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# Abstract

## Background

Making informed decisions about cancer care provision for older cancer patients can be challenging and complex. Evidence suggests cancer care varies by age, however the relationship between age and care experiences from diagnosis to death for cancer patients within the UK has not previously been examined in detail.

## Patients and Methods

Retrospective cohort linking cancer registry and secondary care data for 13,499 adult cancer patients who died between January 2005 and December 2011. Cancer therapies (chemotherapy, radiotherapy, surgery), hospital palliative care referrals, hospital admissions, and place of death were compared between age groups using multivariable regression models.Trends in cancer care over time, overall and within age groups, were also assessed.

## Results

Compared with adult patients under 60 years, patients aged 80 years and over were less likely to receive chemotherapy, radiotherapy, a hospital palliative care referral; or be admitted to hospital; but were more likely to die in a care home.

Overall the percentage of patients receiving chemotherapy, surgery, hospital palliative care referrals, and hospital admissions have increased while deaths in hospital have decreased. Deaths at home have increased for patients aged 80 years and over.

## Conclusion

Older patients are less likely to receive cancer therapies or hospital palliative care before death. Further research is needed to identify the extent to which these results reflect unmet need.

## Keywords

cancer, end-of-life care, hospital admission, place of death, older people

## Key points

- Cancer care provision differed between age groups.
- Older patients were less likely to have received chemotherapy, radiotherapy, hospital palliative care, or hospital admission.
- Older patients were more likely to die in a care home.
- Deaths at home increased while deaths in hospital decreased between 2005 and 2011 for older cancer patients.

# Introduction

Cancer it is a disease which is closely allied with older age, with most registrations and cancer deaths occurring in those aged 65 years and over [1, 2]. Projections from the United Kingdom (UK) suggest that cancer registrations and deaths in older age groups are likely to increase as the population ages [3].

Living and dying well with cancer is a key priority for the UK National Health Service (NHS) [4]. Making informed decisions along the cancer continuum about the most appropriate course of action can be challenging and complex [5]. This can be particularly so when caring for older patients due to existing comorbidities and issues regarding frailty, organ function, and cognitive and functional status. Assessing the benefit of treatments for older patients can also be particularly difficult as many clinical trials explicitly exclude older adults due to the potential problem of comorbidities [6].

Existing evidence suggests that older cancer patients are less likely to receive cancer therapies [7-10] or palliative care support [11, 12], and require less hospital activity [10, 13] compared with younger patients; however this evidence is derived from outdated studies [7, 9, 10] or studies based on small samples [7], limited to specific cancer types [9, 10], addressing specific aspects of cancer management [7, 9, 11-13], or based only on clinical opinion [8].

These studies highlight the need for a large comprehensive study assessing variations in cancer care between age groups for a broad range of cancer care outcomes. We aimed to describe principal cancer treatments and palliative care received by a large cohort of patients that died from cancer over a seven year period to provide a more detailed and comprehensive analysis.

# Methods

## Study design

A population based retrospective cohort study.

## Patients and data

Patients were included in the study if they were aged 18 years or over at date of death; resided within Leeds, a large city within Northern England, died between January 2005 and December 2011, and cancer was recorded on their death certificate. Data was obtained from two sources: the Northern and Yorkshire Cancer Registry (NYCR) and the Patient Pathway Manager (PPM), a clinical information system used by Leeds Teaching Hospitals Trust (LTHT).

An open pseudonymiser system was used to link datasets, using an encrypted code based on NHS numbers.

## Variables

### Outcomes

Patients were identified as having received or not received, at any point from first cancer diagnosis, the following care: chemotherapy, radiotherapy, surgery, hospital palliative care referral, and hospital admission (emergency or any). Information on chemotherapy and radiotherapy received, hospital palliative care, and hospital admissions were extracted from the PPM. We obtained information on whether the patient had received surgery from the NYCR information system.

Place of death was provided by NYCR and was categorised as ‘Own home’, ‘Hospice’, ‘Hospital’, ‘Care home’, or ‘Other/Unknown’.

