The cost of oropharyngeal cancer in England: A retrospective hospital data analysis

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Objectives: To estimate the total costs of treating head and neck cancers, specifically oropharyngeal, laryngeal and oral cavity cancer, in secondary care facilities in England during the period 2006/2007 to 2010/2011.

Design: Patient records were extracted from an English hospital database to estimate the number of patients treated for oropharyngeal, laryngeal and oral cavity cancer in England. Identified resource use was linked to published United Kingdom cost estimates to quantify the reimbursement of treatment through the Payment by Results system.

Setting: Retrospective hospital data analysis.

Participants: From the hospital data, patient records of patients treated for oropharyngeal, laryngeal and oral cavity cancer were selected.

Main outcome measures: Annual total costs of treatment, stratified by inpatient and outpatient setting and by male and female patients.

Results: From 2006/2007 to 2010/2011, total costs of treatment across the three head and neck cancer sites were estimated to be approximately £309 million, with 90% attributable to inpatient care (bundled costs). Oropharyngeal cancer accounted for 37% of total costs. Costs and patient numbers increased over time, largely due to a rise in oropharyngeal cancer, where total costs increased from £17.21 million to £30.32 million, with over 1400 (52%) more inpatients treated in 2010/11 compared to 2006/07.

Conclusions: In 4 years, the number of patients with oropharyngeal cancer receiving some form of inpatient care increased by more than half, and associated costs increased by three quarters. This reinforces the case for prevention and early detection strategies to help contain this epidemiological and economic burden.

1 INTRODUCTION

Head and neck cancers, originating from the upper aero-digestive tract, are amongst the top ten malignancies globally for both incidence and mortality.1 In the most recent National Audit of cases in
England and Wales, approximately 8317 people were diagnosed with such cancers between November 2013 and October 2014, with the vast majority of these being squamous cell carcinomas of the oral cavity, oropharynx and larynx. A total of 2439 patients were diagnosed with oropharyngeal squamous cell carcinoma during this time. Advances in treatment have led to some improvements in prognosis; however, mortality remains high with a 5-year relative survival of approximately 66% for laryngeal cancer and 58% for oral cavity cancer. Patients also suffer a reduced quality of life.

Over the past two decades, cases of oropharyngeal cancer have risen in a number of countries. Common risk factors for oropharyngeal cancer include tobacco and alcohol use. However, the recent rise has been partly attributed to human papillomavirus (HPV) infection, in particular with HPV type 16. There is a wide range of estimates for the proportion of oropharyngeal squamous cell carcinomas attributable to HPV, potentially due to varying diagnostic methodologies, tissue storage and tissue preservation, most notably in earlier studies. Although comprehensive data on the proportion of oropharynx cases associated with HPV infection is lacking, recent studies in the United Kingdom and the United States suggest a figure between 50% and 70%. Importantly, mortality among HPV-positive cases is estimated to be 78% lower than in HPV-negative cases.

Despite the volume of research into the changing epidemiology of head and neck cancers, limited attention has been paid to the resources required to deliver the complex multidisciplinary care required for these patients. This study aims to address this gap by estimating the total costs of treating head and neck cancers, specifically oropharyngeal, laryngeal and oral cavity cancer, in secondary care facilities in England during the period 2006/2007 to 2010/2011. In addition, we sought to examine the distribution of costs between inpatient and outpatient settings, and male and female patients.

Changes in treatment costs for the different cancer subsites (oropharyngeal, laryngeal and oral cavity) over this time period were examined. Particular attention was paid to oropharyngeal cancer, for which it is thought costs may have risen at a faster rate relative to other subsites because of the improved survival profile of the growing proportion of squamous cell carcinoma (SCC) cases, assumed to be HPV positive. These cases can have more complex presentations and diagnostic pathways, which in turn lead to higher resource use.

### METHODS

#### 2.1 Ethical considerations

Approval for use of Hospital Episode Statistics (HES) data was granted by the Health and Social Care Information Centre. The individual HES records extracted contained no sensitive data and were pseudonymised, preventing the true identification of patients. Analyses pertaining to HES records adhered to published regulations. The Health Research Authority decision tool stated no ethical approval was required for this research.

### Keypoints

- Oropharyngeal, laryngeal and oral cavity cancer cost the UK NHS an estimated £309 million over a 5-year period from 2006 to 2011.
- Oropharyngeal cancer accounted for 37% of these costs and almost three-quarters of the costs were associated with the treatment of males.
- Between 2006/07 and 2010/11, inpatient numbers for the head and neck cancers discussed here increased by 25%.

