National Bowel Cancer Audit

Methodology Supplemental Document 2019

NBOCA: Methodology

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About HQIP, the National Clinical Audit and Patient Outcomes Programme and how it is funded:

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Methodology – Supplemental document

Methods - NBOCA 2019

- All data for patients diagnosed with colorectal cancer from 01 April 2013 were submitted via NHS Digital's Clinical Audit Platform (CAP). Data are collected at a trust/hospital level in England and centrally from the Cancer Network Information System Cymru (CaNISC) system in Wales. Only patients with a new primary diagnosis of bowel cancer should be included.
- Historic data submitted via the Open Exeter system has been uploaded into the CAP system.
- Case ascertainment is calculated for English cancer alliances and trusts/hospitals using Hospital Episode Statistics (HES) data to estimate the denominators. For Wales and Welsh MDTs Patient Episode Data Wales (PEDW) is used to estimate the denominators.
- The audit dataset is linked to HES data at the patient level to obtain further information on patient care and follow-up for patients treated in England and PEDW for patients treated in Wales.
- Funnel plots are used to compare the following outcomes: 90-day mortality after major resection; 30-day emergency readmission after major resection; two-year mortality after major resection; adjuvant chemotherapy for stage III colon cancer; unplanned return to theatre (URTT); patients undergoing major resection; 18-month stoma rate after major resection for rectal cancer and proportion of colonic resections with 12 or more lymph nodes reported. Comparisons are made between English cancer alliances and Wales. Further comparisons are then made for individual English trust/hospitals and individual Welsh MDTs. All outcomes, *except lymph node yield*, are adjusted for patient case-mix.
- Potential outliers on four risk-adjusted outcomes (90-day mortality after major resection; 30-day emergency readmission after major resection; two-year mortality after major resection; 18-month stoma rate after major resection for rectal cancer) are reported back to trust/hospital/MDTs in advance of the report being published in order that the results can be validated.

1. Data collection

All eligible NHS trusts/hospital sites in England and Health Boards in Wales submitted data to the audit for inclusion in the 2019 Annual Report. The focus of this report is patients in England and Wales submitted to the audit who were diagnosed between 01 April 2017 and 31 March 2018. Data is also available from the previous audit and comparisons are made across years for certain outcomes.

Since March 2014, patient data has been collected via NHS Digital's Clinical Audit Platform (CAP) system. This can be accessed via https://clinicalaudit.hscic.gov.uk/nboca. This allows only one treatment record to be listed per patient and patients identified as being submitted to the audit in a previous year are excluded from subsequent audits. The dataset has been redesigned to contain fewer items with the aim of improving data completeness across all patients. All participating trusts in England individually submitted their data for this annual report to this system. The Welsh data was submitted centrally from CaNISC.

Historic audit data from Open Exeter was transferred to the CAP system and is available for review and editing if required. Further information about Open Exeter and the data transfer

are available in Section 1.1 of the 2015 supportive document, found at www.nboca.org.uk/content/uploads/2017/07/NBOCA-annual-report-2015-supportive.pdf.

2. Data linkage

Patients are linked to additional datasets using their NHS number, date of birth, sex and postcode. This allows the audit to obtain further information about patient care.

Hospital Episode Statistics/Patient Episode Database Wales (HES/PEDW)

HES and PEDW are administrative databases that contain information about all patient hospital admissions and are derived centrally from data submitted by the hospital that they were admitted to. Linking audit data to HES/PEDW allows the audit to obtain information about patient outcomes such as emergency readmissions and stoma provision. The mode of admission (elective or emergency) and number of co-morbidities (reported according to the Charlson co-morbidity score) are both derived from HES/PEDW for use in risk adjustment.

95% of patients undergoing major surgery at English trusts in the audit could be linked to HES; the equivalent for Welsh patients and PEDW was 99%. Estimates for 30-day unplanned readmissions and 18-month stoma rates exclude those patients not linked to HES/PEDW. Risk-adjusted mortality estimates for patients not linked to HES/PEDW relied on imputed data for co-morbidities and mode of admission (see Section 6).