### Patient characteristics

Age at death was stratified into 18 to 59 years, 60 to 69 years, and 70 to 79 years, and 80 years and over. Other patient characteristics included were gender, Indices of Multiple Deprivation (IMD) quintile (measure of socio-economic deprivation), first cancer diagnosis (categorised into broad groups), and duration of illness (calculated by subtracting date of death from date of first cancer diagnosis).

Two indicators, taken from the death certificate, were included to help identify patients with co-mobidities. The first proxy indicator identifies patients in whom cancer contributed to the death but was not the underlying cause (that is they died of an unrelated disease). The second proxy indicator was patients in whom circulatory disease (ICD 10 I00-I99) was included on the death certificates.

## Data analysis

Frequencies and percentages were used to summarise categorical patient characteristics and cancer care by age groups. Median and inter quartile range (IQR) were used to summarise duration of illness. The likelihood that patient characteristics and cancer care outcomes by age groups were due to chance were assessed using the Pearson's chi-square test ($\chi^2$), for categorical outcome variables, and the Kruskal-Wallis test, for numerical outcome variables.

All cancer care outcomes except place of death were assessed using multivariable logistic regression analyses to compare odds ratios. Place of death was assessed using multivariable multinomial logistic regression, comparing the relative risk ratios (odds ratios) of dying at home, in a hospice, and in a care home, relative to dying in hospital. Age group was included in the models as the independent variable, with age group 18 to 59 years used as the reference group. Gender, year of death, IMD quintile, first cancer diagnosis, cancer underlying cause of death, death certificate included

circulatory disease, and duration of illness were included in the models as extraneous factors. Trends over time in cancer care outcomes for each of the age groups were assessed using the $\chi^2$ test for trend.

All data manipulation and analysis were performed using IBM SPSS version 23.

### Ethics approval

The National Research Ethics Service (PR 13.YH.0301) granted ethical approval for the study.


### Funding

This work was supported by Yorkshire Cancer Research [award reference L384].


# Results

Comparisons of patient characteristics and cancer care by age at death are presented in Table 1.

### Patient characteristics

The study included 13,499 deceased adult cancer patients, of which the majority (55.9%) were aged 70 years or over.

Overall 53.8% of patients were male. The most common cancer sites were cancers of the trachea, bronchus, and lung (29.5%); and upper gastrointestinal cancers (16.1%). Cancer was reported as the underlying cause of death in just over ninety percent (90.5%) of patients, with just over ten percent (10.7%) of patients having circulatory disease included on their death certificate. The median duration of illness was just over one year (median: 1.05 years, inter quartile range: 0.46 to 2.41 years).

Gender ($p<0.001$), deprivation IMD quintile ($p<0.001$), cancer site ($p<0.001$), underlying cause of death reported as cancer ($p<0.001$), death certificate included

circulatory disease (p<0.001) and duration of illness (p<0.001) were all significantly associated with age group.

## Cancer care

Overall approximately half of all patients received chemotherapy (49.0%), sixty percent (60.7%) received radiotherapy, and over one third received surgery (34.5%). The likelihood of receiving chemotherapy (p<0.001), radiotherapy (p<0.001), or surgery (p=0.009) were all significantly associated with age group. The likelihood of receiving chemotherapy, radiotherapy, or surgery were all highest in the youngest age group (18 to 59 years), at 68.7%, 64.5%, and 37.3% respectively, and lowest in the oldest age group (80 plus years), at 27.1%, 57.6%, and 33.6% respectively.

The percentage of patients receiving a hospital palliative care referral (28.6%) and the percentage of patients experiencing at least one hospital admission, overall (38.6%) and as an emergency (29.8%), were also significantly associated with age group (all p<0.001). In all cases the highest percentages were in the 18 to 59 years age groups (hospital palliative care: 36.1%, all admissions: 42.5%; emergency admissions: 33.3%) and lowest in the 80 plus age group (hospital palliative care: 23.4%, all admissions: 35.7%; emergency admissions: 27.4%).

