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Determinants of long-term survival in a population-based cohort study of head and neck cancer patients from Scotland

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Abstract

Background: We investigated long-term survival from head and neck cancer using different survival approaches.

Methods: Patients were followed-up from the Scottish Audit of Head and Neck Cancer. Overall and disease-specific survival were calculated using the Kaplan-Meier method. Net survival was calculated by the Pohar-Perme method. Mutually adjusted Cox proportional hazards models were used to determine the predictors of survival.

Results: n = 1,820. Overall survival at 12-years was 26.3% (24.3%, 28.3%). Disease-specific survival at 12-years was 56.9% (54.3%, 59.4%). Net survival at 12-years was 41.4% (37.6%, 45.1%).

Conclusion: 26.3% patients were alive 12-years after diagnosis, and the determinants associated with long-term survival included age, stage, treatment modality, WHO performance status, alcohol consumption, smoking behaviour, and anatomical site. We recommend that net survival is used for long-term outcomes for HNC patients – it disentangles other causes of death, which are overestimated in overall survival and underestimated in disease-specific survival.

Key words: Head and neck cancer; survival; epidemiology; cohort; Scotland

Introduction

Head and neck cancer (HNC) accounted for more than 650,000 new cases and over 350,000 deaths worldwide in 2012; and collectively HNC was the sixth most common cancer globally⁽¹⁾. There has been an increase in the incidence of HNC in Scotland over the last three decades⁽²⁾ and in 2015, Scotland experienced 1,283 new cases of head and neck cancer⁽³⁾. Survival for HNC patients in Scotland remains poor with little improvement since the 1980's⁽⁴⁾, and over the last ten years, mortality rates in Scotland due to HNC have increased by 12% for men and 22% for women⁽⁵⁾.

The influences on overall and disease-specific survival are well described for HNC patients – the determinants of short-term survival include age, stage, sex, socioeconomic status, smoking behaviour, alcohol consumption, comorbidities⁽⁶⁻⁹⁾, and, in recent years, human papillomavirus (HPV) status which confers a survival advantage^(10, 11). Disease recurrence is most likely to occur within the first three years, and national guidelines recommend follow-up for five-years after a HNC diagnosis, with the aim of detecting early disease recurrence and second primary HNC⁽¹²⁾. Few studies focus on the long-term outcomes of HNC patients^(13, 14), and even less common is the use of net survival in the examination of HNC patient survival^(15, 16).

Overall survival considers the risk of death by all causes, whereas disease-specific survival methods only consider deaths by the disease of interest and ignores other causes deaths that may have been related to or occurred as a secondary effect to the disease of interest⁽¹⁷⁾. Net survival is defined as the excess mortality between the observed mortality of the patients under study and the expected mortality of the population – this provides a more accurate representation of the mortality from a particular disease of interest by disentangling other causes of death, and therefore only measuring causes of death that are related to the disease of interest via the use of excess mortality^(18, 19).

The Scottish Audit of Head and Neck Cancer (SAHNC) is a population-based cohort which provides a unique opportunity to explore a wide range of factors in association with the long-term survival of

HNC patients. This study aims to investigate HNC survival via the use of overall survival, disease-specific survival and net survival analyses together to provide an in-depth and comprehensive picture of the survival of HNC patients. The secondary aim of this paper is to compare different survival methods to assess the association of patient, tumour and treatment factors with survival.

Materials and Methods

Patients

The SAHNC cohort recruited patients between 1st September 1999 and 31st August 2001 – methods have previously been described⁽²⁰⁻²³⁾. During this two-year period, data were recorded on new HNC patients diagnosed in Scotland. Quality assurance processes were carried out including cross-checking the data with medical and pathology results.

Data Linkage and approvals

The SAHNC cohort was linked to the National Records of Scotland (NRS) mortality data as at 30th September 2013 by ISD Scotland. Records were linked using an established probability matching technique based on the Howard Newcombe principle⁽²⁴⁾ which matches individual patients to their national Community Health Index (CHI) number – the unique healthcare identifier used in the National Health Service (NHS) in Scotland. Information governance and data linkage approvals were obtained from the NHS Privacy Advisory Committee (now known as the Public Benefits and Privacy Panel).

Variables included in analysis

Patient (age at diagnosis, sex, socioeconomic status (SES), smoking behaviour, alcohol consumption, patient performance status), tumour (stage, anatomical site) and treatment (treatment modality, geographic location of treatment) factors were all collected at baseline. SES was determined using area-based Carstairs Quintiles^(25, 26) which ranks patients' home postcodes into five categories using 2001 Census socioeconomic data – group 1 represents the most affluent areas and group 5 represents the most deprived areas. Smoking behaviour ('current smoker', 'previous smoker' and 'never smoked'), and alcohol consumption ('current problem drinker', 'previous problem drinker' or 'occasionally/never drinks') were determined at the time of diagnosis and no further data were

collected on the patient's habits following diagnosis. Patient performance status was classified at diagnosis using the World Health Organisation (WHO) Performance Status ⁽²⁷⁾, which groups patients into one of five categories based on their level of physical ability ('normal activity', 'strenuous activity restricted', 'up and about for more than 50% of waking hours', 'confined to a bed or chair for more than 50% of waking hours', and 'confined to a bed or chair for 100% of waking hours'). Stage was determined using the Tumour, Node and Metastases (TNM) Classification of Malignant Tumours ⁽²⁸⁾, and the cohort was grouped into stage I, II, III or IV. Anatomical site was classified using the International Classification of Disease version 10 ⁽²⁹⁾, grouped into seven categories – lip (C00.9), larynx (C32), nasal cavity (C11.9, C30.0, C31), oral cavity (C02–C04, C05.0, C06, C14), oropharynx (C01, C05.1–, C09, C10), hypopharynx (C12, C13), and other or salivary gland (C07, C08, C30.1, C41, C44, C76, C77). Treatment modality was grouped into seven categories: i) surgery only; ii) radiotherapy only; iii) surgery combined with radiotherapy; iv) Surgery, radiotherapy and chemotherapy; v) radiotherapy and chemotherapy; vi) chemotherapy with or without surgery; and vii) no treatment. Location of treatment was based on the service delivered in the Scottish Cancer Networks located in three geographic region – West of Scotland Network (WoSCAN) (which comprises health board areas of Ayrshire and Arran, Forth Valley, Greater Glasgow, Clyde and Lanarkshire); South East Scotland Cancer Network (SCAN) (Borders, Dumfries and Galloway, Fife, Lothian); and North of Scotland Cancer Network (NOSCAN) (Grampian, Highland, Orkney, Shetland, Tayside, Western Isles).