Office for National Statistics (ONS)

Linking audit data to mortality data from the ONS allows the audit to analyse patient mortality across England and Wales without increasing the data entry burden for sites. In addition to date of death, the audit has access to place of death and cause of death. Cause of death was used to produce a short report which can be accessed here: www.nboca.org.uk/reports/short-report-2-2017/.

Cause of death has been used this year to develop the measurement of cancer-specific survival. Place of death was explored in the 2018 Annual Report (Chapter 7, End of Life Care).

Radiotherapy Dataset (RTDS)

RTDS contains detailed information about radiotherapy treatment received by patients including anatomical site, treatment intent, first appointment date, number of attendances, prescribed and actual doses, and which type of radiotherapy was used.

For the time period presented, RTDS data is only available for patients who received their radiotherapy in England. Therefore, for the majority of Welsh patients, receipt of radiotherapy is taken from the audit radiotherapy data item.

In general, treatment episodes were grouped into long-course, short-course and other, based on the number of attendances. The audit date of surgery was used to distinguish between radiotherapy only, pre-operative and post-operative treatment. RTDS data was used as the basis of the first definitive non-surgical treatment. If no RTDS data was available for a patient, information was updated from SACT data (see below) and, finally for Welsh patients, from the audit pre-operative treatment variable (capturing audit-only radiotherapy and chemotherapy patients).

Previously RTDS data was only available in calendar years, therefore for consistency analyses for rectal cancer patients that use RTDS data are presented for patients diagnosed between 01 January and 31 December 2017.

Systemic Anti-Cancer Therapy (SACT)

The SACT dataset contains information about chemotherapy treatment received by patients such as regimen type, planned and actual number of cycles, dose and route of administration.

Regimen start dates were compared to the audit dates of diagnosis and surgery to determine whether chemotherapy was given in the neo-adjuvant or adjuvant setting, or as standalone treatment. SACT is not available for Welsh patients.

This year we report on the use of adjuvant chemotherapy in patients undergoing major resection for stage III colon cancer. A recent paper published by Public Health England has suggested that not all trusts/hospitals in England were regularly submitting SACT data until July 2014 and therefore our analyses only include chemotherapy data from this point onwards.

National Emergency Laparotomy Audit dataset (NELA)

NBOCA patients who need an emergency operation for their colorectal tumour should also be recorded in NELA (National Emergency Laparotomy Audit).

NELA is a national clinical audit and part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP) overseen by HQIP. Its purpose is to facilitate the improvement of quality of care for patients undergoing emergency laparotomy in hospitals in England and Wales. It includes information about pre-operative assessment and risk-stratification, intra-operative findings, procedure, post-operative care and outcomes.

There are four main groups of patients who should be present in both audit datasets and these include:

1. Patients undergoing an elective procedure for their colorectal cancer who subsequently need an emergency operation for complications
2. Patients who have an emergency laparotomy for their colorectal cancer as a temporary measure who go on to have a definitive elective procedure at a later date, for example, emergency de-functioning stoma formation to relieve obstruction followed by elective bowel resection
3. Patients who have primary emergency resection of their tumour
4. Patients who have an emergency laparotomy that does not remove their tumour, for example, the formation of a de-functioning stoma

Linkage of NBOCA and NELA provides a unique opportunity to explore the processes of care and outcomes of colorectal cancer patients presenting as an emergency. NELA is being used to help validate the developmental work we are carrying out regarding unplanned return to theatre rates.

National Cancer Registry data

The National Cancer Registration and Analysis Service (NCRAS) is run by Public Health England (PHE) and is responsible for cancer registration within England. In order for NCRAS to identify every cancer and ensure complete case ascertainment it uses a wide range of

additional data sources including death certificates, histopathology and haematology records, radiotherapy records, hospice records and independent hospitals.

This year we have had access to National Cancer Registry data for the first time. We have performed some initial exploratory work comparing case ascertainment in NBOCA to that within the National Cancer Registry. This work is going to be further developed and will form a short report later in the year.

