Methodology Supplemental Document 2023

NBOCA: State of the Nation Report – Methodology Supplement
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Methodology Supplement

Methods - NBOCA 2023

- All data for patients diagnosed with colorectal cancer from 01 April 2013 were submitted via NHS England'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-APC) 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 Hospital Episode Statistics – Admitted Patient Care (HES-APC) data at 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 measures: 90-day mortality after major resection; 30-day emergency readmission after major resection; two-year all-cause mortality rate after major resection; two-year cancer-specific mortality rate after major resection; adjuvant chemotherapy for stage III colon cancer; unplanned return to theatre; the proportion of rectal cancer patients undergoing a procedure leading to creation of a permanent stoma; severe acute toxicity, and 18-month unclosed diverting ileostomy rate. Comparisons are made between individual English trusts/hospitals and individual Welsh MDTs. All measures, *except adjuvant chemotherapy*, are adjusted for patient case-mix.
- For this report, potential outliers are reported back to trust/hospital/MDTs for ***one*** risk-adjusted outcome (two-year all-cause mortality after major resection) in advance of the report being published in order that the results can be checked and responses given to outlier status.

1. Data collection

All eligible English NHS trusts/hospitals and Welsh Health Boards submitted data to the audit for inclusion in the State of the Nation Report. The focus of this report is patients in England and Wales submitted to the audit who were diagnosed between 01 April 2021 and 31 March 2022. Data is also available from previous audit periods and comparisons are made across years for certain outcomes.

Since March 2014, patient data has been collected via NHS England's Clinical Audit Platform (CAP) system. This allowed 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 audit periods. The dataset has been constantly reviewed with the aim of minimising the data collection burden and improving data completeness. All participating hospitals/trusts in England individually submitted their data for this report to this system. The Welsh data was submitted centrally from CaNISC.

2. Data processing – national data opt-out

National data opt-out allows patients in England who do not want their personal confidential information to be used for purposes other than their individual care to register this fact with NHS England. This scheme replaced the registration of type 2 objections via GP practices in May 2018 (these were automatically converted). Pre-existing type 2 objections were automatically converted to national data opt-out. The deadline for health and care organisations to apply these opt-outs was July 2022.

In October 2022 NBOCA was given an exemption from national data opt-outs on the grounds of patient safety. This is the first NBOCA report that has not had some degree of data opt-out (either within linked to datasets such as HES-APC, ONS, NDRS, within the NBOCA dataset) since the 2015 Annual Report.

3. 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 Admitted Patient Care/Patient Episode Database Wales (HES-APC/PEDW)

HES-APC 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-APC/PEDW allows the audit to obtain additional information about patient outcomes such as emergency readmissions, returns to theatre, chemotherapy use (see Section 11), severe acute toxicity, and stoma provision.

The mode of admission (elective or emergency) and number of co-morbidities (reported according to the RCS Charlson co-morbidity score) are both derived from HES-APC/PEDW for use in risk-adjustment. Ethnicity information for patients diagnosed in Wales is only available from PEDW. Due to delays in receipt of cancer registration data, ethnicity has been taken from HES for patients diagnosed in England for the first time which has led to a higher proportion of patients being recorded as having missing ethnicity.

Over 98% of patients in the analysis dataset who underwent major surgery could be linked to HES-APC (England) or PEDW (Wales). Estimates for 30-day unplanned readmissions, unplanned return-to-theatre, adjuvant chemotherapy use, severe acute toxicity, and 18-month unclosed diverting ileostomy rate exclude those patients whose procedure could not be linked to HES-APC/PEDW. Risk-adjusted mortality estimates for patients not linked to HES-APC/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 cause of death and place of death. Cause of death is used within the measurement of cancer-specific survival to classify deaths as cancer-related or other. Place of death was explored in the 2018 Annual Report.

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. Information on the complete dataset can be accessed here.

At the time of analysis, RTDS data was only available for patients who received their radiotherapy in England. The equivalent data source for Wales will be available for NBOCA in the future, but for this report NBOCA data has been used to determine use of radiotherapy in Wales.

In general, treatment episodes for rectal cancer 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 radiotherapy, and post-operative radiotherapy for rectal cancer patients. RTDS data and SACT data was used as the basis of the first definitive non-surgical treatment for rectal cancer patients. If no RTDS data was available for a rectal cancer patient, information was updated from SACT data (see below).

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 2021.

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. Information on the dataset can be accessed here. SACT is not available for patients treated in Wales.

Information from SACT was supplemented with HES-APC/ PEDW data to identify adjuvant chemotherapy use in patients undergoing major resection for stage III cancer, according to the OPCS-4/ ICD-10 codes in Table 1. The validity of chemotherapy information derived from these data sources has been published here.