Statistical methods

Overall and disease-specific survival were calculated using the Kaplan-Meier method with 95% confidence intervals (CI's). Disease-specific survival was computed using death certificates where the primary cause of death was recorded as a type of HNC using ICD10 codes. Forward stepwise mutually adjusted multivariate Cox proportional hazards models were used to determine the variables with an independent association with overall and disease-specific survival – age at

diagnosis, cancer stage and treatment modality were forced into the model in the first instance due to their strong association with overall and disease-specific survival during unadjusted models (data not shown). As a precaution, the results were checked using a backwards stepwise routine, and we also performed sensitivity analyses by removing patients with oropharynx cancer or who did not receive any treatment. Since this was a large study, many of the p-values were very small and therefore, chi-square results have been added to the analysis as a simple way of visually ranking the importance of each determinant. All overall survival, disease-specific survival results and Cox proportional hazards models were calculated using SAS Software, version 9.4 (SAS Institute Inc., USA). Net survival with 95% CIs was calculated by the Pohar-Perme method^(30, 31) using life-tables provided by the Cancer Survival Group at the London School of Tropical Hygiene and Medicine⁽³²⁾. These life-tables were standardised by age, sex and Carstairs 2001 quintile, and were computed using the *stns* command in Stata 14^(33, 34).

Results

Cohort recruitment

The SAHNC cohort recruited 77% (n = 1,910) of HNC cases that were diagnosed and recorded in the Scottish Cancer Registry over the study period from 1st September 1999 to 31st August 2001. Of the 1,910 patients in the baseline cohort, 1,895 were linked to 12-year mortality records – 15 patients were excluded as they were unable to be matched to CHI numbers for data linkage follow-up. A further 15 patients were excluded as they were unable to be matched to 2001 Carstairs quintiles and 60 patients over the age of 85 were also excluded (requirements for the successful computation of net survival), which left a remaining total of 1,820 patients included in the analyses. Cause of death information was available for all patients from death certificates for disease-specific survival.

Patient demographics

Table 1 outlines the demographic characteristics of the 1,820 patients that were followed up. The age at diagnosis ranged from 13 to 85 with a median age of 63 years, and there was a ratio of 2.5:1 of males to females. The majority of patients were from Carstairs quintiles 4 and 5 areas which accounted for more than half of the cohort. Current or previous smoking was reported in 84.6% of patients, and 39.0% of patients reported that they were current problem or previous problem drinkers. The most common anatomical site was the larynx, followed by the oral cavity, and 79.3% of patients were treated by either 'surgery only', 'radiotherapy only' or 'surgery and radiotherapy'. 55.0% of patients were treated in the West of Scotland, and a total of 1,384 (76.0%) of patients had died by September 2013.

Comparison of overall, disease-specific and net survival results

Overall, disease-specific and net survival proportions at one and 12-years for each of the patient, tumour and treatment factors are displayed in Table 2. Overall survival at one and 12-years was

76.0% (74.0%, 77.9%) and 26.3% (24.3%, 28.3%), respectively. Disease-specific survival at one- and 12-years was 82.3% (80.4%, 84.0%) and 56.9% (54.3%, 59.4%), respectively. Net survival at one- and 12-years was 78.3% (76.2%, 80.3%) and 41.4% (37.6%, 45.1%), respectively. One year after follow-up, males and females had approximately the same survival for all three measurements of survival; however, by 12-years males consistently had the lowest survival. At one year, there were clear gradients in survival by SES with the patients from the most affluent areas experiencing the highest survival for overall (83.4%, (78.1%, 87.5%)), disease-specific (88.0%, (83.9%, 92.2%)) and net (86.1%, (81.3%, 91.0%)) survival. By 12-years, these gradients were not as clear cut, however differences between those from the most affluent and the most deprived areas continued to exist, with patients from the most deprived areas having the lowest survival outcomes for overall, disease-specific and net survival than any other quintile. Patients who had never smoked had a survival advantage compared to the patients who were either current or previous smokers when using the overall, disease-specific and net survival methods, particularly by 12-years for patients who had never smoked with a net survival estimate of 70.6% (57.1%, 84.1%) compared with 32.4% (28.6%, 36.2%) for current smokers. Current and previous problem drinkers had approximately the same survival throughout all three methods of survival, which was substantially higher by 12-years for current problem drinkers using the disease-specific method (45.9% (40.5%, 51.1%)) compared to using the overall (18.2%, 95% CIs 14.9%, 21.7%) and net (23.5% (18.6%, 28.4%)) survival methods. Those with normal activity levels had higher survival than patients who did not have normal activity levels using all three methods of survival. One year after diagnosis, patients with tumours of the lip experienced the highest overall (94.1%, 95% CIs 86.4, 97.5%), disease-specific (97.6%, (90.8%, 99.4%)) and net (97.7%, (92.4%, 100.3%)) survival, however this reduced substantially to 56.5% (45.3%, 66.2%) at 12-years using the overall survival method, but did not reduce significantly using the disease-specific or net survival methods, suggesting these patients are dying of other causes. Clear trends can be seen by stage for all three survival methods with those of stage I experiencing the highest survival. Patients who were treated with surgery alone experienced the highest overall, disease-specific and

net survival results, whereas patients who were treated in the West of Scotland network region generally had the lowest results. There were clear differences between overall, disease-specific and net survival results, with the disease-specific method presenting the highest outcome, followed by the net survival method and, as expected, the overall survival method displayed the lowest results.

Mutually adjusted Cox proportional hazards models for overall and disease-specific survival

Mutually adjusted Cox proportional hazards models are displayed in Table 3 using the overall survival method, and Table 4 using the disease-specific survival method. In the order of which they were entered into the model, the determinants with an independent association with overall survival at both one and 12-years included age at diagnosis, cancer stage, treatment modality, WHO Performance Status, alcohol consumption, anatomical site and smoking status. Results for the mutually adjusted Cox proportional hazards models using disease-specific survival varied slightly – the determinants associated with disease-specific survival at one year included age at diagnosis, cancer stage, treatment modality, WHO Performance Status, network and alcohol consumption; however the determinants associated with 12-years disease-specific survival included age at diagnosis, cancer stage, treatment modality, WHO Performance status, alcohol consumption and anatomical site – interestingly, smoking was not an independent predictor for disease-specific survival at either time points. These results were also obtained when running a backwards elimination method, and similar models were achieved when patients with oropharynx cancer and patients who did not receive treatment were removed (Supplementary Tables 1 and 2).

Discussion

Overall survival at one- and 12-years was 76.0% (74.0%, 77.9%) and 26.3% (24.3%, 28.3%), respectively, while disease-specific survival was higher at both one- and 12-years at 82.3% (80.4%, 84.0%) and 56.9% (54.3%, 59.4%), respectively. Net survival estimates for one- and 12-years were 78.3% (76.2%, 80.3%) and 41.4% (37.6%, 45.1%), respectively. Following mutual adjustment, overall

survival of HNC patients was associated with age at diagnosis, cancer stage, treatment modality, WHO Performance Status, alcohol consumption, anatomical site and smoking status, and disease-specific survival was associated with age at diagnosis, cancer stage, treatment modality, WHO Performance Status, and alcohol consumption, with the addition of network at one-year and anatomical site by 12 years.