Place of death was significantly associated with age group (p<0.001). The percentage of hospice deaths were highest in the 18 to 59 years age group, at 36.0% reducing to 25.5% in the 80 plus age group. The percentage of patients dying in a care home was highest in the 80 plus age group, at 14.7%.

**Table 1.** Characteristics of patients and cancer care received by age group

| Patient characteristics | Age groups at death (years) 18 to 59 | | 60 to 69 | | 70 to 79 | | 80 plus | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | n | % | n | % | n | % | n | % | n | % | P value |
| **Total (n, row %)** | 2601 | 19.3 | 3351 | 24.8 | 4318 | 32 | 3229 | 23.9 | 13499 | 100 | |
| **Patient characteristics by age** | | | | | | | | | | | |
| **Gender** | | | | | | | | | | | |
| Male | 1305 | 50.2 | 1901 | 56.7 | 2394 | 55.4 | 1662 | 51.5 | 7262 | 53.8 | |
| Female | 1296 | 49.8 | 1450 | 43.3 | 1924 | 44.6 | 1567 | 48.5 | 6237 | 46.2 | <0.001 |
| **Deprivation IMD quintile** | | | | | | | | | | | |
| Quintile 1 - Top 20% most deprived | 792 | 30.4 | 977 | 29.2 | 1244 | 28.8 | 787 | 24.4 | 3800 | 28.2 | |
| Quintile 2 | 576 | 22.1 | 686 | 20.5 | 905 | 21 | 646 | 20 | 2813 | 20.8 | |
| Quintile 3 | 423 | 16.3 | 520 | 15.5 | 722 | 16.7 | 545 | 16.9 | 2210 | 16.4 | |
| Quintile 4 | 467 | 18 | 682 | 20.4 | 853 | 19.8 | 745 | 23.1 | 2747 | 20.3 | |
| Quintile 5 - Top 20% least deprived | 343 | 13.2 | 486 | 14.5 | 594 | 13.8 | 506 | 15.7 | 1929 | 14.3 | <0.001 |
| **Cancer site (first diagnosis)** | | | | | | | | | | | |
| Head and neck | 185 | 7.1 | 198 | 5.9 | 204 | 4.7 | 123 | 3.8 | 710 | 5.3 | |
| Upper gastrointestinal | 415 | 16 | 604 | 18 | 732 | 17 | 422 | 13.1 | 2173 | 16.1 | |
| Colorectal | 270 | 10.4 | 364 | 10.9 | 496 | 11.5 | 471 | 14.6 | 1601 | 11.9 | |
| Trachea, bronchus and lung | 567 | 21.8 | 1127 | 33.6 | 1444 | 33.4 | 841 | 26 | 3979 | 29.5 | |
| Breast | 271 | 10.4 | 176 | 5.3 | 201 | 4.7 | 303 | 9.4 | 951 | 7 | |
| Gynaecological | 231 | 8.9 | 238 | 7.1 | 300 | 6.9 | 281 | 8.7 | 1050 | 7.8 | |
| Prostate | 28 | 1.1 | 123 | 3.7 | 350 | 8.1 | 356 | 11 | 857 | 6.3 | |
| Urological | 124 | 4.8 | 166 | 5 | 249 | 5.8 | 256 | 7.9 | 795 | 5.9 | |
| Central nervous system | 244 | 9.4 | 145 | 4.3 | 66 | 1.5 | 7 | 0.2 | 462 | 3.4 | |
| All other cancer sites | 266 | 10.2 | 210 | 6.3 | 276 | 6.4 | 169 | 5.2 | 921 | 6.8 | <0.001 |
| **Underlying cause of death reported as cancer** | | | | | | | | | | | |
| No | 121 | 4.7 | 251 | 7.5 | 423 | 9.8 | 494 | 15.3 | 1289 | 9.5 | |