#### 2.2 Participants, setting and study design

Data on inpatient and outpatient activity associated with oropharyngeal, laryngeal and oral cavity cancer were extracted from the HES database for the period 2006/2007 to 2010/2011. Hospital Episode Statistics contains information on all care delivered by National Health Service (NHS) hospitals. Annual hospitalisations for each subsite of head and neck cancers were extracted from HES. All finished consultant episodes (FCE) and outpatient attendances related to site-specific International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) codes were extracted along with patient identification numbers in order to estimate the annual number of hospitalised patients. A list of the codes used can be found in Table 1.

#### 2.3 Data analysis and statistical methods

A large proportion of payments made to secondary healthcare providers contracted by commissioners in England are governed by the Payment by Results (PbR) framework, with payments for inpatient care linked to hospital stays known as spells. Although the vast majority of spells comprise a single FCE under the care of one

| Cancer site | Code | Description |
|-------------|------|-------------|
| Oropharynx  | C01  | Malignant neoplasm of base of tongue |
|             | C09  | Malignant neoplasm of tonsil |
|             | C10  | Malignant neoplasm of oropharynx |
| Larynx      | C32  | Malignant neoplasm of larynx |
| Oral cavity | C00  | Malignant neoplasm of the lip |
|             | C02  | Malignant neoplasm of other and unspecified parts of tongue |
|             | C03  | Malignant neoplasm of gum |
|             | C04  | Malignant neoplasm of floor of mouth |
|             | C05  | Malignant neoplasm of palate |
|             | C06  | Malignant neoplasm of other and unspecified parts of mouth |
consultant from admission to discharge, in some cases they are spread across a number of FCEs. A spell is also a more robust activity measure than a FCE as the latter can be easily influenced (eg, by transferring patients between consultants).

To group episodes of care into spells of care, the 2010/11 local payment grouper was used (available from http://content.digital.nhs.uk/article/2331/HRG4-201011-Local-Payment-Grouper) and a single Healthcare Resource Group (HRG) was derived for each spell. Core HRGs were then cross-referenced with the National Tariff 2010/11 to estimate the associated spell cost. Data were extracted from 2006/07 until 2010/11, with the final year representative of 9 months of provisional data. To compensate a correction factor of 1.33 was applied to 2010/11 data, to inflate the 9 month figures to cover an entire year.

Some key therapies in head and neck cancers do not have a National Tariff due to wide regional variation in costs and practice. These therapies include (amongst others) chemotherapy, radiotherapy, palliative care and rehabilitation. Payments for these therapies are the product of local negotiations between commissioners and providers. For these costs, the relevant HRGs from HES were cross-referenced with the National Reference Costs and inflated using the pay cost index. It was not possible to represent regional variation in these particular costs and for the purposes of presentation they were disaggregated from the core HRG to compartmentalise this uncertainty. The costs associated with the spell of care included all other costs associated with the initial diagnosis (if encountered in a hospital), surgical procedures and medical treatments.

Outpatient costs were estimated by grouping consultations by treatment specialty based on Treatment Function Codes (TFCs) and whether the consultation was the first of a series or a follow-up. As with the inpatient data, all activities for which reimbursement rates are locally negotiated, such as outpatient chemotherapy and radiotherapy sessions, were disaggregated from the core HRG.

To confirm whether there is evidence that costs have not increased uniformly with patient numbers, that is higher costs for newly diagnosed oropharyngeal patients, a difference in differences (DID) approach was utilised, with the t-test used to assess whether the means of the two groups were statistically different from each other. Oropharyngeal patients were taken to be the “treated” group, due to the expected survival benefits as the proportion of HPV-positive cases increases, with laryngeal and oral cavity cancer patients as controls. Total patients and costs for each cancer site and gender were aggregated by year and transformed using natural logarithms to aid the interpretability of the results. Values among the treated and control group in the baseline year of 2006/07 were then compared for balance. The difference observed between the baseline year and that seen in 2009/10 (the latest year for which complete data were available) was then estimated using ordinary least squares.

All data analysis was conducted in SAS Enterprise guide 4.3 and Microsoft Excel 2010.

### RESULTS

Over the 5-year study period, the mean number of hospital spells per year attributed to the three cancer sites was 27,326, with a mean of 21,498 outpatient attendances per year in addition. The total costs of treatment for patients across all three sites were estimated to be around £309 million at 2011 prices (Table 2). Just over 90% of these were the result of inpatient care covered by bundled HRGs (£280 million), with outpatient radiotherapy sessions accounting for the lowest proportion (£101,000; 0.03%). Costs due to oropharyngeal cancer were slightly higher than for the other two sites (£115 million; 37.06%), with laryngeal and oral cavity cancer accounting for 31.15% (£96 million) and 31.79% (£98 million), respectively. Inpatient costs were observed to be higher than outpatient costs for all reimbursement categories other than radiotherapy for oral cavity cancer.