The association of stage reflects disease-specific deaths, whereas WHO performance status may be a representation of comorbidities in the cohort of patients, which have been described to have a negative impact on the survival of HNC patients⁽³⁵⁾. Similarly, associations with smoking and alcohol behaviours are common risk factors for HNC, and patients often present with many significant comorbidities including chronic obstructive pulmonary disease, heart disease, liver disease and secondary cancers⁽³⁶⁾. The strong association of treatment is likely to reflect those who received palliative care – particularly due to the inclusion of the patients who received 'no treatment', however sensitivity analyses excluding the patients who received no treatment generated similar results (Supplementary Table 1). The variance in survival of patients by anatomical site may be influenced by the inclusion of patients with cancer of the lip, who consistently had substantially improved survival compared with patients with cancers of other HNC sites.

There was a substantial difference between overall survival, disease-specific survival and net survival estimates in this study. Overall survival overestimates deaths as a result of HNC since all causes of death are considered in this measurement, whereas disease-specific survival may be an unreliable estimate when using death certificates as exact causes of death are often unclear. The difference between overall and disease-specific results suggest that patients are dying of other HNC-related causes, but these causes are not as a direct result of HNC and are therefore not documented on death certificates. Net survival estimates background mortality using a group of patients with the same demographics as the patient in the study and calculates the excess death that has occurred as a result of the disease of interest. There is no need to use death certificates to compute this

measurement and thus there is little inaccuracy as to the cause of death in the patient. Therefore, we feel that the use of net survival provides a good compromise to traditional methods, particularly in long-term studies, to estimate the true burden of HNC-specific deaths.

Over the last two decades, there has been an increase in the incidence of HNCs that are associated with HPV^(2, 37, 38). This is particularly common for patients with cancer of the oropharynx for whom around one to two thirds of tumours may be HPV-driven⁽³⁹⁾, suggesting that one limitation of this study is the absence of HPV data. Patients with HPV-positive tumours have considerably better prognoses than patients with HPV-negative tumours, even following adjustment for other baseline covariates^(40, 41). The primary focus of these analyses was to investigate the long-term survival of HNC patients from Scotland diagnosed between the years of 1999 and 2001. The baseline data collection for this study was ahead of the mainstream discovery of the association of HPV with HNC⁽⁴²⁾ and therefore HPV data were not routinely collected or available in this study. However, aside from oropharynx patients, the majority of HNC diagnosed today are HPV-negative and these tumours are likely to be smoking- and alcohol-related^(43, 44), and previous studies suggest that smoking, alcohol, and HPV are three independent risk factors of HNC survival^(45, 46). Furthermore, the oropharyngeal patients in this study did not exhibit the clear survival advantage that is usually observed for HPV-associated oropharyngeal cancer⁽⁴¹⁾. Sensitivity analyses involving the exclusion of patients with oropharynx cancer demonstrated similar results (Supplementary Table 2), however, we were unable to separate out patients with HPV positive tumour. Therefore, the SAHNC patients' cancers are likely to be predominantly related to smoking and problem alcohol behaviours and we propose that our findings remain relevant to clinicians, researchers and other health professionals in gaining an understanding of the long-term prognosis of patients with non-HPV driven HNC, particularly since the prevalence of smoking and problem alcohol consumption was very high in this study.

The SAHNC cohort also pre-dates the use of organ preservation strategies that were introduced in Scotland in 2006⁽⁴⁷⁾. However, studies following the introduction of these practices outline the

importance of ensuring clear margins in surgery in the treatment of HNC^(48, 49). Therefore, due to the high proportion of patients being treated with surgery in the SAHNC cohort, this study also remains relevant and may be used in treatment planning decisions for HNC patients. Moreover, these analyses were based on historical cases (1999 to 2001), which is a prerequisite for estimating long-term follow-up, which we would argue is a strength of the SAHNC cohort.

The SAHNC cohort represented 77% of all HNC cases on the Scottish Cancer Registry over a two-year period and was representative of HNC cases in Scotland. Previous analyses of the SAHNC cohort have outlined five-year overall and disease-specific survival⁽²⁰⁻²³⁾. This study adds to the worldwide literature on long-term HNC survival, and provides an in-depth analysis of overall, disease-specific and net survival of HNC patients using a national clinical cohort. This study also supports the use of net survival, particularly in analyses with long-term follow-up.

Conclusion

Overall survival at one- and 12-years was 76.0% (74.0%, 77.9%) and 26.3% (24.3%, 28.3%), respectively, while disease-specific survival was higher at both one- and 12-years at 82.3% (80.4%, 84.0%) and 56.9% (54.3%, 59.4%), respectively. Following mutual adjustment, overall and disease-specific survival for HNC patients was associated with age at diagnosis, cancer stage, treatment modality, WHO Performance Status, alcohol consumption, anatomical site, smoking status and cancer network. Net survival estimates for one- and 12-years were 78.3% (76.2%, 80.3%) and 41.4% (37.6%, 45.1%), respectively. The substantial difference between overall survival, disease-specific survival and net survival demonstrates the overestimation of HNC-specific deaths when using overall survival, and the underestimation of disease-specific mortality when using death certificates where patients have died only from HNC. These results suggest that patients are dying of other causes that are related to their HNC but are not as a direct result of HNC. Therefore, the use of net survival seems to provide a good compromise to traditional methods to estimate the true burden of HNC in long-term follow-up studies.

Conflict of interest statement

None declared.

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Table 1 – Frequency of all patient, tumour and treatment characteristics and frequency of deaths for all cases

