Colorectal cancer**            |       |              |          |         |                         |
| Probability non-emergency admission³ | 0.92  | Beta         | 128,811  | 11,464  | Hospital Episode Statistics (C18-C20)¹⁸ |
| Probability emergency admission³ | 0.08  | Beta         | 11,464   | 128,811 | Hospital Episode Statistics (C18-C20)¹⁸ |
| Mean days per inpatient admission | 9.80  | Gamma        | 1.00     | 9.80    | Hospital Episode Statistics (C18-C20)¹⁸ |
| GP contacts (at surgery)         | 10.43 | Gamma        | 1.00     | 10.43   | Guest et al., 2006⁸     |
| District Nurse contacts          | 10.43 | Gamma        | 1.00     | 10.43   | Guest et al., 2006⁸     |
| **Prostate cancer (C61)**        |       |              |          |         |                         |
| Probability non-emergency admission³ | 0.91  | Beta         | 51,566   | 5090    | Hospital Episode Statistics (C61)¹⁸ |
| Probability emergency admission³ | 0.09  | Beta         | 5090     | 51,566  | Hospital Episode Statistics (C61)¹⁸ |
| Mean days per inpatient admission | 5.60  | Gamma        | 1.00     | 5.60    | Hospital Episode Statistics (C61)¹⁸ |
| GP contacts (at surgery)         | 14.97 | Gamma        | 1.00     | 14.97   | Guest et al.⁸           |
| District Nurse contacts          | 14.97 | Gamma        | 1.00     | 14.97   | Guest et al.⁸           |
| **Lung cancer (C34)**            |       |              |          |         |                         |
| Probability non-emergency admission³ | 0.81  | Beta         | 68,340   | 16,536  | Hospital Episode Statistics (C34)¹⁸ |
| Probability emergency admission³ | 0.19  | Beta         | 16,536   | 68,340  | Hospital Episode Statistics (C34)¹⁸ |
| Mean days per inpatient admission | 8.80  | Gamma        | 1.00     | 8.80    | Hospital Episode Statistics (C34)¹⁸ |
| GP contacts (at surgery)         | 21.76 | Gamma        | 1.00     | 21.76   | Guest et al.⁸           |
| District Nurse contacts          | 21.76 | Gamma        | 1.00     | 21.76   | Guest et al.⁸           |
| **Social care resource use**     |       |              |          |         |                         |
| Probability of any home care use | 0.13  | Beta         | 0.75     | 3574.00 | Georghiou et al.⁶       |
| Mean days of home care use⁶      | 57.25 | Gamma        | 1.00     | 57.25   | Georghiou et al.⁶       |
| Hours per day of home care use⁶  | 1.20  | Gamma        | 1.00     | 1.20    | Georghiou et al.⁶       |
| Probability of being in a nursing home | 0.03  | Beta         | 519.00   | 19,415.00 | Georghiou et al.⁶       |

(Continued)
Our study is the only one to date to acknowledge and capture, using probabilistic sensitivity analysis, the full extent of the uncertainty surrounding the level of resources used by patients at the end of life. The wide 95% credible intervals indicate that our results are highly uncertain and thus how uncertain knowledge of the cost of providing end of life care is. This uncertainty is driven by two things. The first is that many of the estimates we were able to identify for resource use are themselves highly uncertain. In many cases, only a point estimate was reported in the existing research – for example, while Guest et al.\(^8\) report in some detail the different categories of resources used, they did not report confidence intervals or any other measure of dispersion. As a result, it was necessary in some cases to make highly conservative assumptions about the variability of patient resource use in the model. It is a necessary consequence of making such conservative assumptions that we increase the uncertainty in our results. The second is that in many cases, it was not possible to find data that applied specifically to patients at the end of life. This again leads to conservative assumptions and greater uncertainty in results. Better collection of routine data would enable analysts and service planners to understand better patterns of resource use, including at the end of life.

Additionally, there is a lack of distinction in recorded statistics between care that happens because a patient is at the end of life that is primarily palliative in intent, and all other care a patient receives during this time. This makes estimation of a cost of care for people at the end of life difficult. This is a problem faced by many researchers interested in establishing what care individuals receive towards the end of life. We have taken the pragmatic approach, which is to consider all care at the end of life. But in some cases, patients with co-morbidities would be receiving care irrespective of their cancer diagnosis. However, as data are not coded to indicate whether or not care is because of the end of life being reached, it is not possible to take any other approach. This lack of data may also present problems to those in charge of commissioning or designing services.

