Age-related inequalities in colon cancer treatment persist over time: a population based analysis

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Abstract

Background: Older people experience poorer outcomes from colon cancer. We examined if treatment for colon cancer was related to age and if inequalities changed over time.

Methods: Data from the UK population-based Northern and Yorkshire Cancer Registry on 31,910 incident colon cancers (ICD10 C18) diagnosed 1999-2010 were obtained. Likelihood of receipt of: 1) cancer-directed surgery, 2) chemotherapy in surgical patients, 3) chemotherapy in non-surgical patients by age, adjusting for sex, area deprivation, cancer stage, co-morbidity and period of diagnosis was examined.

Results: Age-related inequalities in treatment exist after adjustment for confounding factors. Patients aged 60-69, 70-79 and 80+ years were significantly less likely to receive surgery than those aged <60 years (multivariable ORs [95% CI] 0.84 [0.74, 0.95], 0.54 [0.48, 0.61] and 0.19 [0.17, 0.21] respectively). Age-related differences in receipt of surgery and adjuvant chemotherapy (but not chemotherapy in non-surgical patients) narrowed over time for the 'younger old' (aged less than 80 years) but did not diminish for the oldest patients.

Conclusions: Age inequality in treatment of colon cancer remains after adjustment for confounders, suggesting age remains a major factor in treatment decisions. Research is needed to better understand the cancer treatment decision-making process, and how to influence this, for older patients.

Keywords: colon cancer, inequalities, registry, population-based, treatment

Summary box

What is already known on this subject?

- Older individuals have poorer survival from colon cancer than younger individuals.
- Inequalities in access to appropriate colon cancer treatment might account for this poorer survival.

What does this study add?

- Older age is associated with lower likelihood of receiving colon cancer directed surgery and adjuvant therapy, and greater likelihood of receiving no cancer directed treatment, after adjustment for confounding factors.
- There is evidence that the treatment gap between youngest patients and the 'younger old' decreased between 1999 and 2010.
- There was no narrowing of the treatment gap between the youngest patients and the 'older old' during this period.

Introduction

Colorectal cancer is the third most commonly diagnosed cancer in men and women in the UK[1] and globally[2]. Survival from colon cancer worldwide is worse in those aged 65 years and older[3], despite more than 70% of cases occurring in this age group[1]. In addition, a survival deficit has been identified in the UK compared to countries with the highest cancer survival (Australia, Canada, Norway & Sweden). Both 1 and 5 year survival for colorectal cancer are 8-10% lower in the UK compared to countries with the highest survival, and this increases to a 10-15% difference for those aged 65 years and older[3]. There is evidence that the gap in colorectal cancer survival between older and younger patients widened between 1988-90 and 1997-99 across Europe in women, although narrowed slightly during the same time period in men[4]. There was lower survival in the UK compared to five other countries with similar levels of healthcare access, included in the International Cancer Benchmarking Partnership, and this was more pronounced in older (aged 70-99 years) patients[5]. Age-related variation in survival is much less marked in the United States than in Europe and has been attributed to earlier diagnosis and more aggressive treatment in the US[6]. It has been suggested that in several countries, including the UK, elderly cancer patients are under-treated compared to younger patients[7-9], and that this unequal access to treatment in practice, despite universal access in theory, accounts for at least some of the reported survival difference[5].

Previous work suggests that elderly patients are significantly less likely to receive adjuvant therapy for colon cancer[10,11]. It has been observed that elderly patients who survive one year after diagnosis of cancer have a similar 5-year prognosis to middle-aged patients[4], suggesting that elderly patients who are in sufficiently good health to withstand treatment can derive similar benefits to younger patients. Determining the best course of cancer treatment for elderly people, a population that is heterogeneous in terms of health status and degree of frailty, is difficult for clinicians[12]. Comorbidities, poorer health status and cancer stage at diagnosis, as well as patient preferences,

may be valid reasons for not offering aggressive treatment to frail, older patients[13]. However, many epidemiological studies of patterns of treatment by age fail to account for these factors.

A better understanding of age-related inequalities in treatment of colon cancer would help to inform interventions to improve cancer control. We undertook a population-based study to investigate if there are age-related inequalities in colon cancer care in the North of the UK, taking into account co-morbidity and other confounders and, if so, if these inequalities have changed over time.