Variable	Frequency (Column %)	Died by September 2013	
		No (Row %)	Yes (Row %)
Total	1,820 (100.0%)	436 (24.0%)	1,384 (76.0%)
Age at diagnosis			
Less than 45	99 (5.4%)	61 (61.6%)	38 (38.4%)
45 to 54	288 (15.8%)	105 (36.5%)	183 (63.5%)
55 to 64	592 (32.5%)	166 (28.0%)	426 (72.0%)
65 to 74	551 (30.3%)	81 (14.7%)	470 (85.3%)
75 and over	290 (15.9%)	23 (8.0%)	267 (92.1%)
Sex			
Male	1,300 (71.4%)	300 (23.1%)	1,000 (76.9%)
Female	520 (28.6%)	136 (26.2%)	384 (73.9%)
Carstairs quintile			
1 (Most affluent)	241 (13.2%)	58 (24.1%)	183 (75.9%)
2	317 (17.4%)	91 (28.7%)	226 (71.3%)
3	325 (17.9%)	77 (23.7%)	248 (76.3%)
4	409 (22.5%)	98 (24.0%)	311 (76.0%)
5 (Most deprived)	528 (29.0%)	112 (21.2%)	416 (78.8%)
Smoking behaviour			
Current smoker	1,134 (62.3%)	228 (21.0%)	906 (79.9%)
Previous smoker	405 (22.3%)	104 (25.7%)	301 (74.3%)
Never smoked	221 (12.1%)	88 (39.8%)	133 (60.2%)
Not recorded	60 (3.3%)	16 (26.7%)	44 (73.3%)
Alcohol consumption			
Current problem drinker	496 (27.3%)	86 (17.3%)	410 (82.7%)
Previous problem drinker	212 (11.7%)	32 (15.1%)	180 (84.9%)
Occasionally/never drinks	891 (49.0%)	262 (29.4%)	629 (70.6%)
Not recorded	221 (12.1%)	56 (25.3%)	165 (74.7%)
WHO Performance Status			
Normal activity	825 (45.3%)	314 (38.1%)	511 (61.9%)
Strenuous activity restricted	465 (25.6%)	64 (13.8%)	401 (86.2%)
Up and about >50%	137 (7.5%)	7 (5.1%)	130 (94.9%)
Confined to bed/chair >50%	97 (5.3%)	1 (1.0%)	96 (99.0%)
Not recorded	296 (16.3%)	50 (16.9%)	246 (83.1%)
Anatomical site			
Lip	85 (4.7%)	45 (52.9%)	40 (47.1%)
Larynx	584 (32.1%)	157 (26.9%)	427 (73.1%)
Nasal cavity	85 (4.7%)	21 (24.7%)	64 (75.3%)
Oral cavity	506 (28.8%)	111 (21.9%)	395 (78.1%)
Oropharynx	323 (17.8%)	62 (19.2%)	261 (80.8%)
Hypopharynx	119 (6.5%)	7 (5.9%)	112 (94.1%)
Other/salivary gland	118 (6.5%)	33 (28.0%)	85 (72.0%)
Stage			
I	383 (21.0%)	165 (43.1%)	218 (56.9%)
II	369 (20.3%)	103 (27.9%)	266 (72.1%)
III	273 (15.0%)	60 (22.0%)	213 (78.0%)
IV	662 (36.4%)	76 (11.5%)	586 (88.5%)
Unknown	133 (7.3%)	32 (24.1%)	101 (75.9%)
Treatment modality			
Surgery only	477 (26.2%)	164 (34.4%)	313 (65.6%)
Radiotherapy only	507 (27.9%)	130 (25.6%)	377 (74.4%)
Surgery + radiotherapy	458 (25.2%)	98 (21.4%)	360 (78.6%)
Surgery, radiotherapy + chemotherapy	65 (3.6%)	20 (4.6%)	45 (3.3%)
Radiotherapy + chemotherapy	143 (7.9%)	21 (4.8%)	122 (8.8%)
Chemotherapy +/- surgery	41 (2.3%)	1 (0.2%)	40 (2.9%)
No treatment	129 (7.1%)	2 (1.6%)	127 (98.5%)
Network/region			
WoSCAN (West of Scotland)	1,001 (55.0%)	214 (21.4%)	787 (78.6%)
SCAN (East of Scotland)	440 (24.2%)	124 (28.2%)	316 (71.8%)
NOSCAN (North of Scotland)	379 (20.8%)	98 (25.9%)	281 (74.1%)

Table 2 – One- and 12-year overall, net and disease-specific survival for all patient, tumour and treatment factors