Regimen start dates in SACT/ HES-APC/ PEDW were compared to NBOCA dates of diagnosis and surgery to determine whether chemotherapy was given in the neo-adjuvant or adjuvant setting, or as standalone treatment.

National Cancer Registry data

National cancer data in England is held by the National Disease Registration Service (NDRS) which is part of NHS England. In order for NDRS 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 hospital records.

NBOCA had access to National Cancer Registry data for the first time in the 2019 annual report. Development work using this data source is ongoing.

Table 1: OPCS-4 and ICD-10 codes to identify chemotherapy in HES-APC/PEDW

OPCS-4 code	Classification
X701	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 1
X702	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 2
X703	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 3
X704	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 4
X705	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 5
X708	Other specified procurement of drugs for chemotherapy for neoplasm in Bands 1-5
X709	Unspecified procurement of drugs for chemotherapy for neoplasm in Bands 1-5
X711	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 6
X712	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 7
X713	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 8
X714	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 9
X715	Procurement of drugs for chemotherapy for neoplasm for regimens in Band 10
X718	Other specified procurement of drugs for chemotherapy for neoplasm in Bands 6-10
X719	Unspecified procurement of drugs for chemotherapy for neoplasm in Bands 6-10
X721	Delivery of complex chemotherapy for neoplasm including prolonged infusional treatment at first attendance
X722	Delivery of complex parenteral chemotherapy for neoplasm at first attendance
X723	Delivery of simple parenteral chemotherapy for neoplasm at first attendance
X724	Delivery of subsequent element of cycle of chemotherapy for neoplasm
X728	Other specified delivery of chemotherapy for neoplasm
X729	Unspecified delivery of chemotherapy for neoplasm
X731	Delivery of exclusively oral chemotherapy for neoplasm
X738	Other specified delivery of oral chemotherapy for neoplasm
X739	Unspecified delivery of oral chemotherapy for neoplasm
X748	Other specified other chemotherapy drugs
X749	Unspecified other chemotherapy drugs
X352	Intravenous chemotherapy
X373	Intramuscular chemotherapy
X384	Subcutaneous chemotherapy
ICD-10 code	**Classification**
Z082	Follow-up exam after chemotherapy for malignant neoplasm
Z292	Other prophylactic chemotherapy
Z511	Chemotherapy session for neoplasm
Z512	Other chemotherapy
Z542	Convalescence following chemotherapy

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-APC data for patients diagnosed in England and PEDW data for patients diagnosed in Wales.

In HES-APC/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 between 01 April 2016 and 31 March 2021. Case ascertainment estimates by year of diagnosis are in Table 2.

5. Data completeness

Data completeness is defined as the proportion of patients with complete data for the variables age, sex, ASA grade, pathological TNM stage (tumour, node, metastasis staging) and site of cancer. This is because these seven variables are used for risk-adjustment. Mode of admission and number of co-morbidities are also used in the risk-adjustment model but are collected from HES-APC/PEDW data and so are not included in the assessment of data completeness. Data completeness is only assessed in patients who underwent major resection 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 where this 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 included in short-term risk-adjusted outcomes, 4.4% were missing ASA grade, 8.9% were missing TNM T-stage, 8.9% were missing TNM N-stage and 8.4% were missing TNM M-stage (ASA grade completeness has improved and TNM staging decreased since the 2021 report). Mode of admission and Charlson co-morbidity score came from HES-APC/PEDW and were only missing in patients who were not linked to HES-APC/PEDW. Virtually all patients had complete data on sex, age, and site of cancer.

Data completeness for the 7 key data items peaked prior to the Covid-19 pandemic and since then has been stable at a level similar to that between 2017 and 2019 (Table 2). Data completeness by trust/hospital/MDT can be found in Table A.1.

Table 2: Case ascertainment and data completeness by audit year

	2017-18		2018-19		2019-20		2020-21		2021-22	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Total patients submitted (% Case Ascertainment)	31,698	95	31,500	91	34,113	96	29,749	94	35,779	93
Total patients undergoing major resection*	19,362		18,170		19,701		16,818		19,310	
Complete data on 7 key items	16,833	86.9	15,907	87.5	17,710	89.9	14,697	87.4	16,852	87.3
Data completeness if TNM M-stage recorded	16,833	94.6	15,907	95.4	17,710	94.5	14,697	93.6	16,852	95.4

Case Ascertainment rounded to nearest whole number

***** Total restricted to those eligible for HES/PEDW/ONS linkage, but no restriction on date of surgery

6. Handling missing data

Multiple imputation using chained equations was used to fill in any missing risk factor information for any adjusted outcomes reported at trust/hospital/MDT 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, surgical procedure, surgical urgency, mode of admission according to the audit, number of lymph nodes extracted, number of positive lymph nodes extracted, quintile of deprivation (based on the relevant Index of Multiple Deprivation (national ranking of residential area measuring its relative deprivation across seven domains for England and eight domains for Wales), length of hospital stay, and time from diagnosis to surgery. The proportions of missing data which required multiple imputation are detailed in the previous section for patients undergoing major surgery. Vascular invasion and differentiation, were also included in the imputation model for 2-year mortality.