Methods

Data sources. Data on age, sex, area deprivation (as a proxy for socioeconomic status (SES)), year of diagnosis, tumour site and stage and treatments received (cancer-directed surgery and chemotherapy) were obtained for all patients diagnosed with colon cancer (ICD10 C18) between 1 January 1999 and 31 December 2010 from the population-based Northern and Yorkshire Cancer Registry (NYCRIS). NYCRIS covers a population of 6.8 million people. Hospitals mandatorily report cases of cancer directly to NYCRS. Extensive quality assurance of the register is performed[14]. Information on treatments received until 31 December 2011 was available (i.e. 12 months after the latest date of diagnosis). Each record was linked to UK National Health Service (NHS) Hospital Episode Statistics (HES) data to provide information on comorbidities. All admissions, outpatient appointments and A&E attendances at NHS hospitals in England are recorded in HES data. NYCRIS supplied the linked and anonymised data to the authors.

Outcome variables. The outcome variables of interest were chosen to reflect current colon cancer treatment guidelines[15,16]: receipt of cancer-directed surgery compared to no cancer-directed surgery (n=31,910 patients included in the analysis), receipt of chemotherapy in surgical patients (n=24,263), receipt of chemotherapy in non-surgical patients (n=7,647) and receipt of no cancer-directed treatment (i.e. no surgery, chemotherapy or radiotherapy; n=31,910).

Explanatory variables. Age at diagnosis was categorised into <60, 60-69, 70-79 and 80+ years. Area deprivation was measured using the rank of the income domain of the Index of Multiple Deprivation (IMD), grouped into quintiles, based on the distribution across England, with quintile 1 representing the most affluent areas and quintile 5 the highest level of deprivation[17]. Year of diagnosis was categorised into three equal sized groups for ease of presentation and interpretation: 1999-2002, 2003-2006, 2007-2010. Cancer stage was assigned using the TNM staging system[18] and categorised as I, II, III, IV, unstaged or staged post-treatment. NYCRIS provided a weighted comorbidity score based on the Charlson comorbidity index (CCM)[19], which provides a count of the number of relevant

in-patent admissions (excluding metastatic cancer) recorded in HES data in the time period 3-18 months prior to the colon cancer diagnosis. The comorbidity score was categorised as 0, 1-2 or 3+ comorbid conditions resulting in an in-patient episode for ease of interpretation.

Statistical analyses. Cases registered on the basis of a death certificate only were excluded (n=495), In the remaining cases, the distribution of receipt of cancer-directed treatment (surgery, chemotherapy in surgical patients, chemotherapy in non-surgical patients and no treatment) by age, sex, SES, period of diagnosis, stage and CCM was examined. As chemotherapy is not an appropriate treatment in early stage colon cancer analyses were repeated, restricted to Stage III and IV cancers.

Univariable and multivariable logistic regression models were used to examine the likelihood of receipt of each of the treatment outcomes by age group with and without adjustment for covariates. Trends in likelihood of receipt of treatment by age over time were examined. Interaction between age and time period of diagnosis was tested by fitting a cross-product term and comparing, using the likelihood ratio test, the model with the cross-product term and nested model without the cross-product term to test if there was a significant interaction . For ease of interpretation, the results presented here show risk estimates for age group, stratified by period of diagnosis. Stata v14.0 (StataCorp, College Station, TX, USA) was used for all analyses.

Results

The analysis included 31,910 patients with incident colon cancer. There was an increase of cases over time. Almost two-thirds (63%) of patients were aged 70 years or older at diagnosis; a slightly higher proportion were men (52%) than women (Table 1).

[Table 1 here]

Receipt of cancer-directed surgery. There was a strong inverse association between age group and the odds ratio for receiving surgery which became even stronger after adjustment for the covariates (table 2); compared to the <60 years age group the multivariable odds ratios were (OR= 0.84, 95% CI 0.74 to 0.95; 0.54, 0.48 to 0.61 and 0.19, 0.17 to 0.21, respectively) (Table 2). **When the analyses were restricted to patients with stage I-III cancers, almost all (98.9%) of patients received surgery. Those in the oldest age group (80+ years) with stage I-III cancers were significantly less likely to receive surgery than those in the <60 years age group (OR=0.40, 95% CI 0.25 to 0.64).** Overall, the likelihood of receiving surgery was lower in the two more recent time periods than in the period 1999-2002 but the 2006-2010 effect markedly attenuated after adjustment and was consistent with chance. There was no gender effect but patients from poorer areas were less likely to receive surgery. Co-morbidity was associated with a reduced odds of surgery.