Variable	Overall		Disease-specific		Net	
	1-year	12-years	1-year	12-year	1-year	12-year
Whole cohort	76.0 (74.0, 77.9)	26.3 (24.3, 28.3)	82.3 (80.4, 84.0)	56.9 (54.3, 59.4)	78.3 (76.2, 80.3)	41.4 (37.6, 45.1)
Age at diagnosis						
Less than 45	90.9 (83.3, 95.2)	62.6 (52.3, 71.3)	94.8 (88.0, 97.8)	72.1 (61.7, 80.1)	91.1 (85.5, 96.8)	64.9 (55.0, 74.7)
45 to 54	83.7 (78.9, 87.5)	37.5 (31.9, 43.0)	86.5 (81.9, 90.0)	60.2 (53.8, 66.0)	84.2 (80.0, 88.6)	42.2 (35.9, 48.5)
55 to 64	78.4 (74.8, 81.5)	30.2 (26.6, 34.0)	83.1 (79.7, 85.9)	60.0 (55.5, 64.2)	79.6 (76.2, 83.0)	38.8 (34.0, 43.7)
65 to 74	73.1 (69.2, 76.6)	18.0 (14.9, 21.3)	81.7 (78.1, 84.8)	54.2 (49.1, 59.1)	75.9 (72.1, 79.8)	35.8 (29.5, 42.2)
75 and over	64.1 (58.3, 69.4)	10.3 (7.2, 14.2)	72.9 (67.2, 77.8)	45.3 (37.9, 52.4)	69.1 (63.2, 75.0)	43.2 (28.0, 58.4)
Sex						
Male	76.2 (73.7, 78.4)	24.9 (22.6, 27.3)	82.0 (79.8, 84.1)	55.3 (52.2, 58.3)	78.5 (76.1, 80.9)	40.5 (36.2, 44.8)
Female	75.8 (71.9, 79.2)	29.6 (25.8, 33.6)	82.8 (79.2, 85.9)	60.9 (56.0, 65.5)	77.6 (73.8, 81.4)	43.0 (36.1, 49.8)
Carstairs quintile						
1 (Most affluent)	83.4 (78.1, 87.5)	27.0 (21.5, 32.7)	88.8 (83.9, 92.2)	61.8 (54.4, 68.4)	86.1 (81.3, 91.0)	40.4 (30.7, 50.0)
2	78.6 (73.6, 82.7)	30.6 (25.6, 35.7)	83.2 (78.5, 86.9)	65.6 (59.6, 70.9)	80.9 (76.2, 85.5)	43.8 (35.0, 52.6)
3	76.3 (71.3, 80.6)	26.2 (21.5, 31.0)	82.2 (77.5, 86.1)	55.5 (49.2, 61.3)	78.6 (73.8, 83.3)	40.7 (31.5, 49.9)
4	75.1 (70.6, 79.0)	26.9 (22.7, 31.3)	81.8 (77.5, 85.3)	55.5 (49.9, 60.8)	77.2 (72.8, 81.5)	46.6 (38.4, 54.7)
5 (Most deprived)	71.8 (67.8, 75.4)	22.9 (19.4, 26.5)	79.1 (75.2, 82.4)	51.1 (46.0, 55.9)	73.7 (69.7, 77.6)	35.7 (29.6, 41.8)
Smoking behaviour						
Current smoker	72.8 (70.1, 75.2)	22.3 (19.9, 24.8)	79.0 (76.4, 81.3)	53.2 (49.9, 56.5)	74.6 (71.9, 77.2)	32.4 (28.6, 36.2)
Previous smoker	80.3 (76.0, 83.8)	27.4 (23.2, 31.8)	87.0 (83.2, 90.0)	59.8 (54.1, 65.0)	83.3 (79.2, 87.3)	49.9 (40.5, 59.2)
Never smoked	85.5 (80.2, 89.5)	43.9 (37.3, 50.3)	89.3 (84.4, 92.8)	66.9 (59.8, 73.0)	87.9 (83.1, 92.7)	70.6 (57.1, 84.1)
Not recorded	75.0 (62.0, 84.1)	28.3 (17.6, 40.0)	86.0 (73.9, 92.7)	67.3 (51.2, 79.1)	77.6 (66.2, 88.9)	40.3 (22.2, 58.5)
Alcohol consumption						
Current problem drinker	70.8 (66.6, 74.6)	18.2 (14.9, 21.7)	77.8 (73.7, 81.3)	45.9 (40.5, 51.1)	72.4 (68.3, 76.5)	23.5 (18.6, 28.4)
Previous problem drinker	72.2 (65.6, 77.7)	17.0 (12.3, 22.3)	76.6 (70.2, 81.8)	49.7 (42.1, 56.9)	74.0 (67.9, 80.2)	23.4 (15.9, 30.9)
Occasional/never	79.2 (76.4, 81.8)	32.3 (29.3, 35.4)	85.0 (82.4, 87.2)	62.1 (58.5, 65.5)	81.7 (78.9, 84.4)	54.1 (48.0, 60.1)
Not recorded	78.7 (72.7, 83.6)	29.0 (23.1, 35.0)	86.7 (81.2, 90.6)	65.4 (57.6, 72.1)	81.3 (75.7, 86.9)	43.9 (33.8, 54.0)
WHO Performance Status						
Normal activity	88.1 (85.7, 90.2)	40.6 (37.2, 43.9)	91.9 (89.8, 92.6)	70.4 (66.8, 73.7)	90.2 (88.0, 92.5)	59.0 (53.5, 64.9)
Strenuous restricted	72.3 (68.0, 76.1)	16.1 (13.0, 19.6)	79.1 (74.9, 82.6)	49.7 (44.1, 55.0)	74.6 (70.5, 78.9)	33.1 (26.7, 41.1)
Up and about >50%	50.4 (41.7, 58.4)	7.3 (3.7, 12.5)	62.0 (52.7, 70.0)	30.3 (21.2, 40.0)	52.2 (44.2, 61.6)	11.6 (5.9, 22.9)
Confined >50%	34.0 (24.8, 43.4)	1.0 (0.1, 5.0)	44.8 (33.7, 55.2)	10.1 (2.8, 23.1)	35.6 (27.0, 46.8)	1.5 (0.3, 9.0)
Not recorded	74.0 (68.6, 78.6)	19.3 (15.0, 23.9)	79.2 (74.0, 83.5)	50.2 (43.4, 56.7)	76.5 (71.5, 81.8)	31.2 (23.7, 41.1)
Anatomical site						
Lip	94.1 (86.4, 97.5)	56.5 (45.3, 66.2)	97.6 (90.8, 99.4)	91.3 (81.5, 96.0)	97.7 (92.4, 100.3)	98.3 (76.3, 120.2)
Larynx	81.9 (78.5, 84.8)	29.5 (25.8, 33.2)	85.9 (82.8, 88.5)	63.8 (59.2, 67.9)	84.4 (81.1, 87.6)	50.5 (43.4, 57.7)
Nasal cavity	77.7 (67.2, 85.1)	25.9 (17.1, 35.5)	82.8 (72.6, 89.4)	52.6 (40.2, 63.6)	79.5 (70.4, 88.5)	31.9 (19.5, 44.4)
Oral cavity	76.9 (67.2, 85.1)	23.7 (20.1, 27.5)	82.1 (78.4, 85.3)	55.4 (50.3, 60.3)	79.1 (75.3, 82.9)	36.8 (30.1, 43.6)
Oropharynx	65.3 (59.9, 70.2)	21.4 (17.1, 26.0)	73.8 (68.5, 78.4)	45.8 (39.6, 51.8)	66.7 (61.4, 72.0)	25.7 (19.7, 31.8)
Hypopharynx	55.5 (46.1, 63.9)	9.2 (4.9, 15.3)	68.4 (58.5, 76.4)	23.6 (14.5, 33.9)	57.0 (47.9, 66.2)	15.8 (7.0, 24.7)
Other/salivary gland	79.7 (71.2, 85.9)	30.5 (22.5, 38.9)	87.7 (80.2, 92.6)	62.3 (51.0, 71.7)	81.6 (74.1, 89.0)	44.8 (29.9, 59.7)
Stage						
I	97.1 (94.9, 98.4)	46.0 (40.9, 50.9)	98.7 (96.9, 99.5)	84.0 (79.4, 87.8)	99.9 (98.2, 101.7)	72.2 (62.7, 81.6)
II	89.2 (85.5, 91.9)	30.4 (25.7, 35.1)	93.3 (90.2, 95.5)	65.6 (59.6, 70.9)	91.9 (88.6, 95.2)	51.8 (42.8, 60.9)
III	74.7 (69.1, 79.5)	23.8 (18.9, 29.0)	81.7 (76.4, 85.9)	53.4 (46.2, 60.0)	76.6 (71.3, 81.9)	32.7 (24.4, 41.0)
IV	57.6 (53.7, 61.2)	13.9 (11.4, 16.7)	66.2 (62.4, 69.8)	35.3 (31.0, 39.6)	59.1 (55.2, 63.0)	21.6 (17.1, 26.0)
Unknown	73.7 (65.3, 80.3)	24.8 (17.9, 32.4)	80.3 (72.2, 86.2)	55.4 (45.4, 64.3)	76.2 (68.5, 83.9)	36.8 (24.5, 49.1)
Treatment modality						
Surgery only	88.9 (85.7, 91.4)	36.7 (32.4, 41.0)	93.5 (90.8, 95.4)	72.8 (68.1, 77.0)	91.7 (88.8, 94.6)	61.7 (53.1, 70.2)
Radiotherapy only	82.1 (78.4, 85.1)	27.6 (23.8, 31.6)	87.0 (83.7, 89.7)	63.1 (58.1, 67.7)	84.8 (81.3, 88.2)	44.3 (37.0, 51.5)
Surgery + radio	83.0 (79.2, 86.1)	24.9 (21.0, 28.9)	86.4 (82.9, 89.3)	54.2 (48.8, 59.3)	84.9 (81.4, 88.5)	36.2 (29.7, 42.6)
Surgery, radio + chemo	69.2 (56.5, 78.9)	32.3 (21.4, 43.7)	70.7 (58.0, 80.2)	47.3 (34.3, 59.2)	70.5 (59.2, 81.9)	39.4 (23.4, 55.5)
Radio + chemo	70.6 (62.4, 77.4)	17.5 (11.8, 23.1)	77.5 (69.6, 83.6)	37.3 (28.3, 46.3)	72.0 (64.4, 79.6)	22.3 (13.8, 30.8)
Chemo +/- surgery	9.8 (3.1, 21.0)	2.4 (0.2, 11.0)	17.2 (5.6, 34.0)	4.3 (0.3, 17.9)	10.0 (1.3, 18.7)	2.6 (1.5, 6.8)
No Treatment	10.9 (6.2, 16.9)	1.6 (0.3, 5.0)	18.1 (10.7, 26.9)	5.6 (1.7, 13.1)	11.2 (6.8, 16.7)	1.7 (0.4, 3.9)
Network/region						
WoSCAN (West Scotland)	75.3 (72.5, 77.9)	24.0 (21.4, 26.7)	82.5 (79.9, 84.8)	54.8 (51.1, 58.3)	77.4 (74.7, 80.2)	36.9 (32.0, 41.7)
SCAN (East Scotland)	76.4 (72.1, 80.1)	30.0 (25.8, 34.3)	82.0 (78.0, 85.4)	60.0 (54.8, 64.8)	78.7 (74.6, 82.8)	50.0 (42.0, 58.1)
NOSCAN (North Scotland)	77.6 (73.0, 81.5)	28.0 (23.5, 32.6)	81.9 (77.6, 85.5)	58.6 (52.9, 63.8)	79.7 (75.4, 84.0)	41.9 (34.7, 49.2)