3. Data processing – type 2 objections

Previously patients in England who do not want their personal confidential information to be shared outside of NHS Digital for purposes other than their direct care could register a type 2 objection with their GP practice. Type 2 objections were replaced by the National Data opt-out in May 2018. National Data opt-outs are now requested directly by the patient; existing Type 2 objections were automatically converted. More information can be found here: https://digital.nhs.uk/services/national-data-opt-out-programme.

The proportion of audit patients who have opted out has increased over time. According to NHS Digital, the proportion of patients who had requested a National Data opt-out in England was 2.74% in March 2019, with variation by region.

NBOCA does not receive HES or ONS data for patients who have registered a type 2 objection. This means NBOCA is unable to include mortality data or risk-adjusted results for these patients.

Table 1 shows the number of records that could not be linked to HES/ONS over the past five years.

Table 1 ONS linkage by audit year (patients submitted prior to HES/ONS linkage deadline only)

		2013-14		2014-15		2015-16		2016-17		2017-18	
		N	%	N	%	N	%	N	%	N	%
All patients	Total	30,629		30,972		30,690		30,491		30,854	
	Not linked	801	2.6	983	3.2	959	3.1	1,022	3.4	1,003	3.3
Patients undergoing Major Resection	Total	19,674		19,564		19,347		19,243		18,796	
	Not linked	571	2.9	636	3.3	610	3.2	683	3.6	641	3.4

4. Case ascertainment

Case ascertainment is expressed as a ratio of the number of bowel cancer patients reported to the audit compared to the total number of patients admitted for the first time to the participating units with a date of diagnosis of bowel cancer within the audit period, according to HES data for patients diagnosed in England and PEDW for patients diagnosed in Wales (Table 2).

In HES/PEDW, a patient was considered to be diagnosed with primary bowel cancer when admitted to hospital for the first time with a diagnosis of bowel cancer (C18, C19 or C20 according to the International Classification of Diseases 10th Revision) in the primary diagnosis field. It was assumed to be a first bowel cancer admission if no previous bowel cancer diagnosis could be identified in any of the diagnostic fields since 01 April 2013.

Table 2 Case ascertainment by year

	2013-14	2014-15	2015-16	2016-17	2017-18
No. Patients identified in HES/PEDW	32,112	32,273	32,527	32,949	33,187
No. Patients identified in NBOCA	30,630	30,973	30,697	30,647	31,676
% case ascertainment	**95**	**96**	**94**	**93**	**95**

5. Data completeness

Data completeness is defined as the proportion of patients with complete data items on all seven of the variables: age, sex, ASA grade, pathological TNM stage (tumour, node, metastasis staging) and site of cancer, as these variables are used for risk adjustment. Mode of admission and number of co-morbidities are also used in the risk adjustment model but as these variables are collected from HES/PEDW data they are not included in the assessment of data completeness. Data completeness is only assessed in patients who underwent major surgery, because only in these patients could all seven data items be expected to be complete.

Where pathological M-stage is submitted as 'not assessed' (Mx) or 'not recorded' (M9) it is updated from pre-operative tumour staging when it is recorded as M0 or M1. For the purposes of the audit, the following recorded tumour stages are considered to be missing data: Tx, T9, Nx, N9, Mx and M9.

Amongst patients undergoing major surgery, 4.6% were missing ASA grade, 6.3% were missing TNM T-stage, 6.5% were missing TNM N-stage and 8.7% were missing TNM M-stage. Mode of admission and Charlson co-morbidity score came from HES/PEDW and were only missing in patients who were not linked to HES/PEDW due to late inclusion. Virtually all patients had complete data on sex, age and site of cancer.

The removal of Duke's staging from the dataset and subsequent change in handling of pathological M-stage data led to a significant drop in overall data completeness in 2013/14 (Table 3). Data completeness reports have been sent to each NHS trust/hospital and Welsh MDT to provide feedback on the data submitted and highlight areas for improvement. Data completeness by trust/hospital/MDT can be found in Table A.1.