[Table 2 here]

Receipt of chemotherapy in surgical patients. Similar age patterns in receipt of chemotherapy were seen, although the gradient was even more extreme (Table 3). The likelihood of surgical patients receiving chemotherapy increased over time in a dose-response pattern. Men and patients with higher stage cancer were more likely to get chemotherapy whilst area deprivation was associated with a reduced likelihood. When analyses were repeated, restricted to Stage III and IV cancers, to take into account that chemotherapy is not appropriate for early stage cancers, similar results were found.

[Table 3 here]

Receipt of chemotherapy in non-surgical patients. Increasing age was also strongly associated with reduced likelihood of receiving chemotherapy alone (OR= 0. 43, 95% CI 0.35 to 0.52; 0.20, 0.17 to 0.24 and 0.03, 0.02 to 0.04 for the 60-69, 70-79 and 80+ year age groups respectively for the fully adjusted model) (Table 4). Other covariates showed the same pattern as for chemotherapy amongst surgical patients with, again, a marked period effect. ***Similar results were found when only patients with stage III and IV cancers, for whom chemotherapy is recommended, were included in the analysis.***

[Table 4 here]

Receipt of no treatment. Age inequalities were found in likelihood of not receiving any treatment (Web Table 1). The odds ratio for receipt of no treatment in those aged 60-69 years was 1.98 (95% CI 1.69 to 2.32) increasing to 15.4 (13.2 to 17.9) in those aged 80+ years, in the fully adjusted model.

Time trends in colon cancer treatment

Figure 1a shows that the difference in the odds ratios for receipt of surgery for patients aged 60-69 years and 70-79 years compared to those aged <60 years stratified by time period diminished over time. However, the change in the odds ratio for patients aged 80+ years was much less marked (OR=0.23, 0.18 to 0.29; 0.19, 0.15 to 0.24 and 0.16, 0.13 to 0.20 for the three time periods respectively).

Significant interactions were found between age and period of diagnosis for receipt of surgery (p=0.010) and receipt of chemotherapy in surgical (p=0.001), but not in non-surgical (p=0.807), patients, suggesting that the relationship between receipt of treatment and age has changed over time.

[Figure here] Odds ratios for receipt of colon cancer directed treatment by age group, over time, adjusted for sex, deprivation, stage and comorbidity

In all time periods, surgical patients in the older age groups remained less likely to receive chemotherapy than those in the <60 years group (Figure 1b). However, the difference in the odds ratios was smaller in 2007-2010 than in 1999-2002 for those in the 60-69 year and 70-79 year age groups. There was no change in the 80+ year age group.

Discussion

Main findings. Age inequalities in the receipt of colon cancer-directed surgery, chemotherapy in surgical patients and chemotherapy in non-surgical patients were apparent in this population-based registry study, after adjustment for factors likely to be associated with the appropriateness of providing treatment, including stage and comorbidity. These differences persisted over time. We identified an interaction between age and time period of diagnosis associated with receipt of treatment. This suggested a narrowing of the treatment gap during the period 1999-2010 between those aged <60 years and those aged less than 80 years, but no change in the treatment gap between those aged <60 years and the oldest (aged 80 years and older) patients.

Strengths of this study. The strengths of this study are the use of a population-based registry, linked to NHS HES data. The NYCRIS has been found to have excellent population coverage[20]. This meant we have robust data on cases of colon cancer, treatment received and information on potential confounding factors. In contrast to many other studies that have examined the relationship between age and receipt of treatment for colon cancer and failed to adjust for comorbidity, data on comorbidity was available for patients included in this study.