Table 3 – Mutually adjusted forward stepwise Cox proportional hazard ratios at one- and 12-years for all patient, tumour and treatment factors for overall survival

Variable	One-year HR (95% CIs)	HR p-value	p-value	Chi-Sq.	12-year HR (95% CIs)	HR p-value	p-value	Chi-Sq.
Age at diagnosis			<0.001	22.23			<0.001	139.21
Less than 45	0.71 (0.42, 1.21)	0.208			0.59 (0.42, 0.84)	0.004		
45 to 54	1.00 (Ref.)	-			1.00 (Ref.)	-		
55 to 64	1.00 (0.77, 1.29)	0.991			1.17 (0.98, 1.40)	0.077		
65 to 74	1.37 (1.05, 1.79)	0.019			1.94 (1.62, 2.32)	<0.001		
75 and over	1.60 (1.18, 2.18)	0.002			2.44 (1.97, 3.01)	<0.001		
Smoking behaviour			0.024	9.40			<0.001	24.62
Current smoker	1.42 (1.04, 1.94)	0.026			1.45 (1.19, 1.77)	<0.001		
Previous smoker	1.12 (0.80, 1.56)	0.520			1.08 (0.87, 1.34)	0.488		
Never smoked	1.00 (Ref.)	-			1.00 (Ref.)	-		
Not recorded	0.94 (0.51, 1.73)	0.835			1.22 (0.83, 1.80)	0.304		
Alcohol consumption			0.023	10.82			<0.001	38.81
Current problem drinker	1.32 (1.08, 1.61)	0.006			1.51 (1.31, 1.73)	<0.001		
Previous problem drinker	1.19 (0.93, 1.53)	0.169			1.36 (1.15, 1.62)	<0.001		
Occasional/never	1.00 (Ref.)	-			1.00 (Ref.)	-		
Not recorded	0.86 (0.63, 1.16)	0.323			1.01 (0.83, 1.23)	0.900		
WHO Performance Status			<0.001	41.46			<0.001	84.55
Normal activity	1.00 (Ref.)	-			1.00 (Ref.)	-		
Strenuous restricted	1.52 (1.23, 1.89)	<0.001			1.46 (1.27, 1.68)	<0.001		
Up and about >50%	2.19 (1.66, 2.90)	<0.001			2.13 (1.73, 2.63)	<0.001		
Conf. to bed/chair >50%	2.38 (1.74, 3.27)	<0.001			2.61 (2.03, 3.36)	<0.001		
Not recorded	1.45 (1.13, 1.85)	0.003			1.42 (1.21, 1.66)	<0.001		
Anatomical site			0.006	18.33			<0.001	32.79
Lip	0.48 (0.23, 1.03)	0.058			0.50 (0.35, 0.73)	<0.001		
Larynx	0.72 (0.57, 0.91)	0.007			0.74 (0.63, 0.88)	<0.001		
Nasal cavity	0.80 (0.54, 1.20)	0.279			0.78 (0.59, 1.04)	0.087		
Oral cavity	1.00 (0.79, 1.27)	0.991			0.98 (0.82, 1.16)	0.790		
Oropharynx	1.00 (Ref.)	-			1.00 (Ref.)	-		
Hypopharynx	0.99 (0.74, 1.31)	0.926			1.06 (0.84, 1.33)	0.624		
Other/salivary gland	1.25 (0.88, 1.77)	0.210			1.02 (0.79, 1.33)	0.881		
Stage			<0.001	22.23			<0.001	83.57
I	1.00 (Ref.)	-			1.00 (Ref.)	-		
II	2.71 (1.81, 4.05)	<0.001			1.44 (1.20, 1.73)	<0.001		
III	4.17 (2.77, 6.27)	<0.001			1.77 (1.45, 2.17)	<0.001		
IV	5.89 (3.98, 8.71)	<0.001			2.38 (1.97, 2.88)	<0.001		
Unknown	4.36 (2.74, 6.95)	<0.001			1.97 (1.52, 2.56)	<0.001		
Treatment modality			<0.001	285.18			<0.001	283.86
Surgery only	1.00 (Ref.)	-			1.00 (Ref.)	-		
Radiotherapy only	1.62 (1.22, 2.56)	<0.001			1.31 (1.09, 1.57)	0.004		
Surgery + radio	0.97 (0.73, 1.29)	0.828			1.02 (0.86, 1.22)	0.810		
Surgery, radio + chemo	1.39 (0.88, 2.19)	0.154			1.00 (0.72, 1.39)	0.984		
Radio + chemo	1.70 (1.21, 2.40)	0.002			1.40 (1.10, 1.78)	0.006		
Chemo +/- surgery	7.25 (4.77, 11.02)	<0.001			6.01 (4.19, 8.62)	<0.001		
No Treatment	7.78 (5.68, 10.66)	<0.001			5.99 (4.67, 7.69)	<0.001		

- Reference category

Table 4 – Mutually adjusted one- and 12-year overall for all patient, tumour and treatment factors for disease-specific survival