| Yes | 2480 | 95.3 | 3100 | 92.5 | 3895 | 90.2 | 2735 | 84.7 | 12210 | 90.5 | <0.001 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Death certificate include circulatory disease (ICD10 I00-I99)** | | | | | | | | | | | |
| No | 2490 | 95.7 | 3069 | 91.6 | 3797 | 87.9 | 2696 | 83.9 | 12052 | 89.3 | |
| Yes | 111 | 4.3 | 282 | 8.4 | 521 | 12.1 | 533 | 16.5 | 1447 | 10.7 | <0.001 |
| **Duration of illness (years)** | | | | | | | | | | | |
| Median | | 1.05 | | 0.96 | | 1.03 | | 1.21 | | 1.05 | |
| IQR | 0.48 - 2.13 | | 0.44 - 2.15 | | 0.46 - 2.44 | | 0.48 - 2.97 | | 0.46 - 2.41 | | <0.001 |
| **Cancer care** | | | | | | | | | | | |
| **Chemotherapy: Received** | | | | | | | | | | | |
| No | 814 | 31.3 | 1350 | 40.3 | 2372 | 54.9 | 2353 | 72.9 | 6889 | 51 | |
| Yes | 1787 | 68.7 | 2001 | 59.7 | 1946 | 45.1 | 876 | 27.1 | 6610 | 49 | <0.001 |
| **Radiotherapy: Received** | | | | | | | | | | | |
| No | 924 | 35.5 | 1277 | 38.1 | 1734 | 40.2 | 1368 | 42.4 | 5303 | 39.3 | |
| Yes | 1677 | 64.5 | 2074 | 61.9 | 2584 | 59.8 | 1861 | 57.6 | 8196 | 60.7 | <0.001 |
| **Surgery: Received** | | | | | | | | | | | |
| No | 1630 | 62.7 | 2205 | 65.8 | 2862 | 66.3 | 2144 | 66.4 | 8841 | 65.5 | |
| Yes | 971 | 37.3 | 1146 | 34.2 | 1456 | 33.7 | 1085 | 33.6 | 4658 | 34.5 | 0.009 |
| **Hospital palliative care referral** | | | | | | | | | | | |
| No | 1662 | 63.9 | 2397 | 71.5 | 3103 | 71.9 | 2475 | 76.6 | 9637 | 71.4 | |
| Yes | 939 | 36.1 | 954 | 28.5 | 1215 | 28.1 | 754 | 23.4 | 3862 | 28.6 | <0.001 |
| **At least one hospital admission at any point from first cancer diagnosis** | | | | | | | | | | | |
| No | 1495 | 57.5 | 2025 | 60.4 | 2695 | 62.4 | 2076 | 64.3 | 8291 | 61.4 | |
| Yes | 1106 | 42.5 | 1326 | 39.6 | 1623 | 37.6 | 1153 | 35.7 | 5208 | 38.6 | <0.001 |
| **At least one emergency hospital admission at any point from first cancer diagnosis** | | | | | | | | | | | |
| No | 1736 | 66.7 | 2321 | 69.3 | 3079 | 71.3 | 2345 | 72.6 | 9481 | 70.2 | |
| Yes | 865 | 33.3 | 1030 | 30.7 | 1239 | 28.7 | 884 | 27.4 | 4018 | 29.8 | <0.001 |
| **Place of death** | | | | | | | | | | | |
| Own Home | 730 | 28.1 | 1016 | 30.3 | 1223 | 28.3 | 770 | 23.8 | 3739 | 27.7 | |
| Hospice | 936 | 36 | 1061 | 31.7 | 1377 | 31.9 | 822 | 25.5 | 4196 | 31.1 | |
| Hospital | 882 | 33.9 | 1163 | 34.7 | 1449 | 33.6 | 1139 | 35.3 | 4633 | 34.3 | <0.001 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Care home | 44 | 1.7 | 97 | 2.9 | 252 | 5.8 | 476 | 14.7 | 869 | 6.4 |
| Other | 9 | 0.3 | 14 | 0.4 | 17 | 0.4 | 22 | 0.7 | 62 | 0.5 |

%=column percentage unless otherwise stated; n = number; IQR=inter quartile range; P-values calculated using $\chi^2$ for categorical variables and Kruskal-Wallis for numeric variables