A lack of widely available data also restricts comparisons between countries. In the systematic review, we identified an additional six studies which estimated the cost of providing care to patients at the end of life in non-UK countries.\(^6\)–\(^11\) In addition to not being UK-based, none of these studies focused exclusively on cancer patients and so were excluded from the review. Direct comparisons of costs between different health economies are difficult – palliative and end of life care can constitute a wide range of different services and patient needs can be met in a wide range of ways. Yet, without reliable data on who gets what care, when and where, and at what cost, it is difficult to make a comparative assessment of outcomes internationally. For example, a recent study from Canada found that the cost of caring for an individual was approximately CAD34,000 (£185,000).\(^25\) However, given differences in the structure of the care system and definitions of the end of life period, it is not possible to

| Category                                           | Mean  | Distribution | α     | β     | Source                          |
|----------------------------------------------------|-------|--------------|-------|-------|---------------------------------|
| Days in nursing home\(^a\)                         | 55.28 | Gamma        | 1.00  | 55.28 | Georghiou et al.\(^6\)          |
| Probability of being in a residential home         | 0.04  | Beta         | 794.00| 19,140.00 | Georghiou et al.\(^6\)          |
| Days in residential home\(^a\)                     | 66.77 | Gamma        | 1.00  | 66.77 | Georghiou et al.\(^6\)          |
| Probability of ‘Other Social Care’ use             | 0.02  | Beta         | 0.96  | 43.34 | Georghiou et al.\(^6\)          |
| Units of ‘Other Social Care’ used\(^a\)            | 5.00  | Gamma        | 1.00  | 5.00  | Georghiou et al.\(^6\)          |
| Charity provided care                              |       |              |       |       |                                 |
| Probability hospice inpatient stay                 | 0.05  | Beta         | 0.91  | 18.37 | Marie Curie Cancer Care data    |
| Hospice inpatient days\(^a\)                       | 22.91 | Gamma        | 1.00  | 22.91 | Marie Curie Cancer Care data    |
| Probability hospice outpatient contact             | 0.05  | Beta         | 0.91  | 18.37 | Marie Curie Cancer Care data    |
| Hospice outpatient visits\(^a\)                    | 5.85  | Gamma        | 1.00  | 5.85  | Marie Curie Cancer Care data    |
| Informal care                                      |       |              |       |       |                                 |
| Probability of receiving any informal care         | 0.34  | Beta         | 0.32  | 0.62  | Hayman et al.\(^19\)            |
| Hours of informal care received (weekly)\(^a\)     | 15.00 | Gamma        | 1.00  | 15.00 | Macmillan Cancer Support\(^5\)  |
| Hours of employment lost by carer (weekly)\(^a\)   | 2.18  | Gamma        | 10.06 | 0.22  | Macmillan Cancer Support\(^5\)  |
| Probability carer’s allowance received by carer\(^a\) | 15.00 | Beta         | 0.90  | 17.10 | Macmillan Cancer Support\(^5\)  |

GP: general practitioner.

\(^a\)These parameters are set equal to 0 where the individual did not use a resource.
make a direct comparison between studies. This restricts further development of cost-effective services and prevents others from drawing on knowledge and experience gained elsewhere. A more useful comparison would be to explore resource use differences between countries; however, there are insufficient data from the identified studies to conduct such an analysis. We expect that the costs of caring for people at the end of life are likely to be significant in all countries, yet differences in the structure

Table 3. Unit costs (all costs adjusted to 2013–2014 prices).