Weaknesses of this study. Data included in this study were from the north of England. This potentially reduces the generalisability of our findings to other settings. As is common in population-based datasets, a notable proportion of patients (14% overall) were unstaged. While this could be due to a failure by the registry to record staging information, the low percentage of unstaged patients who were treated, and the increase in percentage unstaged by age (24% in the 80+ age group compared to 8% in the youngest age group), suggests that it is more likely to be because these patients were simply too unwell to be staged or treated. Even in this large dataset, some sub-groups were relatively small and had few events meaning that the ORs were very small or large. We would suggest that the precise risk estimates are not the most important aspect of our results; rather the importance lies in the observed pattern in treatment receipt by age.

We had information on treatment receipt and, for chemotherapy and radiotherapy this is, in effect, whether an individual started a course of treatment. A limitation is that we did not know whether they completed the course; some studies suggest that a significant proportion of patients cannot complete treatment due to toxicity[21]. Although we took account of comorbidity in our analyses, the Charlson comorbidity index[19] that we used to identify comorbidities, captures information only on conditions that require an in-patient stay. It is possible, therefore, that individuals who had a score of zero recorded for comorbidity suffered from conditions that would be included in the index, but received all their care in primary care or as out-patients. It is also the case that patients with different severity of comorbid diseases receive the same score, making it a somewhat crude measure. In addition, the CCM was not designed to detect frailty, which is common in older individuals and is an important consideration when determining appropriate treatment for colon cancer given the physical burden associated with cancer treatment [12]. It is very likely that we have underestimated true levels of comorbidity in the study population and failed to fully control for confounding by health status. Thus it remains possible that the observed trends in treatment receipt by age could be a result – at least in part - of valid clinical decisions based on the patient's overall health and likely ability to withstand treatment. As is usual with registry data, we did not have information on whether treatment was given with curative or palliative intent. In addition, patient and family preferences around quality of life can also influence treatment decisions and as this is not recorded, we were unable to take these factors into account in our analyses.

We note that, despite those in the oldest age group with a stage I-III cancer being significantly less likely to receive surgery than those in the youngest age group, the number in this age group not receiving surgery was small (n=98 patients; 2%) and this might be accounted for by sound clinical reasons not to offer surgery to these individuals.

Interpretation of findings

Age-related inequalities in the treatment of colon cancer have previously been reported. In particular it has been noted that older people with colon cancer typically receive less adjuvant chemotherapy than younger individuals and that the likelihood of receiving adjuvant chemotherapy decreases with age[22]. Putative reasons for this include that evidence for the effectiveness of adjuvant chemotherapy in older populations is lacking[23]. More good quality trials of different treatment options in the elderly population upon which evidence-based treatment decisions can be made are needed[10]. Where trials in elderly and frail populations have been attempted, successes have been reported. The MRC FOCUS2 trial, an open factorial trial designed to examine reduced dose chemotherapy in elderly and frail patients (median age of 74 years) with advanced colorectal cancer demonstrated that these patients can be included successfully in randomised controlled trials and that age and frailty should not preclude individuals from participation in research[24].

Previous work has suggested that clinicians rely too much on chronological age rather than an assessment of biological age and capacity to withstand treatment when making decisions about how to treat cancer patients[25]. The difficulty of, and resources needed for, evaluating the vulnerability of elderly people to cancer treatment using the comprehensive geriatric assessment (CGA) have been acknowledged. Frailty screening methods to negate the need for the CGA to be used to assess all elderly patients have been proposed, but none has yet proved to be satisfactorily able to discriminate between those who are robust and should receive standard cancer treatment and those who should receive a CGA[12]. Current guidance remains that all elderly people should receive a CGA to inform treatment decisions.

When we considered whether or not inequalities in receipt of treatment had changed over time we found some evidence that the treatment gap between those aged less than 60 years and the 'younger old' (aged less than 80 years) had narrowed to some extent, but that there was no evidence of a narrowing of the treatment gap for the oldest old. This might reflect accumulating trial

evidence suggesting that the benefit of adjuvant chemotherapy is independent of age, at least up to the age of 79 years, but that data on the oldest old is lacking[26]. In a pooled analysis of adjuvant chemotherapy for 3,351 resected colon cancer patients, 14% of included patients were aged 70-79 years but less than 1% were aged 80 years and older, leading the authors to conclude that extrapolation to the oldest age group should be made with caution[26].