Table 3 Percentage of patients undergoing major surgery with complete data on the 7 key items from the audit used in risk adjustment, by audit year

	2013-14		2014-15		2015-16		2016-17		2017-18	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total patients undergoing major resection*	19,674		19,564		19,347		19,243		18,796	
Complete data on 7 key items	15,762	80.1	16,126	82.4	15,792	81.6	16,053	83.4	16,257	86.5
Data completeness if TNM M-stage recorded	15,762	94.7	16,126	95.1	15,792	93.7	16,053	93.1	16,257	94.7

***** Total restricted to those eligible for HES/PEDW/ONS linkage

6. Handling missing data

Multiple imputation using chained equations was used to fill in any missing risk factor information for the four adjusted outcomes reported at trust/hospital/MDT and cancer alliance/Wales level. This method uses a patient's other risk factors to predict their missing information, whilst taking into account the uncertainty due to their missing information.

In addition to the variables in the risk adjustment model and the outcomes, the following variables were included in the imputation model: pre-treatment staging, performance status, treatment intent, circumferential margin status, procedure, surgical urgency, mode of admission according to the audit, surgical procedure, number of lymph nodes extracted, number of positive lymph nodes extracted, Index of Multiple Deprivation (national ranking of residential area measuring its relative deprivation across seven domains), length of hospital stay, and time from diagnosis to surgery. The proportions of missing data for patients undergoing major surgery and therefore requiring multiple imputation, are detailed in the previous section.

7. Definition of surgical urgency

The audit uses the pre-2004 National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) classification of surgical urgency.

Elective: Operation at a time to suit both patient and surgeon e.g. after an elective admission

Scheduled: An early operation (usually within three weeks) but not immediately life-saving. This category often includes patients treated on cancer pathways with targets.

Urgent: As soon as possible after resuscitation and usually within 24 hours

Emergency: Immediate and life-saving operation, resuscitation simultaneous with surgical treatment. Operation usually within two hours.

The audit uses the pre-2004 National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) classification of surgical urgency, despite there being an update to this. The arguments to maintain the pre-2004 NCEPOD definition are that the classification based on this definition correlates strongly with:

- known risk factors for emergency treatment (age, socio-economic deprivation and presence of co-morbidity)
- the mode of admission coded in HES/PEDW
- the observed 90-day mortality

Introducing a new classification system for a key characteristic of the surgical procedure would make it impossible to compare outcomes in different audit periods which would in turn make it impossible to monitor trends in outcome over time, which is one of the key functions of the audit.

8. Statistical analysis

All statistical analyses were performed using Stata version 15.1.

Most results reported in this audit report are descriptive. The results of categorical data items are reported as percentages (%). The denominator of these proportions is, in most cases, the number of patients for whom the value of the data item was not missing.

Results are typically grouped by cancer alliance/Wales and/or trust/hospital/MDT. England's 19 cancer alliances were used in the analyses, and compared to Wales as a nation. The results for Wales are reported according to where the multidisciplinary team who discussed the patients' management were located, rather than by trust/hospital.

9. Adjusted outcomes

Definition of outlier reported outcomes

The audit currently reports outlier status for four risk-adjusted outcomes.

90-day post-operative mortality – defined as death within 90 days of the NBOCA date of surgery with date of death obtained from ONS.

30-day unplanned readmission - derived from HES/PEDW for patients undergoing major surgery. Defined as an emergency admission to any hospital for any cause within 30 days of surgery. Emergency admissions include those via Accident and Emergency, general practitioners, bed bureaus (point of contact for GPs to arrange urgent admission), or consultant outpatient clinics.

Two-year mortality after major resection - the observed rate is the number of patients who died within two years divided by the sum of the amount of time each patient is followed up for. Taking into account the amount of follow-up time means that the estimate compares not just the proportion of patients who died within two years but also how quickly they died.

18-month stoma rate - estimated for rectal cancer patients undergoing major surgery. Patients undergoing an abdomino-perineal excision of the rectum (APER) or Hartmann's procedure according to the audit were assumed to have had a stoma at the time of their primary procedure. This was classified as permanent in patients having an APER. HES/PEDW data were used to capture whether anterior resection patients received a stoma.