| Category                          | Unit cost | Source                                                                 |
|----------------------------------|-----------|------------------------------------------------------------------------|
| **Health care resources**        |           |                                                                        |
| Breast cancer                    |           |                                                                        |
| Elective inpatient admission (initial spell) | £362      | 2013–14 Tariff, JA12C Malignant breast disorder without CC20           |
| Elective inpatient admission (excess day) | £227      | 2013–14 Tariff, JA12C Malignant breast disorder without CC20           |
| Non-elective inpatient admission | £964      | 2013–14 Tariff, JA12C Malignant breast disorder without CC20           |
| Non-elective inpatient admission (excess day) | £227      | 2013–14 Tariff, JA12C Malignant breast disorder without CC20           |
| Colorectal cancer                |           |                                                                        |
| Elective inpatient admission (initial spell) | £1756     | 2013–14 Tariff, FZ46B Malignant Large Intestinal Disorders with length of stay 2 days or more without Major CC20 |
| Elective inpatient admission (excess day) | £218      | 2013–14 Tariff, FZ46B Malignant Large Intestinal Disorders with length of stay 2 days or more without Major CC20 |
| Non-elective inpatient admission | £2829     | 2013–14 Tariff, FZ46B Malignant Large Intestinal Disorders with length of stay 2 days or more without Major CC20 |
| Non-elective inpatient admission (excess day) | £218      | 2013–14 Tariff, FZ46B Malignant Large Intestinal Disorders with length of stay 2 days or more without Major CC20 |
| Lung cancer                      |           |                                                                        |
| Elective inpatient admission (initial spell) | £761      | 2013–14 Tariff, DZ17C Respiratory Neoplasms without CC20               |
| Elective inpatient admission (excess day) | £195      | 2013–14 Tariff, DZ17C Respiratory Neoplasms without CC20               |
| Non-elective inpatient admission | £2071     | 2013–14 Tariff, DZ17C Respiratory Neoplasms without CC20               |
| Non-elective inpatient admission (excess day) | £195      | 2013–14 Tariff, DZ17C Respiratory Neoplasms without CC20               |
| Prostate cancer                  |           |                                                                        |
| Elective inpatient admission (initial spell) | £1421     | 2013–14 Tariff, LB06F Kidney, Urinary Tract and Prostate Neoplasms with length of stay 2 days or more without Major CC20 |
| Elective inpatient admission (excess day) | £205      | 2013–14 Tariff, LB06F Kidney, Urinary Tract and Prostate Neoplasms with length of stay 2 days or more without Major CC20 |
| Non-elective inpatient admission | £1915     | 2013–14 Tariff, LB06F Kidney, Urinary Tract and Prostate Neoplasms with length of stay 2 days or more without Major CC20 |
| Non-elective inpatient admission (excess day) | £205      | 2013–14 Tariff, LB06F Kidney, Urinary Tract and Prostate Neoplasms with length of stay 2 days or more without Major CC20 |
| **Common health care unit costs**|           |                                                                        |
| Outpatient appointment (Initial)  | £223      | 2013–14 Tariff, Clinical Oncology, Multi-Prof20                         |
| Outpatient appointment (follow-up)| £105      | 2013–14 Tariff, Clinical Oncology, Multi-Prof20                         |
| A&E visit                        | £102      | VB05Z Category 2 investigation with category 3 treatment20             |
| District nurse                   | £64       | PSSRU 201121                                                           |
| GP                               | £36       | PSSRU 201121                                                           |
| **Social care resources**        |           |                                                                        |
| Home care per hour               | £17       | PSSRU via Nuffield6                                                   |
| Nursing home per day             | £646      | PSSRU via Nuffield6                                                   |
| Residential home per day         | £529      | PSSRU via Nuffield6                                                   |
| Unit of ‘Other Social Care’ (day care, direct payments and respite care) | £2698     | Nuffield6                                                             |
| **Charity provided resources**   |           |                                                                        |
| Hospice inpatient per day        | £419      | Marie Curie Cancer Care data provided to the authors                  |
| Hospice outpatient visit         | £104      | Marie Curie Cancer Care data provided to the authors                  |
| **Informal care**                |           |                                                                        |
| Hour of lost employment          | £13       | ONS 2011 Annual Survey of Hours and Earnings22                         |
| Carer’s allowance per week       | £61       | https://www.gov.uk/carers-allowance/overview                          |

GP: general practitioner; CC: cancer care; PSSRU: Personal Social Services Research Unit; ONS: Office of National Statistics.