Males were responsible for nearly three quarters (73.64%; £227.77 million) of total treatment costs. The ratio of male to female costs was highest for laryngeal cancer at nearly 5:1 (£79.46 to £16.88 million), and lowest for oral cavity cancer at 1.61:1 (£61.10 to £37.23 million). The HES data showed that more resources were consumed during outpatient chemotherapy and radiotherapy for men compared to women, for both oropharyngeal and laryngeal cancer. In contrast, the reverse situation was observed for oral cavity cancer. However, as these categories comprised only a small proportion of the total cost burden, the overall distribution of costs between treatment settings for both genders remained broadly representative of that for the population collectively.

Figure 1 shows the trend in total costs, separated by reimbursement category, and total patients receiving some form of inpatient care over the course of the study. Both costs and patient numbers increased; total costs rose by 38%, from £53.17 million in 2006/07

#### Table 2: Total costs of treatment delivered through English secondary care facilities during the period 2006/07 to 2010/11, by cancer site, costing category and setting

| Site/Category/Admission | Oropharynx | Larynx | Oral cavity |
|-------------------------|------------|--------|-------------|
|                         | Inpatient (£) | Outpatient (£) | Inpatient (£) | Outpatient (£) | Inpatient (£) | Outpatient (£) | Total (£) |
| Bundled                 | 99 431 698 | 3 952 891 | 88 176 568 | 2 735 216 | 91 750 470 | 2 337 648 | 288 384 490 |
| Unbundled               | 1 363 746 | 75 816 | 1 477 386 | 19 117 | 917 209 | 54 810 | 3 908 084 |
| Chemotherapy            | 4 699 336 | 57 507 | 1 521 681 | 38 930 | 1 394 036 | 4 258 | 7 715 746 |
| Radiotherapy            | 3 243 666 | 1 794 567 | 1 228 443 | 1 146 512 | 814 286 | 1 058 029 | 9 285 505 |
| Total                   | 108 738 446 | 5 880 781 | 92 404 077 | 3 939 776 | 94 876 001 | 3 454 745 | 309 293 825 |
to £73.58 million in 2010/11, with the annual number of inpatients rising from 8890 to 11 185 over the same period (25% increase). The trends for each of the individual cancer sites are shown in Figure 2. It is evident that much of the rise in patient numbers and total costs of head and neck cancers can be traced to oropharyngeal cancer, where the total costs increased from £17.21 million to £30.32 million, a rise of 76%, with over 1400 (52%) more inpatients treated in 2010/11 compared to 2006/07. In contrast, the total costs for laryngeal and oral cavity cancer grew by 19% and 22%, respectively, over the course of the study, with inpatient numbers also increasing, by 372 (13%) and 502 (15%).

Table 3 presents the mean values for the variables used in the DID analysis of the aggregate inpatient data. The results show there were no significant differences in the baseline period between the oropharyngeal and combined oral cavity and laryngeal groups in terms of total costs ($P = .93$) and total patients ($P = .903$). The results from the DID analysis can be found in Table 4. Model 1 included a dummy variable for the male cohort, on which the coefficient was found to be positive and a strong predictor of higher costs ($P < .01$), and showed some indication of differences between the two groups (results not shown). In Model 2, the natural logarithm of total patient numbers was also included and found to be a significant predictor of higher total costs ($P < .01$) along with being male ($P = .059$), while also providing some evidence of a real difference between the two groups in the follow-up period ($P = .053$) (results not shown). However, there was no statistically significant evidence of a real change in differences between total costs for oropharyngeal and laryngeal/oral cavity cancer in either model 1 ($P = .434$) nor model 2 ($P = .161$).

**DISCUSSION**

**4.1 Key findings**

The 2013 National Head and Neck Clinical Cancer Audit reported that between 2004/05 and 2012/13 there were 38 494 new oropharyngeal, laryngeal and oral cavity cancer cases in England and Wales. The results of our analysis show that there is a significant health and economic burden associated with oropharyngeal, laryngeal and oral cavity cancer in England, with approximately 9800 individual patients hospitalised per year between 2006/07 and 2010/11 alone. These amounted to 27 326 spells of care and 4127 radiotherapy or chemotherapy delivery sessions on average per year, at a cost of over £300 million to the NHS. Although the per-patient costs for oropharyngeal cancer did not increase at a faster rate than for other head and neck cancer sites, we did observe a rapid increase in the number of patients being treated for this cancer (1420 more patients admitted to hospital in the final year of the study compared to the first, of which more than 1000 were male). This is consistent with data published elsewhere. Our data also help highlight that head and neck cancers tend to disproportionately impact the male population who accounted for almost 75% of the total economic burden.