Variable	1-year HR (95% CIs)	HR p-value	p-value	Chi-Sq.	12-year HR (95% CIs)	HR p-value	p-value	Chi-Sq.
Age at diagnosis			0.018	11.93			<0.001	22.85
Less than 45	0.70 (0.38, 1.27)	0.236			0.78 (0.51, 1.21)	0.267		
45 to 54	1.00 (Ref.)	-			1.00 (Ref.)	-		
55 to 64	0.89 (0.66, 1.20)	0.432			0.94 (0.74, 1.19)	0.607		
65 to 74	1.03 (0.76, 1.40)	0.856			1.28 (0.99, 1.64)	0.056		
75 and over	1.41 (1.00, 2.00)	0.053			1.58 (1.18, 2.11)	0.002		
Alcohol consumption			<0.001	19.33			<0.001	30.95
Current problem drinker	1.42 (1.13, 1.78)	0.002			1.54 (1.28, 1.86)	<0.001		
Previous problem drinker	1.35 (1.01, 1.80)	0.041			1.42 (1.12, 1.80)	0.004		
Occasional/never	1.00 (Ref.)	-			1.00 (Ref.)	-		
Not recorded	0.69 (0.48, 0.97)	0.035			0.81 (1.15, 1.07)	0.131		
WHO Performance Status			<0.001	31.61			<0.001	43.93
Normal activity	1.00 (Ref.)	-			1.00 (Ref.)	-		
Strenuous restricted	1.60 (1.23, 2.09)	<0.001			1.41 (1.15, 1.73)	0.001		
Up and about >50%	2.25 (1.60, 3.15)	<0.001			2.06 (1.55, 2.74)	<0.001		
Conf. to bed/chair >50%	2.51 (1.72, 3.66)	<0.001			2.66 (1.92, 3.68)	<0.001		
Not recorded	1.51 (1.11, 2.04)	0.008			1.46 (1.16, 1.84)	0.001		
Anatomical site			/	/			0.005	18.47
Lip	/	/			0.25 (0.11, 0.58)	0.001		
Larynx	/	/			0.78 (0.61, 0.99)	0.037		
Nasal cavity	/	/			0.82 (0.56, 1.20)	0.314		
Oral cavity	/	/			0.98 (0.78, 1.25)	0.885		
Oropharynx	/	/			1.00 (Ref.)	-		
Hypopharynx	/	/			1.10 (0.82, 1.47)	0.531		
Other/salivary gland	/	/			0.80 (0.54, 1.18)	0.259		
Stage			<0.001	84.00			<0.001	98.22
I	1.00 (Ref.)	-			1.00 (Ref.)	-		
II	4.89 (2.62, 9.12)	<0.001			2.13 (1.52, 2.98)	<0.001		
III	7.23 (3.85, 13.57)	<0.001			3.03 (2.14, 4.29)	<0.001		
IV	12.42 (6.77, 22.83)	<0.001			4.86 (3.49, 6.77)	<0.001		
Unknown	7.86 (3.99, 15.51)	<0.001			3.83 (2.52, 5.83)	<0.001		
Treatment modality			<0.001	233.82			<0.001	205.62
Surgery only	1.00 (Ref.)	-			1.00 (Ref.)	-		
Radiotherapy only	1.70 (1.21, 2.38)	0.002			1.54 (1.17, 2.03)	0.002		
Surgery + radio	1.12 (0.79, 1.59)	0.532			1.14 (0.88, 1.49)	0.325		
Surgery, radio + chemo	2.08 (1.26, 3.42)	0.004			1.45 (0.95, 2.21)	0.084		
Radio + chemo	2.13 (1.42, 3.19)	<0.001			1.77 (1.28, 2.45)	<0.001		
Chemo +/- surgery	7.27 (4.41, 12.00)	<0.001			6.49 (4.10, 10.26)	<0.001		
No Treatment	10.15 (6.93, 14.87)	<0.001			7.71 (5.54, 10.73)	<0.001		
Network/region			0.043	6.29			/	/
WoSCAN (West Scotland)	0.95 (0.74, 1.20)				/	/		
SCAN (East Scotland)	1.00 (Ref.)	-			/	/		
NOSCAN (North Scotland)	1.30 (0.98, 1.73)				/	/		

- Reference category

/ Not entered into model

Supplementary Tables

Supplementary Table 1 - Mutually adjusted Cox proportional hazards model results when excluding patients who received no treatment (n = 1,691)

Overall			Disease-specific								
1-year	p-value	Chi-Sq.	12-year	p-value	Chi-Sq.	1-year	p-value	Chi-Sq.	12-year	p-value	Chi-Sq.
Age	<0.001	24.45	Age	<0.001	140.09	Age	0.110	7.54	Age	<0.001	18.93
Stage	<0.001	102.76	Stage	<0.001	90.68	Stage	<0.001	86.82	Stage	<0.001	104.10
Treatment	<0.001	46.79	Treatment	<0.001	25.34	Treatment	<0.001	38.60	Treatment	<0.001	28.04
WHO	<0.001	46.77	WHO	<0.001	93.65	WHO	<0.001	32.13	WHO	<0.001	51.71
Alcohol	0.004	13.52	Alcohol	<0.001	34.77	Alcohol	0.001	15.82	Site	<0.001	34.07
Site	<0.001	30.47	Site	<0.001	42.66	Site	0.007	17.62	Alcohol	<0.001	25.90
Smoking	0.022	9.65	Smoking	<0.001	27.49	Network	0.050	5.99	-	-	-

Supplementary Table 2 - Mutually adjusted Cox proportional hazards model results when excluding oropharynx patients (n = 1,497) with larynx as new reference group

Step	Overall			Disease-specific								
	1-year	p-value	Chi-Sq.	12-year	p-value	Chi-Sq.	1-year	p-value	Chi-Sq.	12-year	p-value	Chi-Sq.
2	Age	0.008	13.88	Age	<0.001	102.99	Age	0.015	12.30	Age	0.003	16.53
3	Stage	<0.001	81.75	Stage	<0.001	84.89	Stage	<0.001	67.36	Stage	<0.001	89.54
4	Treatment	<0.001	177.34	Treatment	<0.001	155.18	Treatment	<0.001	149.20	Treatment	<0.001	119.32
5	WHO	<0.001	45.10	WHO	<0.001	86.31	WHO	<0.001	32.06	WHO	<0.001	50.11
6	Alcohol	0.007	12.24	Alcohol	<0.001	31.70	Alcohol	0.001	16.03	Alcohol	<0.001	23.22
7	Site	0.008	15.50	Site	<0.001	29.65	Network	0.004	11.14	Site	0.003	18.04
8	Network	0.028	7.17	Smoking	<0.001	16.39	-	-	-	Network	0.031	6.94

Supplementary Table 3 – Patient demographic, behavioural, tumour and treatment characteristics by Carstairs quintiles