Table 4. Annual deaths by cancer type.

| Cancer type | Annual deaths |
|-------------|---------------|
| Breast      | 10,311        |
| Colorectal  | 14,441        |
| Lung        | 30,273        |
| Prostate    | 9,698         |

Source: Office of National Statistics.23
of health and social care systems require analysis to be conducted on a country by country basis. The methods we describe in this analysis could be adapted to a range of settings in future research focusing on other health systems.

One of our most important findings is the value of the care provided to people at the end of life by informal carers. The cost to the health and social care services to replace informal unpaid care giving with formal paid care giving would be significant. This has important policy implications. If current demographic trends continue, the proportion of older people requiring care will continue to increase, with fewer people capable of providing it. This also has implications for hospice services, which are highly dependent on volunteers at present. If the pool of capable informal carers and volunteers shrinks relative to the population needing care, a greater need for state funding will arise. Commissioners and payers of formal care services should be aware of this, as it may lead to greater pressure on resources than are currently expected.

### Conclusion

As we have shown, the cost to society of providing care to people with one of the four studied cancers at the end of life is significant. For the individual patient, the mean expected cost of care to society is nearly £13,000. Across the roughly 140,000 people who die from cancer each year, this is a considerable sum. If we then consider that between 69% and 82% of the nearly 500,000 deaths in England and Wales will have palliative care needs, it is clear that providing this care is a great cost to society directly and indirectly. Much of this cost is borne by informal care givers. As populations age, there will be a greater demand for care and a decrease in the supply of informal care givers. Service planners should account for these issues when considering the future cost of providing end of life care.

### Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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### Table 5. Mean estimated cost per patient, by cancer type and resource use category, with Bayesian credible intervals.

| Cancer type | Health care | Social care | Charity care | Informal care | Total |
|-------------|-------------|-------------|-------------|---------------|-------|
|             | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) |
| Breast      | £4346 (£395 to £12,545) | £2843 (£84 to £10,170) | £480 (£7 to £1845) | £4868 (£18 to £21,818) | £12,663 (£1249 to £38,712) |
| Colorectal  | £4854 (£413 to £14,485) | £1489 (£44 to £5350) | £470 (£6 to £1833) | £2850 (£10 to £13,350) | £9760 (£1037 to £29,545) |
| Lung        | £3157 (£332 to £8944) | £1358 (£39 to £4838) | £459 (£6 to £1775) | £2420 (£9 to £11,153) | £7467 (£855 to £21,663) |
| Prostate    | £6687 (£535 to £20,257) | £2728 (£83 to £9588) | £482 (£6 to £1906) | £4814 (£18 to £21,981) | £14,859 (£1391 to £46,424) |
| Mean        | £4254 (£332 to £8944) | £1829 (£83 to £9588) | £468 (£6 to £1906) | £3265 (£18 to £21,981) | £9914 (£855 to £21,663) |

CI: credible interval.
Based on 10,000 Monte Carlo simulations.

*Mean weighted by proportion of deaths due to each cancer in the total population (Table 4).

### Table 6. Mean estimated total cost of care, by cancer type and resource category (millions), with Bayesian credible intervals.

| Cancer type | Health care | Social care | Charity care | Informal care | Total |
|-------------|-------------|-------------|-------------|---------------|-------|
|             | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) | Mean (95% CI) |
| Breast      | £44.82 (£4.07–£129.35) | £29.31 (£0.86–£104.86) | £4.95 (£0.07–£19.02) | £50.20 (£0.19–£224.97) | £130.57 (£12.88–£399.16) |
| Colorectal  | £70.10 (£5.96–£209.18) | £21.51 (£0.64–£77.25) | £6.79 (£0.09–£26.47) | £41.16 (£0.15–£192.79) | £140.95 (£14.98–£426.66) |
| Lung        | £95.57 (£10.05–£270.78) | £41.11 (£1.18–£146.47) | £13.90 (£0.17 to £53.72) | £73.25 (£0.27–£337.65) | £226.06 (£25.90–£655.81) |
| Prostate    | £64.85 (£5.19–£196.45) | £26.46 (£0.81–£92.98) | £4.68 (£0.06–£18.49) | £46.69 (£0.17–£213.17) | £144.11 (£13.49–£450.22) |
| Sub-totals  | £275.33 (£18.39 | £118.39 | £30.32 | £211.29 | £641.68 |
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