In patients having an anterior resection or Hartmann's procedure, subsequent stoma reversal was also obtained from HES/PEDW. A procedure code for reversal of ileostomy/colostomy within 18-months of surgery was assumed to mean that the patient had their stoma reversed. To make comparisons between cancer alliances and between trust/hospital/MDTs, 18-month stoma rates for APER, Hartmann's and anterior resection were adjusted for case-mix using the same risk factors as for 90-day mortality (except cancer site). Data for patients undergoing major resection from 01 April 2013 to 31 March 2016 were used to ensure there were sufficient numbers of operations per trust/hospital/MDT in order to make comparisons. It is only the 2015 and 2018 annual reports which have no overlap in the data reported due to using a 3-year period of data.

A previously peer-reviewed model for risk adjustment of post-operative mortality in bowel cancer patients was used. Multivariable logistic regression was carried out to estimate risk-adjusted 90-day post-operative mortality, 30-day emergency readmission, and 18-month stoma rates for rectal cancer patients undergoing major surgery (see Table 4).

A Poisson model was fitted to estimate risk-adjusted two-year mortality after major surgery. Unlike the other outcomes, two-year mortality rate takes into account the length of time each patient was followed up for. The observed two-year mortality is the number of patients who died within two years divided by the sum of the amount of time each patient is followed for. For example, in two trust/hospital/MDTs with the same proportion of patients dying within two years, the site in which patients die earlier will have a higher two-year mortality rate.

Table 4 Variables used for risk-adjusted outcomes

Multivariable Regression Model Variables	
Patient Characteristics	Age (modelled as age plus age-squared) Sex
Morbidity and Presentation	ASA grade Charlson co-morbidity score (according to HES/PEDW) Mode of admission (according to HES/PEDW)
Cancer	T-stage (pathological) N-stage (pathological) M-stage (pathological) Site of tumour

An interaction between age and distant metastases was also included in the models. This is because once patients have metastatic disease the effect of age is found to be far less important than in patients without metastases.

The model for two-year survival additionally included interactions between epoch (0-3 months after surgery vs. 3-24 months after surgery) and all of the risk factors, to allow each risk factor to have a different effect dependent on time from surgery. For example, the effect of ASA grade is much larger peri-operatively than in the longer-term, whilst cancer stage has a bigger influence on mortality long-term. The model for 18-month stoma rate did not include cancer site as it includes only rectal cancer patients.

Patients with missing date of surgery were excluded, and multiple imputation was used to fill in any missing information on the risk factors (see Section 6). Trusts were excluded from the analyses if overall data completeness was less than 20% or ASA grade and/or TNM stage was missing in more than 80% of patients included in the analyses.

The adjusted outcomes were estimated using indirect standardisation. The observed number of events for a trust/hospital/MDT was divided by the number expected on the basis of the multivariable regression model. The adjusted rate was then estimated by multiplying this ratio by the average rate in all patients included in the analysis.

10. Funnel plots

Funnel plots are used to make comparisons between cancer alliance/Wales or between trust/hospital/MDTs on the following outcomes: 90-day mortality after major surgery; 30-day emergency readmission after major surgery; two-year mortality after major surgery; and 18-month stoma rates for rectal cancer patients undergoing major surgery. The rate for each cancer alliance/Wales or for each trust/hospital/MDT is plotted against the total number of patients used to estimate the rate. The 'target' is specified as the average rate across all cancer alliances/Wales or trust/hospital/MDTs.

The funnel limits depend on the target rate and the number of patients included in the estimate; rate estimates have greater uncertainty when estimated from fewer patients. Results fall outside the inner limits if they are statistically significantly different from the target at a 0.05 level, and outside the outer limits if they are statistically significantly different from the target at a 0.002 level.

The inner funnel limit is the threshold for an "alert" and the outer funnel level is the threshold for an "alarm". This implies that 95 per cent of the trust/hospital/MDTs are expected to be within the inner funnel limits and 99.8 per cent within the outer funnel limits, if they are all performing according to the target.