Within the UK there is increasing interest in ensuring that the elderly receive appropriate cancer treatment. Action for the elderly in cancer was identified as a main priority at the Britain Against Cancer Conference in 2013[7]. The National Cancer Equality Initiative, in collaboration with the Pharmaceutical Oncology Initiative (NCEI-POI), is a UK-wide effort to challenge ageism in cancer care. NCEI-POI seeks to better understand how treatment decisions are made in relation to cancer care for older people, to identify how more personalised treatment plans can be developed[27]. It is important that the fitness of the individual patient, the potential benefit they might gain from different treatment regimens and patients', and their family's', perspectives on treatment should all be taken into account when designing an optimum care plan.

It was noted in a recent report published by The Royal College of Surgeons of England that existing national guidance does not make specific recommendations on how to treat older patients with colon cancer, and concluded that 'all reasonable curative treatment options' should be explored[28]. Since it is extremely unlikely that the age-disparities in treatment that we have observed can be explained by patient or family preference, our data suggest that "all reasonable curative options" are still not being explored. It should be acknowledged, however, there remains a lack of good quality research into the treatment of elderly colon cancer patients to inform treatment options[27]. This, together with further research to better understand the treatment decision-making process, and how to influence this, is urgently needed.

Whilst the focus of our enquiries was on age equity, our results also demonstrated marked effects by area deprivation, and for chemotherapy, there were also gender differences. These are also

important in terms of equitable access and appear to have independent effects so that older women in deprived areas would be least likely to receive some interventions.

Colon cancer is common in older people, with 43% of cases diagnosed in people aged 75 years and older in the UK between 2009 and 2011)[1]. Current demographic changes leading to an increasingly older population means the number of individuals diagnosed with colon cancer is likely to increase. There is a need for work both to identify the most effective treatment for colon cancer in older populations and to understand clinicians' decision making processes to ensure equitable access.

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Competing Interest
Competing Interest: None declared.

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Table 1. Demographic and clinical characteristics of cohort with colon cancer (n=31910)

	n	%
Age group		
<60 years	4556	14.3
60-69 years	7377	23.1
70-79 years	11086	34.7
80+ years	8891	27.9
Sex		
Female	15212	47.7
Male	16698	52.3
Deprivation quintile		
1 (least deprived)	5682	17.8
2	6150	19.3
3	5990	18.8
4	6711	21.0
5	7377	23.1
Period of diagnosis		
1999-2002	9860	30.9
2003-2006	10424	32.7
2007-2010	11626	36.4
Stage		
I	2782	8.7
II	9107	28.5
III	7738	24.3
IV	7712	24.2
Unstaged	4440	13.9
Stage PT	131	0.4
CCM		
0	22486	70.5
1-2	2976	9.3
3+	700	2.2
No HES link	5748	18.0
Treatment		
Any surgery*	24263	76.0
Surgery + chemotherapy**	7736	31.9
Chemotherapy alone***	1589	20.8
None*	6058	19.0

*proportion is of all patients with colon cancer (n=31910)

**proportion is of all patients with colon cancer who had surgery (n=24263)

***proportion is of all patients with colon cancer who did not have surgery (n=7647)

Table 2. Likelihood (odds ratio with 95% CI and p value from logistic regression) of receiving cancer-directed **surgery*** by age, and adjusted for sex, deprivation, time period, stage, and comorbidity for patients with colon cancer