7. Definition of surgical urgency

NBOCA uses the pre-2004 National Confidential Enquiry into Patient Outcomes and Death (NCEPOD) classification of surgical urgency, despite there being an update to this.

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 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 comorbidity)
- the mode of admission coded in HES-APC/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 17.0.

Most results 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 21 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

Patients with tumours of the appendix and those whose recorded date of diagnosis was more than 6 months after their recorded date of surgery have also been excluded from these outcomes. Outlier status has only been reported for 2-year all-cause mortality rate after major resection, as this measure still only includes patients diagnosed prior to the COVID-19 pandemic.

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-APC/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.

Feedback received during NBOCA annual report outlier analysis highlighted differences in the coding of discharge method in PEDW compared to HES-APC. Patients with multiple episodes for the same admission in PEDW are often coded as "discharged" at the end of each episode, despite remaining in hospital, leading to subsequent episodes within the same admission being incorrectly captured by NBOCA as readmissions. NBOCA methodology was updated in 2022 to ensure that multiple episodes of the same admission in PEDW are not coded as multiple hospital admissions.

30-day unplanned return to theatre - derived from HES-APC/PEDW for patients undergoing major surgery. Defined as the presence of particular OPCS code listed in HES-APC/PEDW within 30 days of surgery (Table 3). The majority of listed OPCS codes are only valid on days 1-30 after surgery to avoid classifying procedures which were part of the original major surgery as an unplanned reoperation. Further details of validation performed using a combined NBOCA-NELA dataset were published in the 2019 methodology supplement.

Unclosed diverting ileostomy at 18 months after anterior resection - derived from HES-APC/PEDW for patients with rectal cancer undergoing an anterior resection between 01 April 2016 and 30 March 2021.

HES-APC/PEDW data were used to capture whether anterior resection patients received a stoma within 30 days of their procedure; patients whose stoma was coded as an ileostomy were eligible for inclusion (the denominator).

In these patients HES-APC/PEDW data were also used to capture whether any stoma was formed within 18 months of anterior resection and whether this was reversed. Patients without a procedure code for stoma reversal within 18-months of surgery were assumed to have a stoma at 18 months (numerator).

2-year all-cause mortality rate after major resection - the observed rate is the number of patients who died within 2 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 2 years but also how soon after surgery they died.

Table 3: OPCS codes considered to be an unplanned return to theatre

	OPCS code											
Codes valid on day 0	G731	S572	S571	S608	T301	G731						
	S068	S424	S573	T283	T302	S068						
					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	

Risk adjustment

A previously published 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, 30-day unplanned return to theatre, and 18-month unclosed diverting ileostomy rates (Table 4).

A Poisson model was fitted to estimate risk-adjusted two-year all-cause mortality after major surgery. Unlike the other outcomes, two-year all-cause mortality rate takes into account the length of time each patient was followed up for. The observed two-year all-cause 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 trusts/hospitals/MDTs with the same

proportion of patients dying within two years, the site in which patients die earlier will have a higher two-year all-cause 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 all-cause mortality 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).

Organisations 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. A list of these organisations is available here.

10. Funnel plots

Funnel plots are used to make comparisons between trust/hospital/MDTs on the following outcomes: 90-day mortality after major resection; 30-day emergency readmission after major resection; two-year all-cause mortality rate after major resection; two-year cancer-specific mortality rate after major resection; adjuvant chemotherapy for stage III colon cancer; severe acute toxicity; unplanned return to theatre; the proportion of rectal cancer patients undergoing a procedure leading to creation of a permanent stoma; and 18-month unclosed diverting ileostomy rate. The outcome for each trust/hospital/MDT is plotted against the total number of patients used to estimate the outcome. The ‘target’ is specified as the average outcome across all trust/hospital/MDTs.

The funnel limits depend on the target and the number of patients included in the estimate; 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.

When funnel plots are used for outlier reporting, 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.

If outlier reporting is being conducted, hospitals/trusts/MDTs with results outside the outer (99.8%) funnel limit are considered potential outliers as per the NBOCA Outlier Policy.

11. Additional measures

A full description of all performance indicators published by NBOCA can be found here. Detailed methods for some of these indicators are given below.