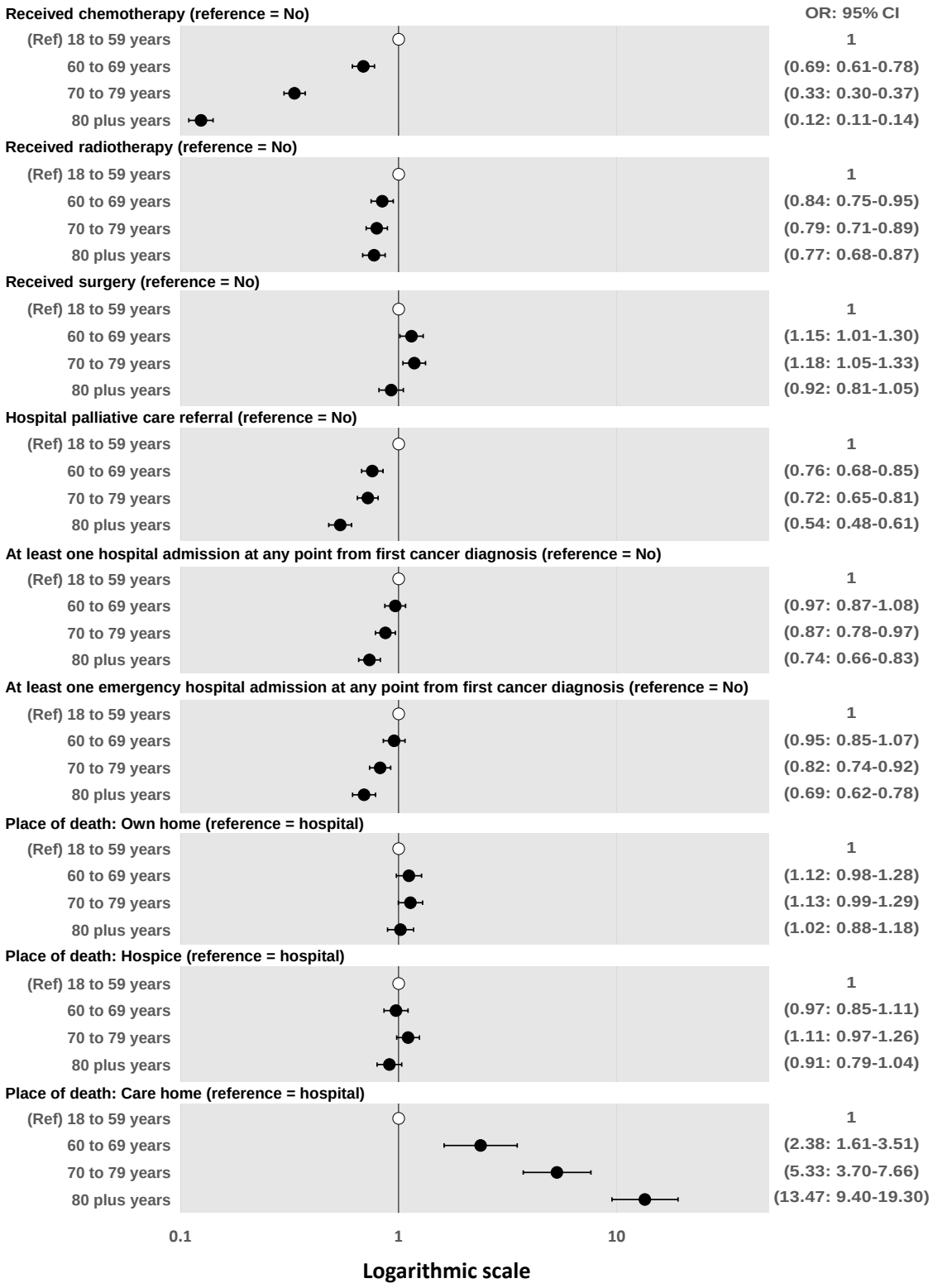
## Multivariable analysis

Figure 1 shows the odds ratios by age group, alongside 95% confidence intervals, for each cancer care outcome from the multivariable logistic and multinomial logistic regression models after controlling for the extraneous variables gender, year of death, deprivation quintile, cancer diagnosis, underlying cause of death cancer, death certificate include circulatory disease, and duration of illness. Please see the tables Appendix 1A to 1C in the supplementary data on the journal website (http://www.ageing.oxfordjournals.org/) for full results.