	Number (%) receiving surgery		Unadjusted (n=31910)			Mutually adjusted (n=31910)		
	n	**%**	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age group	**24263**	**76.0**			**<0.001**			**<0.001**
<60 years	3833	84.1	1.00			1.00		
60-69 years	6194	84.0	0.99	0.89, 1.09	0.809	0.84	0.74, 0.95	0.005
70-79 years	8802	79.4	0.73	0.66, 0.80	<0.001	0.54	0.48, 0.61	<0.001
80+ years	5434	61.1	0.30	0.27, 0.32	<0.001	0.19	0.17, 0.21	<0.001
Sex	**24263**	**76.0**			**<0.001**			**0.052**
Female	11332	74.5	1.00			1.00		
Male	12931	77.4	1.18	1.12, 1.24	<0.001	1.06	0.98, 1.14	0.160
Deprivation quintile	**24263**	**76.0**			**<0.001**			**<0.001**
1 (least deprived)	4574	80.5	1.00			1.00		
2	4797	78.0	0.86	0.79, 0.94	0.001	0.91	0.81, 1.04	0.158
3	4545	75.9	0.76	0.70, 0.83	<0.001	0.76	0.67, 0.86	<0.001
4	5008	74.6	0.71	0.65, 0.78	<0.001	0.77	0.68, 0.87	<0.001
5	5339	72.4	0.63	0.58, 0.69	<0.001	0.62	0.55, 0.70	<0.001
Period of diagnosis	**24263**	**76.0**			**<0.001**			**0.618**
1999-2002	7837	79.5	1.00			1.00		
2003-2006	7805	74.9	0.77	0.72, 0.82	<0.001	0.80	0.72, 0.87	<0.001
2007-2010	8621	74.2	0.74	0.69, 0.79	<0.001	0.93	0.84, 1.03	0.146
Stage	**24263**	**76.0**			**<0.001**			**<0.001**
I	2751	98.9	1.00			1.00		
II	9028	99.1	1.29	0.85, 1.96	0.235	1.39	0.91, 2.11	0.123
III	7626	98.6	0.77	0.51, 1.14	0.194	0.76	0.51, 1.13	0.176
IV	3224	41.8	0.01	0.01, 0.01	<0.001	0.01	0.00, 0.01	<0.001
Unstaged	1506	33.9	0.01	0.00, 0.01	<0.001	0.01	0.00, 0.01	<0.001
Stage PT	128	97.7	0.48	0.15, 1.59	0.231	0.34	0.10, 1.15	0.083
CCM	**24263**	**76.0**			**<0.001**			**0.041**
0	17851	79.4	1.00			1.00		
1-2	2156	72.5	0.68	0.6130.74	<0.001	0.83	0. 73, 0.95	0.007
3+	443	63.3	0.45	0.38, 0.52	<0.001	0.68	0.54, 0.86	0.001
No HES link	3813	66.3	0.51	0.48, 0.55	<0.001	0.71	0.64, 0.79	<0.001

*includes surgery +/- chemotherapy

Table 3. Likelihood (odds ratio with 95% CI and p value from logistic regression) of receiving **chemotherapy in surgical patients** by age, and adjusted for sex, deprivation, time period, stage and comorbidity for patients with colon cancer

[Includes only patients who had surgery; n=24,263]

	Number (%) receiving chemotherapy		Unadjusted (n=24,263)			Mutually adjusted (n=24,263)		
	n	**%**	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age group	**7736**	**31.9**			**<0.001**			**<0.001**
<60 years	2264	59.1	1.00			1.00		
60-69 years	2854	46.1	0.59	0.55, 0.64	<0.001	0.54	0.49, 0.60	<0.001
70-79 years	2356	26.8	0.25	0.23, 0.27	<0.001	0.19	0.17, 0.21	<0.001
80+ years	262	4.8	0.04	0.03, 0.04	<0.001	0.02	0.02, 0.02	<0.001
Sex	**7736**	**31.9**			**<0.001**			**0.126**
Female	3409	30.1	1.00			1.00		
Male	4327	33.5	1.17	1.11, 1.23	<0.001	1.10	1.01, 1.18	0.011
Deprivation quintile	**7736**	**31.9**			**<0.001**			**<0.001**
1 (least deprived)	1620	35.4	1.00			1.00		
2	1658	34.6	0.96	0.88, 1.05	0.386	1.08	0.96, 1.20	0.201
3	1451	31.9	0.86	0.78, 0.93	<0.001	0.92	0.82, 1.03	0.142
4	1468	29.3	0.76	0.69, 0.82	<0.001	0.81	0.72, 0.91	<0.001
5	1539	28.8	0.74	0.68, 0.80	<0.001	0.72	0.65, 0.80	<0.001
Period of diagnosis	**7736**	**31.9**			**<0.001**			**<0.001**
1999-2002	2235	28.5	1.00			1.00		
2003-2006	2515	32.2	1.19	1.11, 1.28	<0.001	1.36	1.24, 1.49	<0.001
2007-2010	2986	34.6	1.33	1.24, 1.42	<0.001	1.83	1.66, 2.01	<0.001
Stage	**7736**	**31.9**			**<0.001**			**<0.001**
I	39	1.4	1.00			1.00		
II	1442	16.0	13.2	9.59, 18.2	<0.001	17.1	12.5423.6	<0.001
III	4191	55.0	84.8	61.7, 116.8	<0.001	155.9	109.8, 210.1	<0.001
IV	1841	57.1	92.6	67.0, 127.9	<0.001	137.3	98.7, 191.0	<0.001
Unstaged	123	8.2	6.18	4.29, 8.92	<0.001	5.48	3.78, 7.95	<0.001
Stage PT	100	78.1	248.4	146.9, 419.8	<0.001	216.0	122.5, 380.9	<0.001
CCM	**7736**	**31.9**			**0.506**			**<0.001**
0	5935	33.3	1.00			1.00		
1-2	414	19.2	0.48	0.43, 0.53	<0.001	0.53	0.46, 0.61	<0.001
3+	59	13.3	0.31	0.23, 0.41	<0.001	0.30	0.21, 0.41	<0.001
No HES link	1328	34.8	1.07	1.00, 1.15	0.061	0.89	0.79, 0.99	0.043