If all trust/hospital/MDTs in this report had the same underlying rate for a particular outcome, four would be expected to lie above and four below the inner limits, and 0.2 above and 0.2 below the outer limits by chance alone.

Cancer alliances/Wales and trust/hospital/MDTs with results outside the outer (99.8%) funnel limit are considered potential outliers and have been contacted according to the recommended HQIP procedure which can be accessed here: https://www.nboca.org.uk/resources/nboca-outlier-policy/

11. New outcomes

Major resection in patients with "curable" disease

This outcome aims to evaluate variation in practice for patients who we might expect to undergo major resection.

For this analysis we included patients diagnosed between 01 April 2017 and 31 March 2018 with an elective presentation (screening or GP referral source) of colon cancer. We excluded rectal cancer patients for this analysis given the heterogeneity in neo-adjuvant treatment and recent shift in practice to 'watchful waiting' in complete responders which may affect the major resection rate.

In addition, patients needed to have a pre-treatment staging of T2-T4 and no evidence of metastatic disease. The rationale behind this decision-making was to try to exclude those patients with 'too little' disease (i.e. T1 tumours which may be removed by local excision) and those with 'too much' disease.

We explored the characteristics of patients undergoing major resection versus those not according to pre-screening, screening and post-screening age bands. Funnel plot methodology was used to explore variation in major resection rate within this homogeneous group at trust/hospital/MDT level.

Adjuvant chemotherapy after major resection for stage III colon cancer

This outcome measures the proportion of patients who received adjuvant chemotherapy following major resection for pathological stage III colon cancer.

Patients undergoing major resection for pathological stage III colon cancer between 01 June 2014 and 31 August 2017 were included to give large enough numbers for trust/hospital level analyses. SACT data for 01 July 2014 to 31 Dec 2017 was used. These date ranges were used to take in to account SACT data completeness and provide all patients with a minimum of 4 months to receive adjuvant chemotherapy following surgery. NBOCA records were then linked to Hospital Episode Statistics (HES) and Systemic Anti-cancer Therapy (SACT) datasets. Hospitals in Wales do not submit SACT data.

Patients were considered to have received adjuvant chemotherapy if they had a linked SACT record demonstrating receipt of a standard adjuvant colorectal chemotherapy regimen within 4 months after their NBOCA date of surgery. Alternatively, they could have a chemotherapy code (ICD-10 diagnostic code or OPCS-4 procedural code) recorded within the same 4 month period within HES. Regimens considered to be standard adjuvant therapy included: 5-fluorouracil alone, 5-fluorouracil and oxaliplatin (FOLFOX), capecitabine alone or capecitabine and oxaliplatin (CAPOX).

HES was used as a validation tool for the patients identified within SACT as receiving adjuvant chemotherapy. HES does not contain detailed information about regimens given and therefore can only tell us whether or not chemotherapy was given.

Variation in the use of adjuvant chemotherapy at English cancer alliance level and trust/hospital level was explored using funnel plots. These funnel plots currently show unadjusted chemotherapy rates and are not yet outlier reported.

Unplanned Return to Theatre (URTT)

Unplanned return to theatre within 28 days of major resection was reported in the 2012 NBOCA Annual Report, based on a published algorithm[1], with additional OPCS codes representing URTT identified in linked HES data (https://www.nboca.org.uk/reports/).

For the 2019 Annual Report the list of eligible OPCS codes was amended to include surgical procedures included in the National Emergency Laparotomy (NELA) algorithm used to identify emergency laparotomies in HES (https://www.nela.org.uk/Audit-info-Documents#pt) and restricted to operative (open/laparoscopic) procedures.

Linked NBOCA-NELA data was used to validate the NBOCA URTT algorithm. Patients who underwent a major resection in NBOCA between 30 Nov 2013 and 01 Dec 2017 who could be linked to a NELA procedure within 0-28 days of the NBOCA one and whose baseline major resection date in HES was within 30 days of the NELA operation date were included.