The odds of receiving chemotherapy ($p<0.001$), receiving radiotherapy ($p<0.001$), receiving a hospital palliative care referral ($p<0.001$), and being admitted to hospital (all admissions: $p<0.001$, emergency admissions: $p<0.001$) all differed significantly between age groups, with significantly lower odds in patients in the older age groups compared with patients aged 18 to 59 years.

The likelihood of receiving surgery also differed significantly by age group ($p<0.001$), with patients ages 60 to 69 years (OR: 1.15, 95% CI: 1.01-1.30) and 70 to 79 years (OR: 1.18, 95% CI: 1.05-1.33) having significantly higher odds of receiving surgery compared to patients aged 18 to 59 years.

Significant differences were found overall between age groups for the odds of dying in a hospice ($p=0.016$) and dying in a care home ($p<0.001$), compared with dying in hospital, however there was no significant difference by age group in the likelihood of dying at home compared to dying in hospital ($p=0.145$).The odds of dying in a care home increased with age. (60-69 years: OR=2.38, 95% CI=1.61-3.51; 70-79 years: OR=5.33, 95% CI=3.70-7.66; 80 plus years: OR=13.47, 95% CI=9.40 -19.30).




Multivariable analysis controlling for gender, year of death, deprivation quintile, cancer diagnosis, underlying cause of death cancer, death certificate include circulatory disease, and duration of illness; OR: Odds ratio; CIs: confidence intervals

**Figure 1:** Odds ratios by age group from multivariable analysis of cancer care outcomes

## Trends over time

Trends in cancer care by age and year of death are presented in Figure 2.