Table 4. Likelihood (odds ratio with 95% CI and p value from logistic regression) of receiving **chemotherapy in non-surgical patients** by age, and adjusted for sex, deprivation, time period, stage and comorbidity for patients with colon cancer

[Includes only patients who didn't have surgery; n=7647]

	Number (%) receiving chemotherapy		Unadjusted (n=7647)			Mutually adjusted (n=7644)		
	n	**%**	**OR**	**95% CI**	**p**	**OR**	**95% CI**	**p**
Age group	**1589**	**20.8**			**<0.001**			**<0.001**
<60 years	450	62.2	1.00			1.00		
60-69 years	500	42.3	0.44	0.37, 0.54	<0.001	0.43	0.35, 0.52	<0.001
70-79 years	520	22.8	0.18	0.15, 0.21	<0.001	0.20	0.17, 0.24	<0.001
80+ years	119	3.4	0.02	0.02, 0.03	<0.001	0.03	0.02, 0.04	<0.001
Sex	**1589**				**<0.001**			**<0.001**
Female	607	15.6	1.00			1.00		
Male	982	26.1	1.90	1.70, 2.13	<0.001	1.40	1.22, 1.61	<0.001
Deprivation quintile	**1589**				**<0.001**			**<0.001**
1 (least deprived)	320	28.9	1.00			1.00		
2	304	22.5	0.71	0.59, 0.86	<0.001	0.79	0.63, 0.99	0.037
3	316	21.9	0.69	0.58, 0.83	<0.001	0.67	0.54, 0.84	<0.001
4	316	18.6	0.56	0.47, 0.67	<0.001	0.62	0.50, 0.78	<0.001
5	333	16.3	0.48	0.40, 0.57	<0.001	0.44	0.36, 0.55	<0.001
Period of diagnosis	**1589**				**<0.001**			**<0.001**
1999-2002	331	16.4	1.00			1.00		
2003-2006	559	19.8	1.26	1.09, 1.47	0.003	1.42	1.18, 1.70	<0.001
2007-2010	739	24.6	1.67	1.44, 1.93	<0.001	2.42	2.01, 2.90	<0.001
Stage	**1589**				**<0.001**			**<0.001**
I	2	6.5	1.00			1.00		
II	9	11.4	1.86	0.38, 9.16	0.443	2.15	0.41, 11.4	0.369
III	43	38.4	9.04	2.05, 39.8	0.004	7.10	1.50, 33.9	0.014
IV	1406	31.3	6.61	1.58, 27.8	0.10	4.20	0.94, 18.7	0.060
Unstaged	126	4.3	0.65	0.15, 2.76	0.560	0.72	0.16, 3.25	0.671
Stage PT	3	100.0	-					
CCM	**1589**				**<0.001**			**<0.001**
0	1172	25.3	1.00			1.00		
1-2	100	12.2	0.41	0.33, 0.51	<0.001	0.68	0.553 0.87	0.002
3+	19	7.4	0.24	0.15, 0.38	<0.001	0.30	0.18, 0.51	<0.001
No HES link	298	15.4	0.54	0.47, 0.62	<0.001	0.60	0.50, 0.72	<0.001