In addition to procedure dates, the NELA dataset provided information on whether that procedure was an initial procedure or for complications after elective surgery and whether there was a subsequent return to theatre after the NELA procedure. Using this information, two groups of patients who underwent a return to theatre were defined from NELA in the validation dataset:

1. Those who underwent an emergency procedure as a second operation after elective resection
    - recorded as a complication of an elective procedure in the same admission
2. Those who underwent an emergency procedure who had subsequent procedure
    - Recorded as a first procedure with recorded return to theatre (no information about the subsequent procedure is available in the NELA dataset so it was assumed to be one that the NBOCA algorithm would capture)

Patients fulfilling either criteria were labelled as undergoing URTT. Comparison of the NELA results with those of the NBOCA URTT algorithm indicated agreement of return to theatre status in 91% of patients.

Table 5 OPCS codes considered to be URTT

	OPCS code											
Codes valid on day 0	G731	S242	S424	S573	S608	T301						
	S068	S572	S571	S577	T283	T302						
						T303						
Codes valid on days 1-30	G35	G711	G76	H17	H531	J72	M258	N249	S472	T282	T343	T419
	G36	G712	G78	H19	H541	L703	M264	P111	S474	T283	T348	T423
	G52	G713	G822	H29	H558	M021	M274	P131	S476	T288	T349	T428
	G53	G714	G824	H303	H568	M025	M292	P134	S478	T289	T361	T431
	G584	G715	G828	H304	H581	M062	M359	P138	S571	T301	T362	T432
	G588	G718	H04	H305	H582	M136	M37	P253	S572	T302	T365	T463
	G589	G72	H05	H308	H583	M151	M624	P258	S573	T303	T368	T468
	G591	G731	H06	H311	H588	M162	M651	Q552	S577	T304	T369	T469
	G601	G733	H07	H312	H589	M168	M733	S068	S608	T308	T374	T488
	G602	G734	H08	H33	H62	M191	M734	S242	S628	T309	T384	T554
	G608	G738	H09	H412	H662	M193	M735	S352	T252	T312	T388	T571
	G61	G74	H10	H418	J021	M202	M736	S358	T253	T313	T398	T77
	G63	G751	H11	H444	J04	M212	M737	S359	T259	T315	T411	T963
	G674	G752	H122	H448	J18	M218	M738	S422	T262	T316	T412	
	G69	G753	H13	H464	J212	M221	M763	S423	T272	T318	T413	
	G702	G754	H14	H468	J241	M223	M764	S424	T273	T331	T414	
		G755	H15	H469	J69	M228	N242	S428	T278	T341	T415	
		G758	H16	H47	J701	M229	N248	S438	T279	T342	T418	

Two-year cancer-specific mortality rate

Cancer-specific death was defined as death from any cause within 90 days of surgery or death with bowel cancer or cancer of an unspecified site as the underlying cause in the 91 days to two years after surgery. ONS defines the underlying cause of death for each patient as “the disease or injury which initiated the train of morbid events leading directly to death…”. The observed two-year cancer-specific mortality rate for a trust/hospital/MDT is the number of patients with a cancer-specific death within two years divided by the sum of the amount of time each patient is followed up for.

Risk-adjustment was carried out using indirect standardisation, described in Section 9 above. A competing risks flexible parametric survival model, with death from other causes as the competing event, was used to estimate the expected number of cancer-specific deaths for a trust/hospital/MDT[2]. The flexible parametric survival model uses regression splines to model the baseline cause-specific hazards. Knot locations for the splines were chosen to be at 3, 6 and 12 months. The risk factors in Table 4 were used in the risk adjustment model. The effect of the following risk factors was allowed to vary with time by introducing interactions between each risk factor and epoch of follow-up (before or after 3 months): TNM stage T4, TNM stage N1, TNM stage N2, distant metastases, ASA grade 2, 3 and 4/5. As with the other risk-adjusted outcomes, patients with missing date of surgery were excluded, and multiple imputation was used to fill in any missing information on the risk factors (see Section 6). Trusts were excluded from the analyses if overall data completeness was less than 20% or ASA grade and/or TNM stage was missing in more than 80% of patients included in the analyses.

References

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