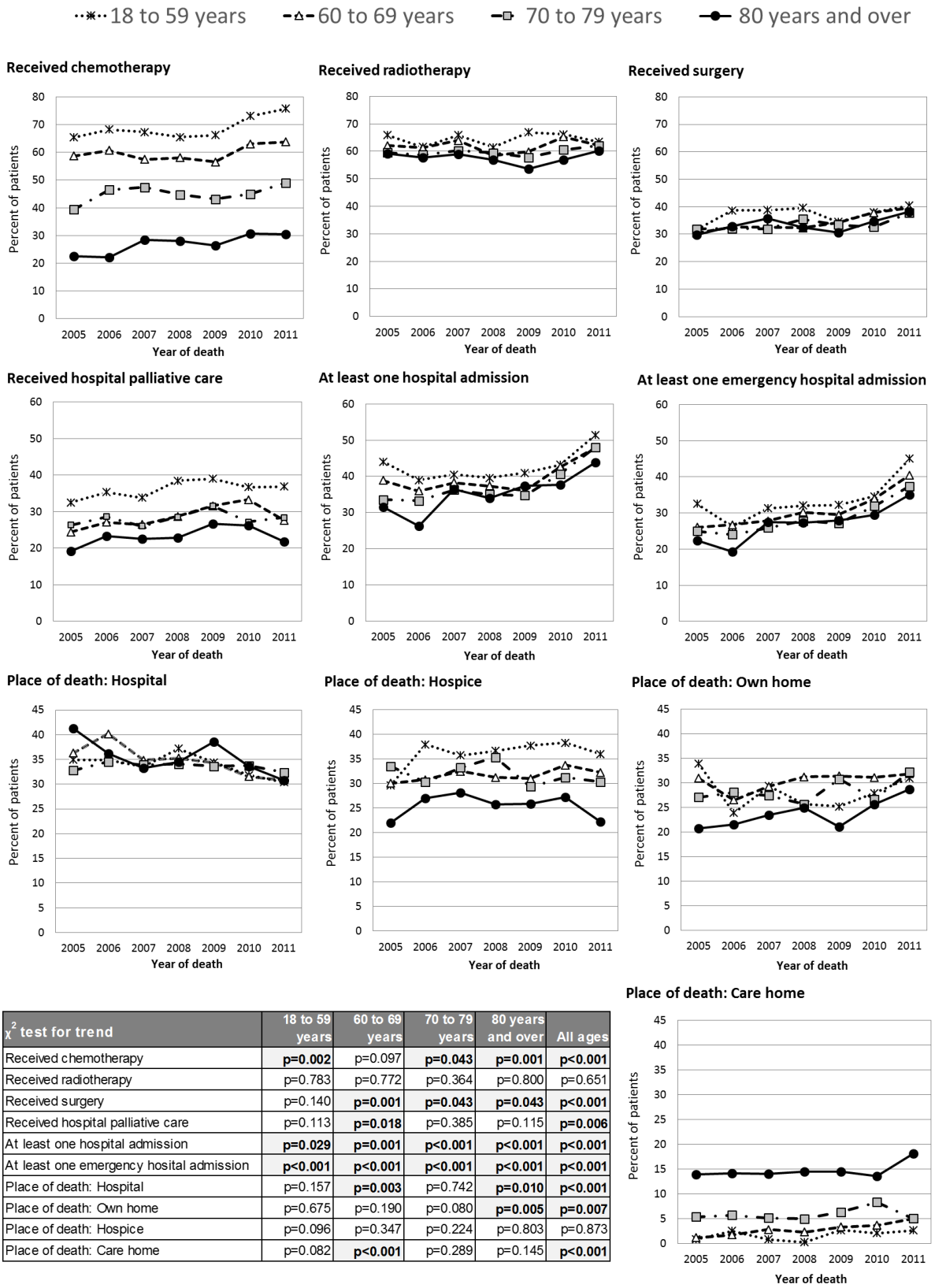
A significant increasing trend in the percentage of patients receiving chemotherapy was identified overall ($p<0.001$), and for all age groups except patients aged 60 to 69 years, with an overall increase from 45.6% to 52.4%. The percentage of patients who received surgery showed an increasing trend overall ($p<0.001$) from 31.0% to 38.7%, and for all except the youngest age group (18 to 59 years). Hospital palliative care also showed an increasing trend overall, from 25.6% to 28.0% ($p=0.006$), however within age groups this trend was only significant for patients aged 60 to 69 years ($p=0.018$). There was no significant trend in the percentage of patients receiving radiotherapy before death ($p=0.651$).

Admissions to hospital, and emergency only admissions to hospital, increased (both $p<0.001$) from 36.3% to 47.4% and from 26.1% to 38.5% respectively. Significant increasing trends in hospital admissions were observed for all age groups.

Significant trends were found for all ages combined in the percentage of patients dying in hospital ($p<0.001$), at home ($p=0.007$), and in a care home ($p<0.001$). Between 2005 and 2011 the percentage of deaths in hospital reduced from 36.0% to 31.3% while the percentage of deaths at home and in a care home increased from 28.0% to 31.0% and from 5.4% to 7.9% respectively for all age groups.

Within age groups no significant trends in place of death were identified for patients aged 18 to 59 years and 70 to 79 years. Significant reductions were identified in the percentage of deaths in hospital for patients aged 60 to 69 years ($p=0.003$) and 80 years and over ($p=0.01$). Patients ages 60 to 69 years also experienced a significant increasing trend in the percentage of deaths in a care home ($p<0.001$). Patients aged

80 years and over experienced a significant increasing trend in the percentage of home deaths (p=0.005).