**4.2 Strengths and limitations of the study**

This research is the first to quantify the cost of treating head and neck cancers in England over time. The results provide important insights into how the cost burden for these cancers has changed over recent years, particularly for inpatient care where the data are most comprehensive.

The Audit Commission has stated that in 2012/13, only 4.1% of all outpatient attendances had a known primary diagnosis. As this was our primary means of extracting information on patients with head and neck cancers, the figures for outpatient activity will not cover all consultations relating to the cancers under investigation and may be underestimated. Underestimation of inpatient costs is also likely to a lesser extent.

The HES database is heavily reliant on correct clinical coding and, as a result, data gaps have arisen. Although it was possible to assess a patient as having multiple hospital admissions from the data, it was not possible to distinguish between an initial or recurrent patient. The data did also not permit analysis of disease stage at presentation, which may in turn influence resource use.
The use of National Tariff precludes analysis of regional variation and contract negotiation and underestimates radiotherapy costs. High-cost drugs are excluded, and no indication of hospital prescribing data are available within HES. The associated costs could therefore not be included in this analysis. Definitions for HRGs may alter year upon year and inaccurately matched codes and definitions could have potentially led to under- or overestimations.

There has doubtless been an increased attention on the increasing incidence of oropharyngeal cancer, and parallel interest in the role of HPV as a major aetiological factor. As a consequence of this, it may be that the accuracy of coding, for example, site accuracy between oral cavity and oropharynx, may have increased over time but the effect of this on the relative incidence of oropharyngeal cancer is not quantifiable.

Together, the impact of these limitations, alongside the potential underestimation of outpatient costs and non-inclusion of indirect costs, result in our overall cost estimates most likely representing an underestimate of the true economic burden of treating head and neck cancers.

**TABLE 3** Mean values of key variables included in the difference in differences analysis

|                  | LR/OC Cancer | OP Cancer | Difference* | P     |
|------------------|--------------|-----------|-------------|-------|
| Number of        | 4            | 2         | –           | –     |
| observations     |              |           |             |       |
| Ln total costs   | 15.824       | 15.765    | −0.059 (0.09) | .93   |
| Ln total patients| 7.17         | 7.086     | −0.084 (0.13) | .903  |

* t statistics presented in parentheses.
TABLE 4 Results of the differences in differences (DID) analysis

| Model | Baseline LR/OC Cancer | OP Cancer | Difference* | Follow-Up LR/OC Cancer | OP Cancer | Difference* | DID |
|-------|------------------------|-----------|-------------|------------------------|-----------|-------------|-----|
| 1     | 15.264                 | 15.205    | -0.059 (-0.19) | 15.332                 | 15.574    | 0.241 (0.92) | 0.300 (0.434) |
| 2     | 9.686                  | 9.698     | 0.011 (0.14)  | 9.677                  | 9.876     | 0.200 (2.28)* | 0.188 (0.161) |

* t statistics presented in parentheses.  
* P < .1.

4.3 | Comparisons to other studies

In line with other studies, our research demonstrates that inpatient episodes account for the largest proportion of costs for head and neck cancer care.\(^2\) As a result of the data not permitting analysis of disease stage at presentation, we were not able to estimate per-patient costs, which have been the focus of previous research. Préaud and Largeron (2013)\(^2\) conducted a pan-European literature search on the economic burden of non-cervical HPV-related cancers, finding three UK study estimates for the cost per patient of oropharyngeal (£15 000 per patient over the lifetime horizon\(^2\)), head and neck (£23 212 over 5 years\(^2\)) and oral cavity, oropharyngeal and pharyngeal (£13 513 for stage IV over 3 years\(^2\)) cancers. High variation exists in per-patient cost estimates for these cancers, stemming from the complex treatment pathways observed. Management of these cancers involves multidisciplinary teams, with varying medical specialists, diagnostic tools and treatment functions. There is also high variation in anatomic site classification, time horizon and cost perspectives, and therefore caution should be employed when drawing comparisons.

4.4 | Clinical applicability of findings

The costing estimates presented here highlight that the cost burden of head and neck cancers is growing in England. The increasing pressure on NHS resources requires strategic investment for both treatment and prevention of these diseases. The observation that in 4 years, the number of patients with oropharyngeal cancer receiving some form of inpatient care has increased by more than half and the associated costs have increased by over three quarters reinforces the argument for prevention and early detection strategies to help contain these cost and health burdens.

The results of the present analyses suggest that the use of chemotherapy and radiotherapy in patients with oropharyngeal cancer has increased in recent years. It is not possible from the current data to determine why this is but greater use of chemotherapy and radiotherapy may have significant impacts on workforce and resource planning in head and neck oncology centres. It also highlights a need for better evidence from clinical trials in how to best manage this oropharyngeal cancer epidemic.

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