Adjuvant chemotherapy after major resection for stage III colon cancer

This measures the proportion of patients who received standard adjuvant chemotherapy, according to NICE guidelines, following major resection for pathological stage III colon cancer.

Patients undergoing major resection for pathological stage III colon cancer between 01 December 2018 and 31 August 2021 were included to give large enough numbers for trust/hospital/MDT level analyses.

Previously, adjuvant chemotherapy rates have only been reported for English NHS hospitals/trusts because Systemic Anti-Cancer Therapy (SACT) data is not available for Wales. Subsequent methodological work has shown that it is possible to assign adjuvant chemotherapy regimens within HES-APC using OPCS-4 codes. Specific combinations of chemotherapy procurement and delivery codes are identified within HES-APC using the National Tariff Chemotherapy Regimens List. This also means that it is now possible to identify adjuvant chemotherapy regimens within PEDW for Wales.

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 (OPCS-4 procedural code) recorded within the same 4 month period within HES-APC or PEDW. Regimens considered to be standard adjuvant therapy included: 5-fluorouracil alone, 5-fluorouracil and oxaliplatin (FOLFOX), capecitabine alone or capecitabine and oxaliplatin (CAPOX).

SACT data for 01 January 2019 to 31 Dec 2021 was used. These date ranges were used to take into account SACT data completeness (reduced in the last quartile of the audit period) and provide all patients with a minimum of 4 months to receive adjuvant chemotherapy following surgery.

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

Severe acute toxicity

This measures the proportion of patients who received adjuvant chemotherapy for stage III colorectal cancer that required an overnight hospital admission for severe acute toxicity. Severe acute toxicity was determined from International Classification of Diseases, 10th revision (ICD-10) diagnosis codes in HES-APC. This includes, for example, gastrointestinal toxicities such as diarrhoea and vomiting, and haematological toxicities such as anaemia and neutropenia. The methodology for developing and validating the coding framework for identifying severe acute toxicity is described in detail here.

Any planned or unplanned admissions requiring an overnight stay, from administration of the first cycle of chemotherapy up until 8 weeks after the last cycle of chemotherapy, were examined to identify International Classification of Diseases, 10th revision (ICD-10) diagnosis codes from the severe acute toxicity coding framework. Toxicities corresponded to at least Grade 3 according to the Common Terminology Criteria for Adverse Events (CTCAE) (CTCAE) dictionary.

For the small proportion of patients undergoing a surgical procedure during this timeframe, the date of this surgery was used as the cut-off for identifying toxicities to ensure that post-operative complications were not captured.

The methodology exploring the use of this coding framework as a performance indicator is described in detail here. This includes work to evaluate the validity, statistical power, fairness, and between-unit variation in using severe acute toxicity as a performance indicator. Risk-adjustment for this performance indicator includes age, sex, number of comorbidities, performance status, tumour site, and staging.

Patients were considered to have received adjuvant chemotherapy in the same way that was described in the previous section, with the denominator for the outcome being the number of patients recorded as receiving adjuvant chemotherapy.

This outcome is reported by the organisation coded as delivering chemotherapy rather than the diagnosing or surgical trust. In some areas of England and Wales, specific organisations are responsible for chemotherapy delivery for patients who underwent their initial treatments elsewhere.

Two-year cancer-specific mortality rate

Cancer-specific mortality rate 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 (Section 9). 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. The flexible parametric survival model uses regression splines to model the baseline cause-specific hazards. Knot locations for the splines were set at the 0^{th}, 50^{th} and 100^{th} centiles of the distribution of the uncensored log times.

The standard risk factors (Table 4) were used in the risk adjustment model. The effect of the following risk factors was allowed to vary with time: 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.

This measure is reported at cancer alliance/Wales level and hospital/trust/MDT level alongside two-year all-cause mortality for patients undergoing major resection. Observed and adjusted rates are reported, but only all-cause mortality will be outlier reported at present.

Proportion of rectal cancer resections with creation of a permanent stoma

This is calculated by dividing the number of rectal cancer patients undergoing an APER (including pelvic exenteration) and Hartmann's procedure by the total number recorded as undergoing a major resection.

Mismatch repair or microsatellite instability testing

This uses data submitted directly to NBOCA and is calculated by dividing the number of patients with a record of testing for either mismatch repair or microsatellite instability (MMR/MSI) by the total number of patients submitted by the organisation. If both variables were recorded as "Not assessed" then the patient was considered to have not been tested.

This analysis excludes patients with tumours of the appendix and those with discrepancies between the date of diagnosis and date of surgery i.e. date of surgery predates date of diagnosis by more than 6 months. The addition of MSI to the dataset in 2021-22 increased the number of patients with a record of testing by 774 for 2021-22 and 127 for previous years (97% of whom were diagnosed in 2020-21).