| $\chi^2$ test for trend | 18 to 59 years | 60 to 69 years | 70 to 79 years | 80 years and over | All ages |
|---|---|---|---|---|---|
| Received chemotherapy | **p=0.002** | p=0.097 | **p=0.043** | **p=0.001** | **p<0.001** |
| Received radiotherapy | p=0.783 | p=0.772 | p=0.364 | p=0.800 | p=0.651 |
| Received surgery | p=0.140 | **p=0.001** | **p=0.043** | **p=0.043** | **p<0.001** |
| Received hospital palliative care | p=0.113 | **p=0.018** | p=0.385 | p=0.115 | **p=0.006** |
| At least one hospital admission | **p=0.029** | **p=0.001** | **p<0.001** | **p<0.001** | **p<0.001** |
| At least one emergency hosital admission | **p<0.001** | **p<0.001** | **p<0.001** | **p<0.001** | **p<0.001** |
| Place of death: Hospital | p=0.157 | **p=0.003** | p=0.742 | **p=0.010** | **p<0.001** |
| Place of death: Own home | p=0.675 | p=0.190 | p=0.080 | **p=0.005** | **p=0.007** |
| Place of death: Hospice | p=0.096 | p=0.347 | p=0.224 | p=0.803 | p=0.873 |
| Place of death: Care home | p=0.082 | **p<0.001** | p=0.289 | p=0.145 | **p<0.001** |

**Figure 2:** Trends in cancer care 2005 to 2011 by age group

# Discussion

To our knowledge this is the largest analysis of hospital based cancer and palliative care provided to patients from diagnosis to death. Our results show even after controlling for comorbidities there were significant differences in cancer care by age group. We found older patients with cancer were less likely to receive chemotherapy or radiotherapy, be referred to hospital palliative care services, or be admitted to hospital, as an emergency or planned admission. In terms of place of death, older patients were more likely to die in a care home but differences in the percentages of deaths at home or in a hospice between age groups were not significant once other patient characteristics were taken into consideration.

The percentages of patients receiving chemotherapy, surgery, a hospital palliative care referral, admission to hospital, and dying at home or in a care home all show an increasing trend overall, while the percentage of patients dying in a hospice has remained fairly stable over the period for all age groups. The percentage of hospital deaths showed a decreasing trend overall and for patients aged 60 to 69 years and 80 years and over in particular.

The results for chemotherapy and radiotherapy support previous research from small or cancer site specific studies which showed that older patients with cancer were less likely to receive cancer therapies [7-10]. While this may suggest some clinicians are using chronological age alone as a cancer management decision aid [14] it is also likely to reflect that age related factors; including toxicity risk, tolerability of treatment, and higher risks associated with some comorbidities, are taken into account when deciding on appropriate therapies [15-17].

The lower percentage of hospital based palliative care for older adults is likely to reflect the lower proportion of older adults admitted to hospital compared with younger

patients. The lower levels of older adults receiving an emergency hospital admission is encouraging as this outcome is considered an indicator for poor cancer care [18]. The reasons for this difference between ages are not known but may reflect differences in the care needs and existing support services available between age groups [13].

Most people who express a preference would prefer to die at home rather than in hospital and a home death is often used as an indicator for quality end of life care [19]. Our study found that though a higher percentage of younger patients die at home or in a hospice compared to older patients, after taking other factors, including comorbidities, into account there were no significant differences between age groups when comparing dying at home or hospice compared to dying in hospital. The main differences in place of death between ages were in comparisons between dying in a care home compared with dying in hospital, with a reduced likelihood of dying in a hospital for older patients. This substantiates the evidence that care homes are frequently the main provider of end of life care [13] and highlights the need for palliative care skills to be embedded within these settings.

Several limitations should be noted when interpreting these findings. Firstly the data comes from a single UK city. While the population is broadly representative of the UK cancer population, in terms of cancer prevalence, age, sex and survival, the extent to which therapies and care provided are representative are more difficult to determine. Secondly the data used in this study were extracted from live clinical systems and, as such, are likely to include inherent errors and omissions.

We found significant differences in the care received by cancer patients across the care pathway from diagnosis to death by age group. While these differences may be explained by variation in disease status, increased risks factors associated with age,

differences in need between age groups, or differences in existing support, evidence suggests that to a greater or lesser extent chronological age may be influencing treatment or care decisions [8, 14].

# Conclusion

In relation to age there are significant differences in the cancer treatment and level of access to palliative care services received by patients prior to a death from cancer. Further research is needed to identify the extent to which these results reflect unmet need.

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