Variable	Total (Col. %)	Frequencies of Carstairs 2001 quintiles (Col. %)					Chi-square p-value
		1 – Most affluent	2	3	4	5 – Most deprived	
Whole cohort (Row %)	1,820 (100.0%)	241 (13.2%)	317 (17.4%)	325 (17.9%)	409 (22.5%)	528 (29.0%)	-
Age at diagnosis							0.470
Less than 45	99 (5.4%)	16 (6.6%)	23 (7.3%)	16 (4.9%)	21 (5.1%)	23 (4.4%)	
45 to 54	288 (15.8%)	35 (14.5%)	44 (13.9%)	45 (13.9%)	68 (16.6%)	96 (18.2%)	
55 to 64	592 (32.5%)	70 (29.1%)	105 (33.1%)	108 (33.2%)	140 (34.2%)	169 (32.0%)	
65 to 74	551 (30.3%)	72 (29.9%)	90 (28.4%)	111 (34.2%)	108 (26.4%)	170 (32.2%)	
75 and over	290 (15.9%)	48 (19.9%)	55 (17.4%)	45 (13.9%)	72 (17.6%)	70 (13.3%)	
Sex							0.440
Male	1,300 (71.4%)	161 (66.8%)	227 (71.6%)	236 (72.6%)	289 (70.7%)	387 (73.3%)	
Female	520 (28.6%)	80 (33.2%)	90 (28.4%)	89 (27.4%)	120 (29.3%)	141 (26.7%)	
Smoking status							<0.001
Current smoker	1,134 (62.3%)	118 (49.0%)	173 (54.6%)	191 (58.8%)	256 (62.6%)	396 (75.0%)	
Previous smoker	405 (22.3%)	60 (24.9%)	86 (27.1%)	68 (20.9%)	100 (24.5%)	91 (17.2%)	
Never smoked	221 (12.1%)	56 (23.2%)	45 (14.2%)	50 (15.4%)	41 (10.0%)	29 (5.5%)	
Not recorded	60 (3.3%)	7 (2.9%)	13 (4.1%)	16 (4.9%)	12 (2.9%)	12 (2.3%)	
Alcohol consumption							<0.001
Current (problem) drinker	496 (27.3%)	51 (21.2%)	77 (24.3%)	80 (24.6%)	108 (26.4%)	180 (34.1%)	
Previous (problem) drinker	212 (11.7%)	25 (10.4%)	29 (9.2%)	49 (15.1%)	47 (11.5%)	62 (11.7%)	
Occasional/never drank	891 (49.0%)	138 (57.3%)	164 (51.7%)	150 (46.2%)	198 (48.4%)	241 (45.6%)	
Not recorded	221 (12.1%)	27 (11.2%)	47 (14.8%)	46 (14.2%)	56 (13.7%)	45 (8.5%)	
WHO performance status							0.003
Normal activity	825 (45.3%)	137 (56.9%)	169 (53.3%)	137 (42.3%)	177 (43.3%)	205 (38.8%)	
Strenuous activity restricted	465 (25.6%)	54 (22.4%)	66 (20.8%)	94 (28.9%)	102 (24.9%)	149 (28.2%)	
Up and about > 50%	137 (7.5%)	18 (7.5%)	23 (7.3%)	17 (5.2%)	33 (8.1%)	46 (8.7%)	
Confined to bed/chair >50%	97 (5.3%)	8 (3.3%)	18 (5.7%)	22 (6.8%)	26 (6.4%)	23 (4.4%)	
Not recorded	296 (16.3%)	24 (10.0%)	41 (12.9%)	55 (16.9%)	71 (17.4%)	105 (19.9%)	
Anatomical site							0.470
Lip	85 (4.7%)	11 (4.6%)	17 (5.4%)	18 (5.5%)	23 (5.6%)	16 (3.0%)	
Larynx	584 (32.1%)	71 (29.5%)	102 (32.2%)	103 (31.7%)	143 (35.0%)	165 (31.3%)	
Nasal cavity	85 (4.7%)	12 (5.0%)	14 (4.4%)	22 (6.8%)	15 (3.7%)	22 (4.2%)	
Oral cavity	506 (27.8%)	76 (31.5%)	93 (29.3%)	78 (24.0%)	97 (23.7%)	162 (30.7%)	
Oropharynx	323 (17.8%)	40 (16.6%)	53 (16.7%)	63 (19.4%)	69 (16.9%)	98 (18.6%)	
Hypopharynx	119 (6.5%)	12 (5.0%)	19 (6.0%)	20 (6.2%)	35 (8.6%)	33 (6.3%)	
Other/salivary gland	118 (6.5%)	19 (7.9%)	19 (6.0%)	21 (6.5%)	27 (6.6%)	32 (6.1%)	
Stage							0.023
I	383 (21.0%)	58 (24.1%)	85 (26.8%)	75 (23.1%)	73 (17.9%)	92 (17.4%)	
II	369 (20.3%)	48 (19.9%)	62 (19.6%)	65 (20.0%)	88 (21.5%)	106 (20.1%)	
III	273 (15.0%)	37 (15.4%)	42 (13.3%)	40 (12.3%)	80 (19.6%)	74 (14.0%)	
IV	662 (36.4%)	79 (32.8%)	102 (32.2%)	125 (38.5%)	145 (35.5%)	211 (40.0%)	
Unknown	133 (7.3%)	19 (7.9%)	26 (8.2%)	20 (6.2%)	23 (5.6%)	45 (8.5%)	
Treatment modality							0.064
Surgery only	477 (26.2%)	72 (29.9%)	83 (26.2%)	86 (26.5%)	106 (25.9%)	130 (24.6%)	
Radiotherapy only	507 (27.9%)	74 (30.7%)	99 (31.2%)	98 (30.2%)	117 (28.6%)	119 (22.5%)	
Surgery + radiotherapy	458 (25.2%)	59 (24.5%)	82 (25.9%)	73 (22.5%)	101 (24.7%)	143 (27.1%)	
Chemo +/- radio +/- surgery	249 (13.7%)	23 (9.5%)	34 (10.7%)	48 (14.8%)	56 (13.7%)	88 (16.7%)	
No treatment	129 (7.1%)	13 (5.4%)	19 (6.0%)	20 (6.2%)	29 (7.1%)	48 (9.1%)	
Network							<0.001
WoSCAN (West Scotland)	1,001 (55.0%)	85 (35.3%)	110 (34.7%)	149 (45.9%)	244 (59.7%)	413 (78.2%)	
SCAN (East Scotland)	440 (24.2%)	83 (34.4%)	85 (26.8%)	108 (33.2%)	108 (26.4%)	56 (10.6%)	
NOSCAN (North Scotland)	379 (20.8%)	73 (30.3%)	122 (38.5%)	68 (20.9%)	68 (20.9%)	59 (11.2%)	